Socioeconomic and Environmental Determinants to Preterm Birth in Tibetan Women: An Analysis Based on the Hierarchically Conceptual Frame

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Abstract

Background: Preterm birth is a common cause of death in newborns and may result from many determinants, but evidence for the socioeconomic and environmental determinants of preterm birth in Tibetan women of childbearing age is limited. The aim of this study was to understand the current status of preterm birth in native Tibetan women and investigate the socioeconomic and environmental determinants.

Methods: Data were drawn from a cohort study which was conducted from August 2006 to August 2012 in rural Lhasa, Tibet, China. A total of 1419 Tibetan pregnant women were followed from 20 weeks' gestation until delivery; the loss to follow-up rate was 4.69%. The incidence of preterm birth was estimated to show the status of preterm births in Tibet. Logistic regression models for longitudinal data were established, and odds ratios (*OR*s) together with 95% confidence intervals (*CI*s) were used to evaluate the association between the occurrence of preterm birth and 16 selected potential determinants based on the hierarchical conceptual frame.

Results: The incidence of preterm birth was 4.58% (95% *CI* = 3.55–5.80%). After adjusting for health-related variables of the mothers and newborns, socioeconomic and environmental determinants associated with preterm birth included season (spring: *OR* = 0.28, 95% *CI* = 0.09–0.84; autumn: *OR* = 0.21, 95% *CI* = 0.06–0.69; and winter: *OR* = 0.31, 95% *CI* = 0.12–0.82) and calendar year of delivery (2010: *OR* = 5.03, 95% *CI* = 1.24–20.35; 2009: *OR* = 6.62, 95% *CI* = 1.75–25.10; and 2007–2008: *OR* = 5.93, 95% *CI* = 1.47–23.90).

Conclusions: The incidence of preterm birth among native Tibetan women was low and there was a decreasing trend in recent years; however, it is still essential to strengthen seasonal maternal care, extend the spacing between pregnancies, and reinforce adequate maternal nutrition.

Key words: Determinants; Preterm Birth; Tibet

INTRODUCTION

Preterm births occur at <37 completed weeks' gestation and are one of the main adverse pregnancy outcomes.[1] Preterm births account for approximately 75% of perinatal mortality and have long-term adverse consequences for health, such as cerebral palsy, learning disabilities, and sensory deficits, which in turn impose a huge public health burden.[2,3] Preterm birth might result from many determinants, including biological factors (premature rupture of membranes and intrauterine infection) and other socioeconomic and environmental determinants (maternal occupation, maternal education, cultural level, and prenatal visits).[4,5] These socioeconomic and environmental determinants may be more important than biological factors for the sake of control and prevention. There is thin air and low oxygen content in the Tibet region. The culture of the Tibetan region is

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unique, and the social environment has changed rapidly in recent years. In this environment, the pregnant uterine arteries and fetal umbilical arterial blood flow mechanics influence the placenta and fetal blood supply.[6] Preterm birth is associated with abnormal uteroplacental circulation; thus, preterm birth might be more problematic in the Tibet region.[7] Moreover, preterm newborns may have lower IQ scores than term newborns.[8] Therefore, it is necessary to study the determinants of preterm births among native Tibetan women of childbearing age to prevent the occurrence of preterm births, especially important socioeconomic and environmental determinants; however, there are very limited epidemiologic data on preterm births among Tibetan women living on the Qinghai-Tibet plateau in recent years. In the current study, we assessed the incidence of preterm births among Tibetan women and examined the socioeconomic and environmental determinants by means of the data from a cohort study in the rural Tibet region of China.

METHODS

Ethical approval

Informed consent was signed by each participant at the beginning of the follow-up. The study was approved by the Ethics Committee in Medical Research of Xi'an Jiaotong University (No. 20070712) on 12 July, 2007. The study conformed to the ethics guidelines of the *Helsinki Declaration*.

Study setting and data source

The Tibet region is located on the Qinghai-Tibet plateau and has an average altitude of 4000 m.[9] The gross domestic product of Tibet increased from 29.07 billion Ren Min Bin (RMB) in 2006 to 70.10 billion RMB in 2012. The total population increased from 2.85 million in 2006 to 3.08 million in 2012 and >95% of the population is ethnic Tibetan. The data in this study were derived from a cohort study on health care during pregnancy, which was conducted in rural Lhasa of Tibet from 2006 to 2012. Lhasa area is located in the middle of Tibet and has an average altitude of 3658 m. Lhasa area is one of the living centers for Tibetan people and is an area representative of Tibetan culture and customs. Two counties of Lhasa (Chushur and Taktse) and four rural communes of Lhasa city were selected as the study site, across which the altitude varies from 3500 to 5000 m.

A total of 1558 pregnant women from the study sites were followed and 1433 pregnant women were followed from 20 weeks' gestation until delivery; the loss to follow-up rate was 4.69%. In the current study, 1419 pregnant women with singleton gestations were included [Figure 1]. According to a preterm birth rate of 5%, an error of 1.80%, $\alpha = 0.05$, $1 - \beta = 90\%$, and expected 20% nonresponse rate, we estimated the sample size for this study at 677. Thus, the number of the women from the cohort met the requirement of preterm birth analysis.

Participants and follow-up during pregnancy

All participants were Tibetan pregnant women 15–49 years of age who were Tibetan natives living in rural areas of the
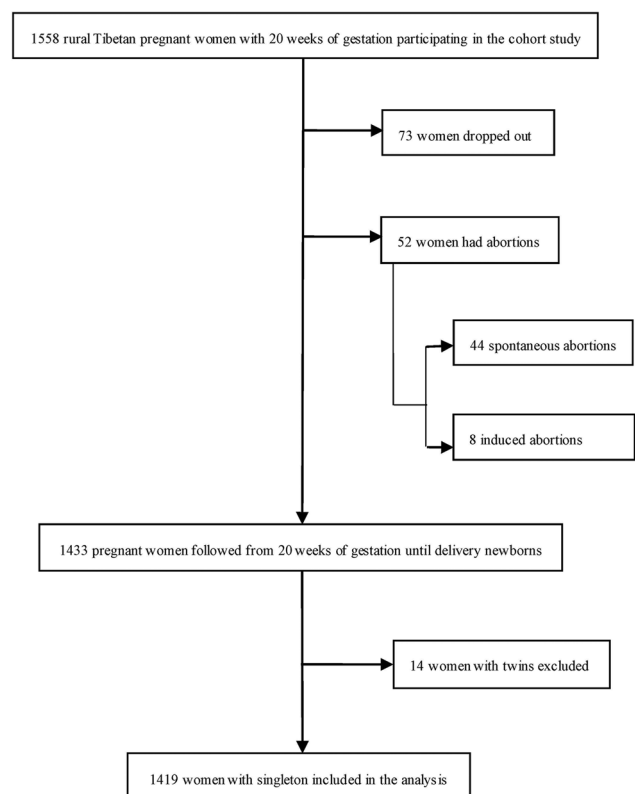
Figure 1: The flowchart of the participants involved in the preterm birth study.

study site. The participants were interviewed three times during the follow-up period. The first interview occurred at 20 weeks' gestation, at the time the women enrolled in the study. Gestational age was calculated based on the last menstrual period. The second interview took place at 28 weeks' gestation, and the final interview was at 32 weeks' gestation. Information on prenatal care was collected at each interview and included maternal weight, upper arm circumference, hemoglobin level, blood pressure, heart rate, the presence of edema, fundal height, and abdominal girth. Socioeconomic and environmental information was collected during the first interview. All participants were interviewed and followed by a trained maternal and child health (MCH) care staff. Gynecologists and obstetricians collected outcome data from births occurring in city and county hospitals, while birth outcome data from births occurring in homes were collected by MCH staff of the county hospitals.

Definitions of preterm birth

Adverse pregnancy outcomes included preterm births, miscarriages, and stillbirths.[10] Preterm birth was defined as births occurring at <37 completed weeks' gestation. The incidence of preterm births was calculated by dividing the number of preterm births by the total number of deliveries.[11,12] In the current study, preterm birth was classified as moderate preterm (32–37 completed weeks' gestation) and very preterm (28–32 completed weeks' gestation).[1]

Hierarchically conceptual frame of determinants

Based on the literature and the characteristics of the Tibetan participants,[13-15] we selected 16 variables for exploratory analysis regarding the association with preterm birth. According to the hierarchically conceptual frame,[16] we built different levels of determinants considering the complex dynamic of preterm birth and the potential interaction between different levels. As shown in Figure 2, variables in the theoretical framework were classified into distal, intermediate, and proximate determinants and referred to Levels I, II, and III, respectively. At the distal level (Level I), the following socioeconomic and environmental variables were included: season and year of delivery. Variables, such as the age of the husband, maternal education, place of residency, prenatal visits, family size, and family livelihood, were placed in the intermediate level (Level II). The proximate determinants level (Level III) reflected the health-related variables of the mothers and newborns and included age of menarche, maternal age, body mass index (BMI) of the mothers, anemia during early pregnancy, parity, number of preterm births, gender, and weights of the newborns.

Using the method of the division of four seasons at an altitude of 4000 m,[17] we grouped April, May, and June as spring, July as summer, August and September as autumn, and October, November, December, January, February, and March as winter. The classification of anemia was based on the adjusted hemoglobin level, which was associated with altitude.[18] We differentiated mothers in whom the hemoglobin level was <127 g/L for the first time as anemica.

Quality control

To ensure that the results of the survey were accurate and reliable, we invited experts from the Maternal and Child Health Care Hospital in Lhasa to train MCH staff, who were responsible for providing follow-up to the participants, and instructed them on the working procedures. A standardized Tibetan-Chinese bilingual questionnaire was used to collect the information on sociodemographics, prenatal visit data during the entire pregnancy, and pregnant outcome data. We unified inquiry and measurement methods before the formal investigation. Regular assessments and examinations were performed during the entire follow-up period.

Statistical analysis

A database was established using Epi Data 3.1 software (The EpiData Association, Odense, Denmark), and duplication was adopted for data entry. Continuous variables were summarized as the mean with standard deviation or median (Q_1, Q_3), and categorical variables were reported as
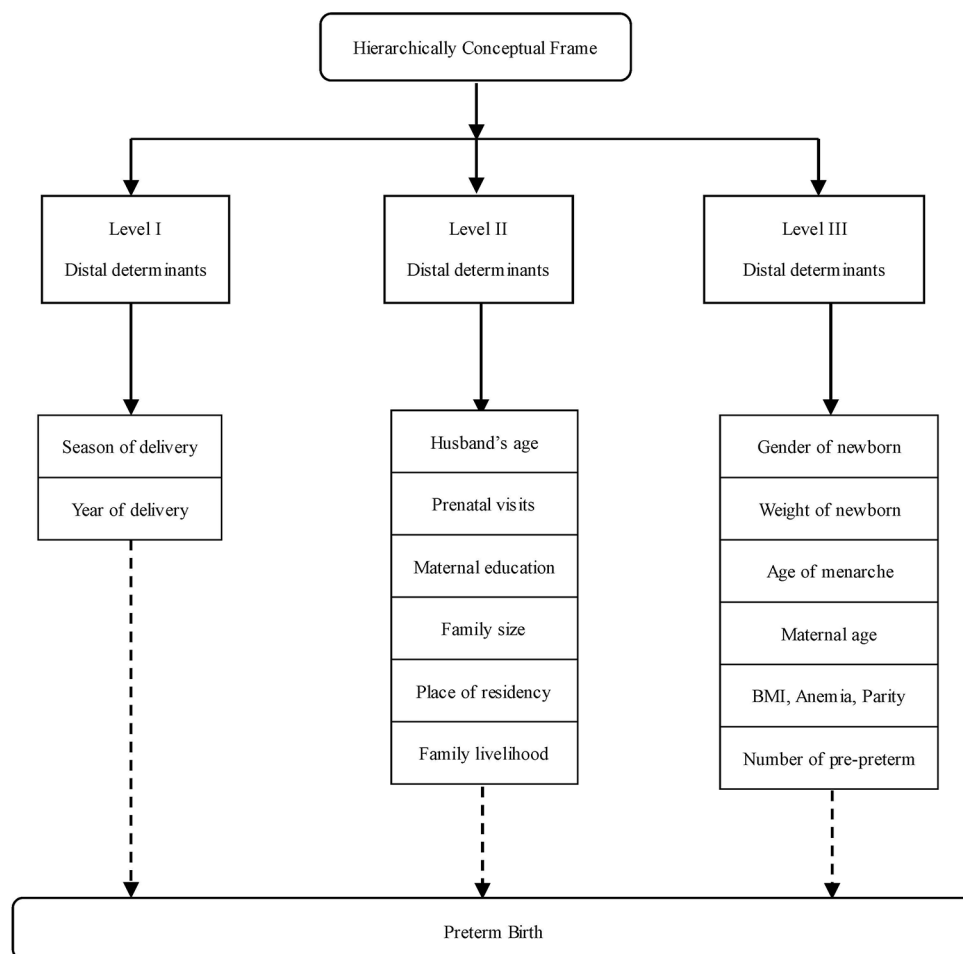
Figure 2: Socioeconomic and environmental determinants of the preterm birth among Tibetan women: A hierarchically conceptual framework.

percentages. Differences in variables between preterm and term births were compared using Chi-square tests and t-tests, and the incidence of preterm births was also compared by Chi-square tests for selected determinants. Figures were created with Excel 2012. Logistic regression models for longitudinal data were established, and odds ratios (ORs) with 95% confidence intervals (CIs) were used to evaluate the association between the occurrence of preterm births and 16 selected factors. All analyses were performed using STATA statistical software (version 12.0; StataCorp LP, College Station, TX, USA). A two-tailed $P < 0.05$ was considered statistically significant.

RESULTS

Characteristics of the participants

The mean gestational age at delivery of Tibetan women was 39.31 ± 1.86 weeks. Among the deliveries, the proportion of term births was 95.42%. Based on the percentage distribution of characteristics in relation to the distal, intermediate, and proximate variables of the participants by pregnancy status [Table 1], women with a preterm birth were significantly different from women with term births regarding season and year of delivery ($P < 0.05$). Furthermore, it appeared that women with preterm births more often had more than one pre-preterm birth ($\chi^2 = 7.12$, $P = 0.008$). Newborn weight and length of preterm birth were significantly different from term births ($P < 0.001$); however, there were no significant differences between women with a preterm birth and women with a term birth as a function of husband age, prenatal visits, maternal education, family size, family livelihood, place of residency, maternal age, age of menarche, BMI, anemia, parity, and gender of the newborn.

Incidence of preterm births

The incidence of preterm births was 4.58% (95% $CI = 3.55$–5.80%) among Tibetan women. Figure 3 shows that the highest rate of preterm births (9.42%) occurred in the summer, followed by the winter, spring, and autumn ($\chi^2 = 8.59$, $P = 0.035$). The incidence of preterm births decreased significantly from 6.25% in 2007–2008 to 1.25% in 2011 ($\chi^2 = 11.05$, $P = 0.011$). The women who were involved in farming had a similar rate of preterm birth compared with women in animal husbandry (4.89% vs. 3.00%, $\chi^2 = 1.59$, $P = 0.208$). The Tibetan rural women had a higher incidence of preterm births than urban women, but there was no statistical significance (5.00% vs. 3.42%, $\chi^2 = 1.60$, $P = 0.206$). In addition, 90.77% of preterm births were at 32–37 weeks' gestation and only 9.23% of preterm births (2 males and 4 females) occurred at 28–32 weeks' gestation. The weight of the preterm newborns was 2300 g on average (2000 g, 2690 g) and the median length was 45 cm (40 cm, 48 cm).

Determinants of preterm birth

As shown in Table 2, the univariate analysis for distal determinants showed a direct association for year of delivery (2010: $OR = 4.12$, 95% $CI = 1.39$–12.24; 2009: $OR = 4.67$, 95% $CI = 1.60$–13.59; and 2007–2008: $OR = 5.25$, 95% $CI = 1.76$–15.70) and an inverse association for season of delivery (spring: $OR = 0.37$, 95% $CI = 0.16$–0.82; autumn: $OR = 0.36$, 95% $CI = 0.15$, 0.87; and winter: $OR = 0.44$, 95% $CI = 0.22$–0.87). In addition, the intralevel multivariate analysis for distal determinants showed the same direction and reduced the strength of OR for the season of delivery (spring: $OR = 0.37$, 95% $CI = 0.16$–0.84; autumn: $OR = 0.34$, 95% $CI = 0.14$–0.84; and winter: $OR = 0.41$, 95% $CI = 0.21$–0.81), while increasing the strength for the year of delivery (2010: $OR = 4.22$, 95% $CI = 1.41$–12.60; 2009: $OR = 4.80$, 95% $CI = 1.64$–14.05; and 2007–2008: $OR = 5.38$, 95% $CI = 1.79$–16.16).
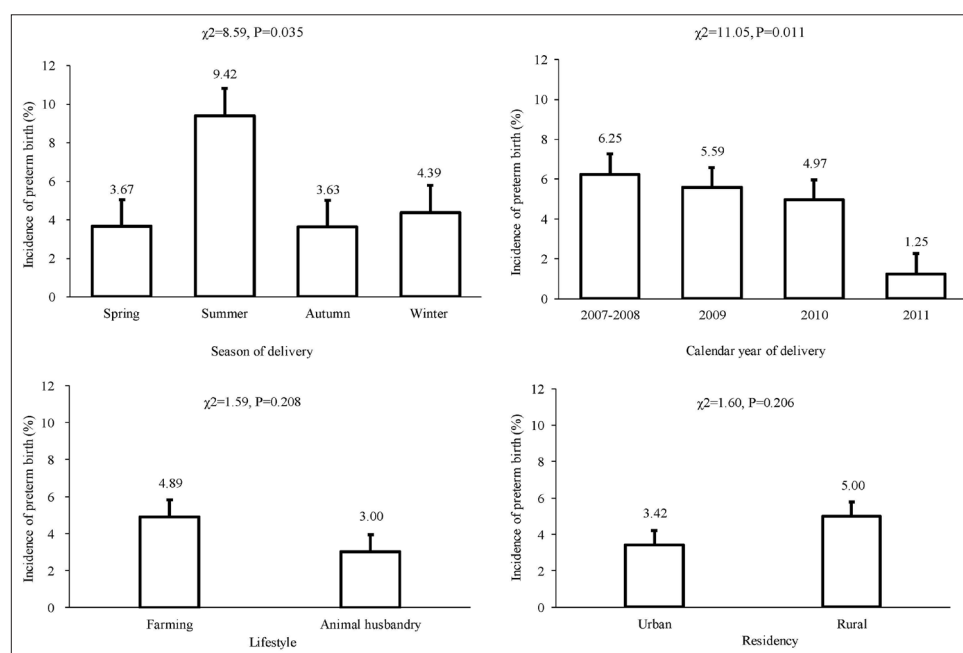

Figure 3: The incidence of preterm birth by season, calendar year, lifestyle, and residency ($n = 1419$).

Table 1: The characteristics of participants in rural Tibet, China ($n = 1419$)

Variables	Total	Preterm birth	Term birth	Statistical values	P
Gestational age (year)*	39.31 ± 1.86	34.66 ± 2.17	39.53 ± 1.53	24.59[†]	<0.001
Distal variables					
Season of delivery, n (%)					
Summer	138 (9.73)	13 (20.00)	125 (9.23)	8.59[‡]	0.035
Spring	327 (23.04)	12 (18.46)	315 (23.26)		
Autumn	248 (17.48)	9 (13.85)	239 (17.65)		
Winter	706 (49.75)	31 (47.69)	675 (49.85)		
Year of delivery, n (%)					
2011	319 (22.50)	4 (6.15)	315 (23.28)	11.05[‡]	0.011
2010	382 (26.94)	19 (29.23)	363 (26.83)		
2009	429 (30.25)	24 (36.92)	405 (29.93)		
2007–2008	288 (20.31)	18 (27.69)	270 (19.96)		
Intermediate variables					
Husband's age (years)*	27.70 ± 4.97	27.43 ± 4.87	27.71 ± 4.97	0.45[†]	0.655
Prenatal visits*	7.01 ± 2.49	7.31 ± 2.61	6.99 ± 2.48	−0.89[†]	0.372
Maternal education (years)*	5.06 ± 3.70	5.28 ± 3.26	5.05 ± 3.72	−0.48[†]	0.630
0 year, n (%)	340 (23.96)	12 (18.46)	328 (24.22)	1.79[‡]	0.409
1–5 years, n (%)	257 (18.11)	15 (23.08)	242 (17.87)		
≥6 years, n (%)	822 (57.93)	38 (58.46)	784 (57.90)		
Family size (person)*	4.91 ± 1.77	5.18 ± 1.85	4.90 ± 1.76	−1.28[†]	0.200
≤3, n (%)	321 (22.62)	14 (21.54)	307 (22.67)	1.66[‡]	0.435
4–5, n (%)	632 (44.54)	25 (38.46)	607 (44.83)		
≥6, n (%)	466 (32.84)	26 (40.00)	440 (32.50)		
Family livelihood, n (%)					
Farming	1186 (83.58)	58 (89.23)	1128 (83.31)	1.59[‡]	0.208
Animal husbandry	233 (16.42)	7 (10.77)	226 (16.69)		
Place of residency, n (%)					
Urban	380 (26.78)	13 (20.00)	367 (27.10)	1.60[‡]	0.206
Rural	1039 (73.22)	52 (80.00)	987 (72.90)		
Proximate variables					
Maternal age (years)*	25.39 ± 4.63	24.85 ± 4.50	25.42 ± 4.63	0.96[†]	0.336
Age of menarche (years)*	15.33 ± 1.52	15.66 ± 1.55	15.31 ± 1.52	−1.80[†]	0.072
BMI of the women at early pregnancy (kg/m²)*	20.94 ± 2.46	20.83 ± 2.16	20.94 ± 2.47	0.35[†]	0.723
Anemia during early pregnancy, n (%)					
No	833 (58.79)	36 (55.38)	797 (58.95)	0.33[‡]	0.568
Yes	584 (41.21)	29 (44.62)	555 (41.05)		
Parity, n (%)					
0	788 (55.53)	41 (63.08)	747 (55.17)	1.57[‡]	0.210
≥1	631 (44.47)	24 (36.92)	607 (44.83)		
Number of pre-preterm birth, n (%)					
0	1342 (94.84)	57 (87.69)	1285 (95.19)	7.12[‡]	0.008
≥1	73 (5.16)	8 (12.31)	65 (4.81)		
Gender of newborn, n (%)					
Male	690 (48.87)	29 (44.62)	661 (49.07)	0.49[‡]	0.483
Female	722 (51.13)	36 (55.38)	686 (50.93)		
Weight of newborn (g)*	3011.55 ± 557.3	2290.31 ± 718.54	3046.18 ± 524.30	11.14[†]	<0.001
Normal birth weight, n (%)	1255 (88.44)	22 (33.85)	1233 (91.06)	198.65[‡]	<0.001
Low birth weight, n (%)	164 (11.56)	43 (66.15)	121 (8.94)		
Length of newborn (cm)*	46.45 ± 9.33	41.49 ± 11.80	46.69 ± 9.13	4.42[†]	<0.001

*Data were presented by mean ± SD. [†]t value; [‡]χ^2 value. BMI: Body mass index; SD: Standard deviation.

For the intermediate variables, there were no significant determinants associated with preterm birth based on univariate and intralevel multivariate analyses. Among the proximal variables, the number of pre-preterm births ($OR = 2.77$, 95% $CI = 1.27$–6.06) and the weight of the newborn ($OR = 19.92$, 95% $CI = 11.53$–34.41) were significant and directly associated with preterm birth based on univariate analysis. The intralevel multivariate analysis showed the same direction and increased the strength of OR (number of pre-preterm births: $OR = 23.56$, 95% $CI = 2.96$–187.67; weight of newborn: $OR = 395.10$, 95% $CI = 46.90$–3328.22).

Table 2: Univariate and multivariate intralevel analysis of determining preterm birth factors among Tibetan women

Variables	Univariate analysis		Multivariate analysis (by level)	
	OR (95% CI)	P	OR (95% CI)	P
Level I (distal determinants)				
Season of delivery				
Summer	1.00		1.00	
Spring	0.37 (0.16–0.82)	0.015	0.37 (0.16–0.84)	0.017
Autumn	0.36 (0.15–0.87)	0.023	0.34 (0.14–0.84)	0.019
Winter	0.44 (0.22–0.87)	0.018	0.41 (0.21–0.81)	0.010
Year of delivery				
2011	1.00		1.00	
2010	4.12 (1.39–12.24)	0.011	4.22 (1.41–12.60)	0.010
2009	4.67 (1.60–13.59)	0.005	4.80 (1.64–14.05)	0.004
2007–2008	5.25 (1.76–15.70)	0.003	5.38 (1.79–16.16)	0.003
Level II (intermediate determinants)				
Husband's age (years)	0.99 (0.94–1.04)	0.654	0.99 (0.93–1.05)	0.638
Prenatal visits	1.05 (0.94–1.17)	0.372	1.06 (0.94–1.19)	0.316
Maternal education				
0 year	1.00		1.00	
1–5 years	1.69 (0.78–3.68)	0.184	2.36 (0.95–5.83)	0.064
≥6 years	1.32 (0.68–2.57)	0.405	1.58 (0.70–3.54)	0.270
Family size (person)				
≤3	1.00		1.00	
4–5	0.90 (0.46–1.76)	0.765	0.72 (0.33–1.54)	0.393
≥6	1.30 (0.67–2.52)	0.446	1.14 (0.54–2.42)	0.729
Family livelihood				
Farming	1.00		1.00	
Animal husbandry	0.60 (0.27–1.34)	0.213	0.52 (0.20–1.36)	0.185
Place of residency				
Urban	1.00		1.00	
Rural	1.49 (0.80–2.76)	0.209	1.16 (0.59–2.30)	0.669
Level III (proximate determinants)				
Maternal age (years)	0.97 (0.92–1.03)	0.336	0.98 (0.87–1.10)	0.710
Age of menarche (years)	1.16 (0.99–1.36)	0.072	1.29 (0.91–1.84)	0.152
BMI of the women at early pregnancy (kg/m^2)	0.98 (0.89–1.09)	0.723	1.05 (0.84–1.31)	0.672
Anemia during early pregnancy				
No	1.00		1.00	
Yes	1.16 (0.70–1.91)	0.569	1.70 (0.59–4.95)	0.328
Parity				
0	1.00		1.00	
≥1	0.72 (0.43–1.21)	0.212	0.45 (0.13–1.62)	0.223
Number of pre-preterm birth				
0	1.00		1.00	
≥1	2.77 (1.27–6.06)	0.010	23.56 (2.96–187.67)	0.003
Gender of newborn				
Male	1.00		1.00	
Female	1.20 (0.73–1.97)	0.483	1.48 (0.52–4.22)	0.468
Weight of newborn				
Normal birth weight	1.00		1.00	
Low birth weight	19.92 (11.53–34.41)	<0.001	395.10 (46.90–3328.22)	<0.001

OR: Odds ratio; CI: Confidence interval; BMI: Body mass index.

To address the hierarchical approach and access the independent contribution of distal determinants, Models A and B were performed [Table 3]. Because we postulated that socioeconomic and environmental level (level I) has an effect on preterm birth not mediated by level II, we added the intermediate variables to the distal variables. Table 3 shows the influence of season of delivery decreased slightly (spring: OR = 0.30, 95% CI = 0.12–0.80; autumn: OR = 0.29, 95% CI = 0.10–0.83; and winter: OR = 0.37, 95% CI = 0.17–0.82) and year of delivery was attenuated in 2010 (OR = 3.91, 95% CI = 1.09–14.06) and increased in 2009 (OR = 5.71,

Table 3: Hierarchical analysis of distal determining preterm birth factors among Tibetan women

Variables	Model A			Model B		
	OR	95% CI	P	OR	95% CI	P
Season of delivery						
Summer	1.00			1.00		
Spring	0.30	0.12–0.80	0.016	0.28	0.09–0.84	0.028
Autumn	0.29	0.10–0.83	0.021	0.21	0.06–0.69	0.011
Winter	0.37	0.17–0.82	0.015	0.31	0.12–0.82	0.020
Year of delivery						
2011	1.00			1.00		
2010	3.91	1.09–14.06	0.037	5.03	1.24–20.35	0.024
2009	5.71	1.66–19.63	0.006	6.62	1.75–25.10	0.005
2007–2008	5.47	1.52–19.71	0.009	5.93	1.47–23.90	0.012

Model A included the distal variables and intermediate variables; Model B included the proximate variables plus variables in Model A. *OR*: Odds ratio; *CI*: Confidence interval.

95% $CI = 1.66–19.63$) and 2007–2008 ($OR = 5.47$, 95% $CI = 1.52–19.71$).

In the end, Model B was performed for preterm births, which added proximate variables (level III) to Model A. After adjusting for health-related variables of the mothers and newborns, the association between season of delivery (spring: $OR = 0.28$, 95% $CI = 0.09–0.84$; autumn: $OR = 0.21$, 95% $CI = 0.06–0.69$; and winter: $OR = 0.31$, 95% $CI = 0.12–0.82$) was attenuated significantly, while the strength of the risk for preterm birth for the year of delivery (2010: $OR = 5.03$, 95% $CI = 1.24–20.35$; 2009: $OR = 6.62$, 95% $CI = 1.75–25.10$; and 2007–2008: $OR = 5.93$, 95% $CI = 1.47–23.90$) was increased. Thus, socioeconomic and environmental level (level I) may have an effect on preterm births not mediated by intermediate and proximate variables.

DISCUSSION

All participants in the study were Tibetan women who lived in the Tibet region of China, which has a higher altitude and unique cultural and social environments. The current study investigated the status of preterm births among Tibetan women and showed a lower incidence of preterm births (approximately 4.58%), which was lower than reported in China (6–10%),[19,20] Brazil (12%),[21] and other countries (5–15%).[22] Based on the view of environmental adaptation and evolutionary adaption, several human populations, including the Tibetans, have survived for millennia at high altitudes and have adapted well to hypoxic conditions.[23] In addition, Tibetan women have an inferred autosomal dominant major gene for high oxygen saturation that may be associated with higher offspring survival.[24] Therefore, it is a likely possibility that the occurrence of preterm births may not be influenced much by the special natural and humane environments in the Tibet region.

In fact, much has been learned about the risks associated with preterm births at the individual level. Few studies have explored the structural causes responsible for the overall effect to the incidence of preterm births at the population level. In the current study, we adopted a hierarchically conceptual frame to investigate the socioeconomic and environmental determinants to preterm births in Tibetan women from three levels to explore the overall effect of the role of some relevant socioeconomic and environmental determinants explaining the variation in incidence of preterm births from a large sample of Tibetan women. Our findings suggest that the season and the year of delivery constitute main determinants of the incidence of preterm births among Tibetan women. A study[25] in Korea indicated an association between seasonal pattern and preterm birth. For Tibetan women, the high risk for preterm birth in the summer was more remarkable after adjusting for the intermediate and proximate determinants, which was consistent with the study conducted in Greece.[26] In Tibet, the summer refers to 1 month only (July); the stimulation of temperature to the intrauterine environment and more exercise may be some reasons for the high rate of preterm births. As a result, we suggest that seasonal maternal care measures should be strengthened in Tibetan women of childbearing age. Moreover, our results showed that the risk for preterm birth had a decreasing trend in recent years, and the trend persisted after adjusting for the intermediate and proximate determinants. This time trend was consistent with the Magro Malosso *et al*.'s study.[27] The improvement in the reproductive healthcare of Tibetan women and their nutritional status with local economic development might account for the observed trend.

In the current study, intermediate determinants were not shown to have a significant association with preterm birth, while the effect of socioeconomic and environmental determinants was partially produced by health-related variables (proximate variables). An important finding was that the risk for preterm birth among Tibetan women was related to the number of previous preterm births, which was in agreement with a report in which women with a previous preterm birth had a three to seven times higher risk for recurrent preterm birth at the next delivery.[28] One potential explanation may be that the uterus takes time to return to a normal state, including resolution of the

inflammatory status associated with the previous pregnancy, so it is essential to extend the spacing of pregnancy.[29] We also found that the low birth weight newborns had a higher risk for preterm birth. Low birth weight was an important indicator to assess poor nutrition during pregnancy.[30] Poor nutrition in pregnant women can be described by body size and preterm birth can be caused by maternal thinness due to decreased blood volume and a reduction in uterine blood flow.[31] Therefore, it is essential to improve the nutritional interventions to pregnant women to prevent low birth weight and preterm birth.

The current study used population-based data from a cohort study with a larger sample size and can reflect the targeted population of interest; however, there were some potential limitations, which might confound the results. First, data on the nonrespondents were not available due to poor traffic in rural areas of Tibet. Second, we had investigated some potential determinants, but there might be other factors not included in our study, especially some psychosocial factors, such as social support and stresses which arise from negative life events that the woman experienced since she became pregnant or the negative impact of pregnancy-related anxiety during pregnancy which could not be collected due to the study design.

Conflicts of interest
There are no conflicts of interest.

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