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Prenatal care and preterm birth in the Western Brazilian Amazon: A population-based study

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ABSTRACT

Brazil is among the top ten countries in preterm delivery worldwide. This study assesses the factors associated with preterm birth in the Western Brazilian Amazon. A population-based cross-sectional study was held between July 2015 to June 2016 in Cruzeiro do Sul, Brazilian Amazon. A total of 1525 births were included in this analysis. Preterm birth was defined as births at gestational age < 37 weeks. A stepwise multiple logistic regression was used to identify factors associated with preterm delivery. The prevalence rate of preterm birth was 7.9% ($n = 120$; 95% CI: 6.5–9.3). After adjusting for confounding factors, a positive association with preterm birth was observed for pregnant women who completed less than six antenatal care visits (OR: 2.93; 95% CI: 1.89–4.56), who had a birth interval of < 18 months (OR: 2.65; 95% CI: 1.04–6.75), and who experienced bleeding (OR: 2.17; 95% CI: 1.39–3.38) and hypertension during pregnancy (OR: 1.74; 95% CI: 1.07–2.82). Factors associated with preterm birth in the Western Brazilian Amazon were mostly related to the aspects of health care provided to women, and thus could be prevented. Proper, timely, and regular antenatal care visits can help reduce adverse outcomes, such as hypertension and bleeding.

Abbreviations: ANC: antenatal care; MINA-Brazil: Maternal and child health and nutrition in Acre, Brazil; GA: Gestational age; LMP: last menstrual period; SIVEP: Surveillance and Information System; OR: odds ratio; IC: confidence interval; SINASC: Information System on Live Births

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Introduction

Annually, more than 1 in 10 births worldwide, about 15 million, are preterm (<37 weeks of gestation), and prematurity is the major cause of newborn death (more than one million deaths every year) (Chawanpaiboon et al., 2019). Also, preterm birth complications are the leading cause of deaths in children under 5 (1.055 million deaths in 2015) (Liu et al., 2016), and has long-term impacts on child development (Carter & Msall, 2017). The ten countries with the highest

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number of preterm deliveries include India, China, Nigeria, Bangladesh, Indonesia, Pakistan, United States, Ethiopia and Brazil (the latter was estimated to have 339 239 preterm births in 2010, a rate of 11.2%) (Chawanpaiboon et al., 2019). Figures based on official statistics for Brazil are likely to be underestimated due to inaccurate reporting of gestational age and to data quality (Miranda et al., 2012). A national study among women aged 15–24 attending public maternities in 2009 showed a preterm birth rate of 21.7%, ranging from 6.9% in the South region to 36.1% in the North (Miranda et al., 2012). Also, a systematic review showed that the preterm birth rate in Latin America increased, on average, 0.5% annually from 1990 to 2010 (Blencowe et al., 2012).

Although there are gaps in the understanding of drivers of preterm birth (Miranda et al., 2012), potential determinants include low socioeconomic status, low maternal weight at the beginning of pregnancy, illiteracy, age at pregnancy, twin pregnancy, infections (e.g. malaria, HIV), nutritional deficiencies, poor antenatal care (ANC), hypertension, maternal lifestyle (e.g. smoking, illicit drug use, and excessive physical activity), emotional stress, violence, trauma, varied pregnancy-related issues (e.g. cervical incompetence, multiple pregnancies, short birth intervals, abortion, premature rupture of membrane, and previous preterm labour), other medical conditions (e.g. diabetes mellitus, and urinary and genital tract infections), and unnecessary cesarean delivery (Blencowe et al., 2013, 2012; Chang et al., 2013; El-Kady et al., 2004; Krymko et al., 2004; Savitz et al., 2004). Thus, common interventions to reduce preterm birth often include lifestyle change, delivery care, screening and treatment of infections, and nutritional supplementation (Chang et al., 2013). Although Brazil has intensified actions to improve pregnant women's health, and has a comprehensive protocol for antenatal care (at least six ANC visits providing clinical examinations, laboratory tests, educational activities, counselling, nutritional evaluation supplementation with iron and folate, and immunisation) (Brasil, 2005, 2012), the unequal coverage and quality of services provided at the primary care level across the country present challenges (Brasil, 2005, 2012).

In this study, we assessed potential factors associated with preterm birth in Cruzeiro do Sul, a municipality in the Western Brazilian Amazon, located in a low resource setting and an area of high malaria transmission (The Juruá River Valley) (Pincelli et al., 2018), with the largest foci of *Plasmodium Falciparum* malaria transmission in the country (Ferreira & Castro, 2016). This area was chosen by our study group to launch the first birth cohort study from the prenatal period in the Brazilian Amazon. Therefore, we leverage a rich, population-based study, to shed light on correlates of prematurity in an Amazonian context.

Materials and methods

Study area and data

Cruzeiro do Sul is the second largest city in Acre State, distancing 636 Km from the state's capital, and bordering Amazonas State and Peru. It has more than 80,000 inhabitants, 50% women, and 70.5% living in the urban area (IBGE, 2014, 2017). The 2010 Municipal-level Human Development Index for Cruzeiro do Sul was 0.663 (medium) (IBGE, 2010), and only 12.7% of the households had access to good sanitation facilities in 2010 (IBGE, 2010). The vast majority of births (more than 95%) is delivered at the only Maternity Hospital in the city.

A prospective population-based birth cohort study from the prenatal period named Maternal and Child Health and Nutrition in Acre, Brazil (MINA-Brazil) (Cardoso et al., 2020) was launched in Cruzeiro do Sul in July 2015, aiming to assess early-life exposures related to child health and development. This study is a cross-sectional study that uses the information on single births recorded from July 1st 2015 to June 30th 2016. Participants were recruited at the only maternity ward in the municipality; hospitalisations were monitored daily, and all women who checked in for a delivery and whose residence was in Cruzeiro do Sul were considered eligible to be included in the study. The research team visited the mother within 24 h after birth, when the study protocol was explained, and the women were invited to participate. Upon acceptance, data on antenatal characteristics, socioeconomic and environmental factors, and obstetric and health history were collected through a structured interview; additional information was gathered from hospital charts. To avoid bias, only singleton deliveries were included in this analysis.

A total of 1865 pregnant women admitted to maternity ward of the Women and Children's Hospital of Jurua Valley for delivery during the period of study; there were 128 exclusions due to stillbirth ($n = 16$), or abortions ($n = 112$). Of the remaining 1737 parturients, 199 refused to participate (Figure 1). Thirteen additional exclusions were due to twin pregnancies. Thus, 1525 mother-infant pairs were eligible to enrol in the study. For this study we included single pregnancy and live fetuses.

Births were categorised as preterm if the gestational age was smaller than 37 weeks (Chawanpaiboon et al., 2019). From the hospital records, data were gathered on the gestational age (GA) at delivery (Cardoso et al., 2020; Lourenço et al., 2020). The best estimate of gestational age was obtained from ultrasonography, available for approximately one-third of study participants, or the reported date of the last menstrual period (LMP), for those without an ultrasound scan or with poor ultrasound images, as described elsewhere (Lourenço et al., 2020; Pincelli et al., 2018).

Drawing on the available evidence of possible preterm delivery correlates, and considering the social and environmental context in Cruzeiro do Sul, three groups of variables were included in the analysis: (i) sociodemographic characteristics: maternal age (≤ 19, 20–34, and ≥ 35 years), maternal education (Illiterate, ≤ 9, 10–11, and ≥ 12 years of former schooling), head of the family (partner, pregnant woman, or other), living with a partner (yes or no), maternal occupation (paid job or unpaid), beneficiary of *Bolsa Família*, the conditional cash transfer programme in Brazil (no or yes), and quintiles of a wealth index based on asset ownership (used as a proxy for household income); (ii) environmental characteristics: location of the household (urban or rural), type of household construction (masonry, wood, or mixed), number of people living in the household (≤ 2, 3, 4 or ≥ 5), and number of rooms in the household (≤ 3, 4, or ≥ 5); and (iii) clinical and obstetric history: planned pregnancy (no or yes), birth interval (first pregnancy, < 18 months and ≥ 18 months), number of ANC visits (< 6 or ≥ 6), malaria during pregnancy – based on reported cases from the malaria surveillance system (no or yes), gestational urinary tract infection –

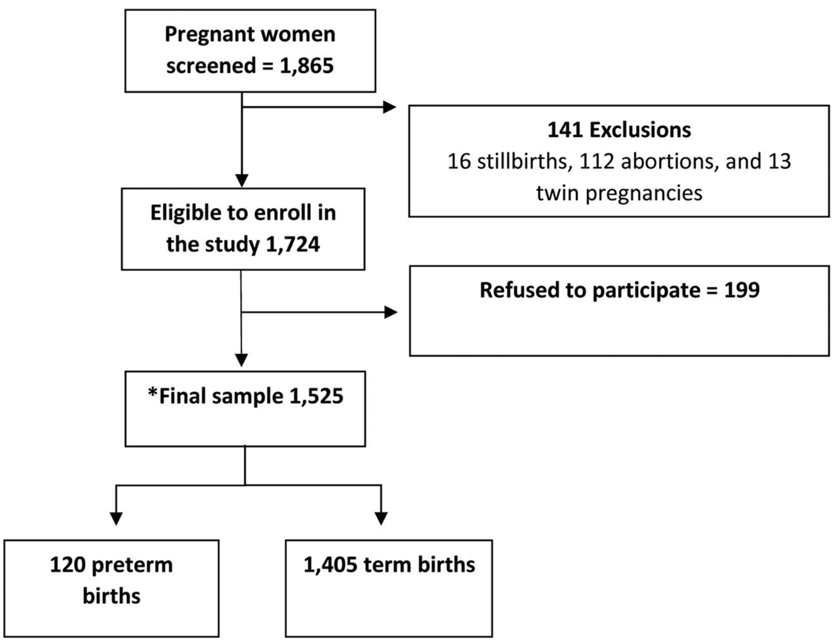

Figure 1. Flow-diagram of cohort recruitment and outcome assessments.

self reported (no or yes), hypertension during pregnancy – self reported (no or yes), bleeding during pregnancy – self reported (no or yes), and type of delivery – collected from the medical records at the maternity (vaginal or cesarean section).

The wealth index was built using principal component analysis (Filmer & Pritchett, 2001). The final index was categorised into quintiles, with the 5th quintile representing the worse off households, and the 1st those that were better off.

Data on episodes of clinical malaria during pregnancy, irrespective of parasite density, diagnosed by thick-smear microscopy, were retrieved from the Malaria Epidemiological Surveillance and Information System (SIVEP) of the Ministry of Health of Brazil (Pincelli et al., 2018).

The MINA-Brazil Study was approved by the Ethics Committee of the School of Public Health, University of São Paulo (Number 872.613, Nov 13th, 2014).

Data analysis

The dependent variable was an indicator of a preterm birth. We used Pearson's Chi Square (χ^2) tests to visualise the relationship between dependent and independents variables. Logistic regressions were performed to assess correlates of preterm delivery. Univariate models were run. For the multiple model we did not include variables that had a p value >0.20 in the univariate analysis, except wealth index and maternal education. Coefficients were presented as odds ratio (OR), with associated 95% confidence interval (95% CI), and significance assessed at $p < 0.05$. Missing data were included in the models by creating missing-value categories. Hosmer and Lemeshow statistical test for goodness of fit was calculated. All analyses were performed in Stata 14.0 (StataCorp, College Station, Texas, USA).

Results

The preterm birth rate was 7.9% ($n = 120$; 95% CI: 6.5–9.3). General characteristics of the study population are shown in Table 1. The majority of participants were between 20–35 years old (64.33%), but 26.23% were teenagers. More than 40% of our population completed less than 10 years of formal schooling, 58.82% had an unpaid occupation, and about two-thirds were living in the urban area of the municipality, in houses with four or more people (54.03%). Almost 60% of pregnancies were not planned, and about 40% of the parturients experienced their first pregnancy. More than one-fourth of participants did not complete six ANC visits, and 43.87% of deliveries were cesarean sections. The prevalence of symptomatic malaria infections during pregnancy was 7.93%. Eight characteristics were significantly different among women who had a preterm delivery and those who did not: maternal age, birth interval, number of ANC visits, malaria during pregnancy, gestational urinary tract infection, hypertension during pregnancy, bleeding during pregnancy and type of delivery.

In the univariate model (Table 2), risk factors that had a significant association included ANC visits < 6 (OR: 2.61, 95% CI: 1.78–3.84), birth interval <18 months (OR: 3.35, 95% CI: 1.40–7.99), first pregnancy (OR: 1.68, 95% CI: 1.11–2.53), bleeding during pregnancy (OR: 2.64, 95% CI: 1.76–3.93), hypertension during pregnancy (OR: 1.96, 95% CI: 1.10–3.51), and maternal age ≤ 19 (OR: 1.78, 95% CI: 1.18–2.68-). A significant protective factor was women who had malaria during pregnancy (OR: 0.27, 95% CI: 0.08–0.89). We did not include variables with p value >0.20 except wealth index and maternal education.

Results of the multiple model (Table 2) indicated that parturients who experienced ANC <6 visits (OR: 2.93, 95% CI: 1.89; 4.56), a birth interval < 18 months (OR: 2.65 95% CI: 1.04–6.75), bleeding during pregnancy (OR: 2.17, 95% CI: 1.39–3.38), and hypertension during pregnancy (OR: 1.74, 95% CI: 1.07–2.82) had higher odds for preterm birth compared with those ones who did not present these conditions. Having had an episode of malaria during pregnancy was no longer significant

Table 1. Sociodemographic, environmental, and obstetric characteristics of the MINA-Brazil parturient, according to term and preterm deliveries.

Variables	Total (%)	Preterm birth (% of the total) $N = 120$	Term birth (% of the total) $N = 1405$	*P*-value*
Sociodemographic characteristics				
Maternal age ($n = 1525$)				0.01
≤19	400 (26.23)	43 (35.83)	357 (25.41)	
20–34	981 (64.33)	62 (51.67)	919 (65.41)	
≥35	144 (9.44)	15 (12.50)	129 (9.18)	
Maternal education ($n = 1507$)⍰				0.53
Illiterate	49 (4.40)	4 (3.33)	45 (4.48)	
≤9	616 (40.39)	48 (40.0)	568 (40.43)	
10–11	626 (41.05)	46 (38.33)	580 (41.28)	
≥12	216 (14.16)	22 (18.33)	194 (13.81)	
Head of the family ($n = 1459$)[§]				0.82
Partner	731 (47.93)	58 (48.33)	673 (47.90)	
Pregnant woman	194 (12.72)	13 (10.83)	181 (12.88)	
Other	534 (35.02)	45 (37.50)	489 (34.80)	
Living with a partner ($n = 1459$)[§]				0.14
Yes	1146 (78.55)	85 (73.28)	1061 (79.00)	
No	313 (21.45)	31 (26.72)	282 (21.00)	
Maternal occupation ($n = 1459$)[§]				0.11
Paid job	562 (36.85)	54 (45.00)	508 (36.16)	
Unpaid job	897 (58.82)	62 (51.67)	835 (59.43)	
Receipt of *Bolsa Família* ($n = 1459$)[§]				0.44
No	831 (56.96)	70 (60.34)	761 (56.66)	
Yes	628 (43.04)	46 (39.66)	582 (43.34)	
Wealth Index (quintiles) ($n = 1459$)[§]				0.48
1 (highest wealth)	296 (20.29)	29 (25.00)	267 (19.88)	
2	293 (20.08)	22 (18.97)	271 (20.18)	
3	291 (19.95)	17 (14.66)	274 (20.40)	
4	288 (19.74)	25 (21.55)	263 (19.58)	
5 (lowest wealth)	291 (19.95)	23 (19.83)	268 (19.96)	
Environmental				
Location of the household ($n = 1459$)[§]				0.46
Urban	970 (63.61)	80 (66.67)	890 (63.35)	
Rural	555 (36.39)	40 (33.33)	515 (36.65)	
Type of household construction ($n = 1459$)[§]				0.25
Masonry	377 (25.84)	32 (27.59)	345 (25.69)	
Wood	177 (12.13)	19 (16.38)	158 (11.76)	
Mix (masonry + wood)	905 (62.03)	65 (56.03)	840 (62.55)	
Number of people living in the household ($n = 1459$)[§]				0.40
≤2	292 (19.15)	29 (24.17)	263 (18.72)	
3	343 (22.49)	29 (24.17)	314 (22.35)	
4	264 (17.31)	18 (15.00)	246 (17.51)	
≥5	560 (36.72)	44 (36.67)	520 (41.42)	
Number of rooms in the household ($n = 1459$)[§]				0.29
≤3	329 (22.55)	23 (19.83)	306 (22.78)	
4	324 (22.21)	21 (18.10)	303 (22.56)	
≥5	806 (55.24)	72 (62.07)	734 (54.65)	
Clinical and obstetric history				
Planned pregnancy ($n = 1459$)[§]				0.27
No	874 (59.90)	75 (64.66)	799 (59.49)	
Yes	585 (40.10)	41 (35.34)	544 (40.51)	
Birth interval ($n = 1525$)	<0.001			
First pregnancy	582 (42.24)	56 (51.85)	526 (41.42)	
<18 months	40 (2.90)	7 (6.48)	33 (2.60)	
≥18 months	756 (54.86)	45 (41.67)	711 (55.98)	
Number of ANC visits ($n = 1503$)[¥]				<0.001
<6	415 (27.61)	55 (47.83)	360 (25.94)	
≥6	1088 (72.39)	60 (52.17)	1028 (74.06)	
Malaria during pregnancy ($n = 1525$)				0.02
No	1404 (92.07)	117 (97.50)	1287 (91.60)	
Yes	121 (7.93)	3 (2.50)	118 (8.40)	

(*Continued*)

Table 1. Continued.

Variables	Total (%)	Preterm birth (% of the total) $N = 120$	Term birth (% of the total) $N = 1405$	*P*-value*
Gestational urinary tract infection ($n = 1525$)				<0.001
No	544 (35.67)	36 (30.00)	508 (36.16)	
Yes	981 (64.33)	84 (70.00)	897 (63.84)	
Hypertension during pregnancy ($n = 1525$)				0.02
No	1415 (92.79)	105 (87.50)	1310 (93.24)	
Yes	110 (7.21)	15 (12.50)	95 (6.76)	
Bleeding during pregnancy ($n = 1525$)				<0.001
No	1245 (81.64)	78 (65.00)	1167 (83.06)	
Yes	280 (18.36)	42 (35.00)	238 (16.94)	
Smoking during the pregnancy ($n = 1458$)†				0.67
No	1415 (95.74)	114 (8.06)	1301 (91.94)	
Yes	63 (4.26)	6 (9.52)	57 (90.48)	
Type of delivery ($n = 1525$)				0.04
Vaginal	856 (56.13)	57 (47.50)	799 (56.87)	
Cesarean section	669 (43.87)	63 (52.50)	606 (43.13)	

*Pearson's Chi Square (χ^2); §47 missing data; ⍰18 missing data; ¥22 missing data; †48 missing data.

(OR: 0.31, 95% CI: 0.09–1.02). No other variable included in the model showed a significant association with preterm births. The Hosmer and Lemeshow test was 0.97, indicating a good model fit.

Discussion

This study appraised factors associated with preterm birth in the Western Brazilian Amazon, utilising data from a population-based cohort study. The rate of preterm births was 7.9%. Maternal variables (age, birth interval and number of ANC visits) and clinical history during pregnancy (urinary infection, hypertension, bleeding, and malaria) were distinguishing factors between women who had a preterm birth and those who did not. In a multiple regression model, factors associated with preterm delivery included less than six ANC visits throughout pregnancy, shorter birth interval, and bleeding and hypertension during pregnancy.

Based on publicly available data from the Information System on Live Births (SINASC) of the Ministry of Health, there were 1839 and 1636 births recorded in the municipality of Cruzeiro do Sul in 2015 and 2016, respectively, with an observed preterm birth rate of 15.3% in 2015 and 14.6% in 2016 (Brazil, 2016). Discrepancies between our observed estimate and the data from SINASC are potentially explained by registration error in the birth certificate and failure to use an adequate method to estimate the gestational age. In this study, we obtained estimates of gestational age for one-third of the participants through ultrasonography, mostly living in urban areas. At the same time, LMP was used for the remaining women. Therefore, recall bias in precisely determining the LMP cannot be ruled out. For example, women living in rural areas had fewer years of education than those from urban areas, which can contribute to error in the recall of the onset of the LMP.

Our findings regarding ANC visits and preterm delivery corroborate existing evidence (Balbi et al., 2016; Domingues et al., 2015; Leal et al., 2015; Miranda et al., 2012; Moreau et al., 2005; Silveira et al., 2010; Viellas et al., 2014). Based on data from SINASC, Brazil has observed a major increase in prenatal care coverage, with the percentage of women with more than six ANC visits jumping from 49% in 1995–68.1% in 2016 (Brazil, 2016), and the percentage of women who did not have any ANC visits reducing from 10.8% in 1995–2.1% in 2016 (Brazil, 2016). An important factor for the increase in coverage was the implementation and expansion of primary care in Brazil through the Family Health Strategy (Macinko & Harris, 2015). The high coverage in 2016, however, carried a marked regional inequality, ranging from 48.7% in the North region (where our study site is located) to 78.2% in the South. In our sample, 26.1% of the women had less than six ANC visits

Table 2. Logistic regression models to assess correlates of preterm deliveries.

Variables	Crude			Multiple		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Sociodemographic characteristics						
Maternal age (Reference: 20–34)						
≤ 19	1.78	1.18; 2.68	0.005	1.40	0.84; 2.34	0.18
≥ 35	1.72	0.95; 3.11	0.07	1.55	0.79; 3.01	0.19
Maternal education (Reference: ≥ 12)						
10–12	0.94	0.61; 1.44	0.78	0.99	0.62; 1.69	0.98
1–9	1.34	0.78; 2.29	0.28	1.30	0.67; 3.11	0.50
Illiterate	1.05	0.36; 3.07	0.66	1.10	0.31; 3.54	0.87
Head of the family (Reference: Pregnant woman)						
Partner	1.19	0.64; 2.23	0.56	–	–	–
Other	1.28	0.67; 2.43	0.44	–	–	–
Living with a partner (Reference: Yes)						
No	1.37	0.89; 2.11	0.15	1.31	0.83; 2.05	0.61
Maternal occupation (Reference: Paid job)						
Unpaid job	0.69	0.44;1.02	0.06	0.78	0.50; 1.22	0.29
Receipt of *Bolsa Família* (Reference: No)						
Yes	0.85	0.58; 1.26	0.44	–	–	–
Wealth Index (quintiles; Reference: highest wealth)						
2	0.74	0.41; 1.33	0.76	0.78	0.41; 1.45	0.43
3	0.57	0.30; 1.06	0.50	0.69	0.35; 1.37	0.29
4	0.87	0.49; 1.53	0.99	1.04	0.53; 2.01	0.90
5 (lowest wealth)	0.79	0.44; 1.40	0.34	0.92	0.44; 1.92	0.84
Environmental						
Location of the household (Reference: Urban)						
Rural	0.86	0.58; 1.28	0.46	–	–	–
Type of household construction (Reference: Masonry)						
Wood	0.83	0.53; 1.29	0.42	–	–	–
Mix (masonry + wood)	1.29	0.71; 2.35	0.39	–	–	–
Number of people living in the household (Reference: ≤ 2)						
3	0.83	0.48; 1.43	0.52	0.93	0.50; 1.75	0.83
4	0.66	0.35; 1.22	0.19	0.67	0.33; 1.34	0.26
≥ 5	0.68	0.41; 1.12	0.13	0.63	0.34; 1.16	0.14
Number of rooms in the household (Reference: ≥5)						
4	0.70	0.42; 1.16	0.17	0.76	0.43; 1.33	0.35
≤3	0.76	0.47; 1.24	0.28	0.69	0.39; 1.22	0.20
Clinical and obstetric history						
Planned pregnancy (Reference: Yes)						
No	1.24	0.83; 1.85	0.27	–	–	–
Birth interval (Reference: ≥18 months)						
<18	3.35	1.40; 7.99	0.006	2.65	1.04; 6.75	0.04
First pregnancy	1.68	1.11; 2.53	0.01	1.50	0.86; 2.60	0.14
Number of ANC consultations (Reference: ≥6)						
< 6	2.61	1.78; 3.84	<0.001	2.93	1.89; 4.56	<0.001
Malaria during pregnancy (Reference: No)						
Yes	0.27	0.08; 0.89	0.03	0.31	0.09; 1.02	0.05
Gestational urinary tract infection (Reference: No)						
Yes	1.32	0.88; 1.98	0.17	1.31	0.83; 2.05	0.23
Hypertension during pregnancy (Reference: No)						
Yes	1.96	1.10; 3.51	0.02	1.74	1.07; 2.82	0.02
Bleeding during pregnancy (Reference: No)						
Yes	2.64	1.76; 3.93	<0.001	2.17	1.39; 3.38	<0.001
Type of delivery (Reference: Vaginal)						
Cesarean section	1.45	1.00; 2.11	0.05	1.35	0.88; 2.08	0.16

OR = Odds ratio; IC = 95% confidence interval; *P*-value = Wald test; missing data were included in the models by creating a missing-value category (coefficients not shown).

(Berg et al., 2009). Important to note is that the North region also records delayed care, with a high number of women initiating prenatal care after 16 weeks of pregnancy, mostly due to access barriers (Domingues et al., 2015; Leal et al., 2015). Among the factors previously associated with poor access to prenatal care in Brazil are: being an indigenous woman, low education, high parity, and living in the North and Northeast regions (Leal et al., 2015). Prenatal care is a protective factor for maternal and fetal health, and thus must start early and be conducted systematically, contributing to reduce obstetric complications and to mitigate health conditions during pregnancy (e.g. hypertension and bleeding) (Domingues et al., 2015).

In our study, women who had hypertension during pregnancy had 1.7 times the odds to have a preterm birth. Hypertension in pregnancy is a known risk factor for many adverse events for the mother and the fetus, such as preterm birth, intrauterine growth restriction, placental abruption, fetal distress, intrauterine death, and low birth weight (Berg et al., 2009). Also, chronic hypertension and pre-eclampsia were previously associated with a provider-initiated preterm birth (Leal et al., 2016). Similarly, we showed that women who experienced bleeding during pregnancy had two times the odds of a preterm birth, corroborating previous findings (Watanabe et al., 2002). Our study did not find significant associations between preterm birth and other factors previously described in the literature, such as cigarette smoking (Polakowski et al., 2009), urinary tract and genital infection (Murphy, 2007), poverty (Miranda et al., 2012), low maternal education, unemployment (Silveira et al., 2010), and single motherhood (Moreau et al., 2005). Yet, it is important to note that only 4.2% of women in our sample reported smoking during pregnancy.

The association between malaria and preterm delivery was not significant in the multiple regression. A malaria infection during pregnancy may lead to an abortion or stillbirth (WHO, 2015). Therefore, the lack of association may reflect a survival bias, since we do not have records of women whose pregnancy ended prematurely due to a malaria infection. Rijken et al. (2014) found that malaria in pregnancy was associated with an increased risk for low birth weight, small for gestational age, and a significant result with preterm birth. Malaria during pregnancy may cause maternal anemia and placental infection, and therefore may affect fetal growth and contribute to low birth weight (Walker et al., 2014).

Our results call for the discussion of two important context-specific aspects: (i) the use of the reported date of LMP to calculate gestational age, and (ii) the extraordinarily high rates of cesarean sections in Brazil. Gestational age can be estimated by the date of LMP, ultrasound-based dating, or neonatal estimates. Dating based on LMP is simple and low cost, but carries much uncertainty due to other types of bleeding, irregularity or individual variations in the length of the menstrual cycle, short birth spacing, preconception amenorrhea after oral contraceptive use, digit preference, and recall biases by the mother (Lynch & Zhang, 2007; Waller et al., 2000; Wegienka & Baird, 2005). In Brazil, the national guidelines for pregnancy care recognise that between 11–42% of gestational ages based on the date of LMP could be uncertain, and offer a detail protocol for estimation of the gestational age, which includes ultrasound dating (Brasil, 2005, 2012). The difference between the two methods, could be positive or negative, indicating that the date of LMP can underestimate or overestimate the gestational age, which exposes the health of the mother and the fetus at risk.

Uncertainties in the gestational age are critical for the second context-specific aspect for discussion: cesarean sections. Although our study did not observe an association between premature birth and cesarean section in the final model, we must emphasise that Brazil has one of the highest rates worldwide, 55.4% in 2016, much higher than the 10–15% rate considered associate with decreases in maternal, neonatal and infant mortality (WHO, 1985). New approaches to evaluate the determinants of cesarean deliveries are rising worldwide to allow standardised comparisons across countries (Vogel et al., 2015). A Cesarean section should only be considered when having a medical recommendation otherwise can cause permanent risks to the health of the mother and baby or even death, especially in places with poor access to health and/or capacity to conduct a safe procedure (WHO, 2015). There is regional inequality in this indicator; about 60% in the South and Southeast regions, and 45.6% in the North (in our study, located in the North region, 43.9% women had a cesarean section delivery, corroborating the regional indicator). A recent estimate suggested that more than 300,000 infants are unnecessarily born early term each year in Brazil, due to provider-initiated cesarean section in the absence of medical complications (Leal et al., 2017). Likewise, the provider-initiated low rate of preterm birth may reflect a lack of recognition of pregnancy complications and the inability to provide timely intervention, especially in low developed countries (Morisaki et al., 2014). However, considering an evidence-based decision process and with well-trained health care providers, the decision to provider-initiated cesarean section can be a life-saving decision-making process.

A major strength of this is the population-based design, and the fact that it is the first birth cohort in the Amazon. A limitation is that information on morbidity – urinary tract infection, bleeding during pregnancy and hypertension during pregnancy – was self-reported, collected at the maternity, rather than drawn from a review of antenatal records. Also, the gestational age used in this study was measured by the reported date of LMP.

Conclusion

This study identified factors associated with preterm birth in the Western Brazilian Amazon. Most of these factors could be improved with access to accurate screening for risk factors that could prevent preterm birth. Also, besides the successful model of primary care and a comprehensive protocol for antenatal care in Brazil, more programmes should be designed considering different contexts that pregnant women and families are inserted, as this region is marked by a high prevalence of malaria. Likewise, investment in the quality of antenatal could be mitigated by improved access to and quality of the health system. While the mechanisms to address and mitigate the preterm delivery problem are in place, inequalities in access still remain, and were recently exacerbated due to economic and political crisis. Addressing remaining barriers to access and programmatic gaps that result in inequities of service delivery are of utmost importance.

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