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Association of Maternal age 35 years and over and prenatal care utilization, preterm birth, and low birth weight, Mexico 2008–2019

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CLINICAL ARTICLE

Obstetrics

Association of maternal age 35 years and over and prenatal care utilization, preterm birth, and low birth weight, Mexico 2008–2019

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Abstract

Objective: To evaluate prenatal care utilization, low birth weight, and preterm birth among women aged 35 years and older in Mexico from 2008 to 2019.

Methods: We conducted a historical cohort study of all singleton live births in Mexico from 2008 to 2019. Outcomes were inadequate prenatal care, preterm birth, and low birth weight. We compared outcomes among women aged 35–39, 40–44, and 45–49 years with births to women aged 20–34 years. We used logistic regression to account for individual, health system, and contextual confounders.

Results: We included a total of 19 526 922 births; 2 325 725 (11.9%) were to women aged 35 years and older. Women aged 45-49 years had the lowest levels of education, were more likely to be uninsured, and came from highly marginalized municipalities while those aged 35-39 years had the highest levels of education and insurance and came from the least marginalized municipalities. The odds of inadequate prenatal care (adjusted odds ratio [aOR] 1.12; 95% confidence interval [CI] 1.09–1.15), preterm birth (aOR 2.05; 95% CI 1.97–2.13), and low birth weight (aOR 2.03; 95% CI 1.95–2.12) were highest for women aged 45–49 years, compared with women aged 20–34 years. The odds of adverse perinatal outcomes increased progressively with age, but the odds of inadequate prenatal care (aOR 0.77; 95% CI 0.76–0.77) were lowest for women aged 35–39 years, when compared with women aged 20–34 years.

Conclusion: Women who deliver at 35 years and over are a heterogeneous group in Mexico. Being 35 years old and older is associated with increases in preterm birth and low birth weight neonates. Women who give birth between 45 and 49 years may be especially vulnerable.

KEYWORDS
birth outcomes, health services research, low birth weight, maternal age, Mexico, prenatal care, preterm birth

1 | INTRODUCTION

There is a clear trend in higher-income countries towards delaying childbirth to later reproductive years[1] and this trend is also becoming more common in low- and middle-income countries.[2,3] For example, births to women aged 35 years and older represent nearly 20% of births in the USA.[1] Widespread use of family planning, postponing pregnancy because of education or career goals, and advances in assisted reproductive technology contribute to pregnancy later in life.[4] Prenatal care is important for a healthy pregnancy and birth outcomes, especially for older women.[5] Enhanced prenatal care that includes additional monitoring during pregnancy and birth is recommended for women over the age of 35 years due to associated health risks.[6] Additionally, pregnancy after age 35 years is associated with adverse birth outcomes including low birth weight, small for gestational age, preterm birth, and congenital disorders.[7,8]

Countries in the Latin American region have also reported increases in maternal age at birth over the last several decades.[9] In Mexico, some evidence suggests that younger generations of Mexican women are delaying first births.[10,11] Births to women aged 35 years and over also represent higher-order births; so, births to older women include both those who delay childbearing and those who have multiple births. Socioeconomic conditions may be different for older women with multiple children compared with older nulliparous women.[12] In Mexico, although deliveries overwhelmingly occur in health facilities,[13,14] disparities exist in prenatal care coverage and quality and birth outcomes by socioeconomic status, and indigenous ethnicity.[15]

Much of the literature on maternal and infant outcomes for births to women over 35 years ignores possible heterogeneity in this age group.[7] Studies do not always take into account clinical and socio-structural factors that influence both health service utilization and health outcomes,[16] making it difficult to isolate the effects of maternal age from other factors. The purpose of this study was to describe the characteristics of live births to women over the age of 35 years in Mexico by 5-year age groups, compare them with births to women aged 20–34 years, and test the association of age (over 35 years) and inadequate prenatal care, low birth weight, and preterm birth accounting for clinical and social factors.

2 | MATERIALS AND METHODS

We conducted a historical cohort study of all singleton live births in Mexico from 2008 to 2019. We identified births through the Birth Information Subsystem (Subsistema de Información sobre Nacimientos, SINAC), an initiative of the Mexican government that provides data on live births obtained from registered birth certificates beginning in 2008.[17] These birth certificate data include self-reported maternal characteristics and birth outcomes identified by the birth attendant. We excluded birth records missing maternal age (n = 71 571; 0.36%) (Figure 1). This analysis focuses on women aged 20–49 years at the time of birth. We included all births in order to calculate the proportion of births to all age groups; we then restricted all analyses to women aged 20–49 years at the time of birth (Figure 1). This is a de-identified secondary data-only study, therefore patient consent was not applicable.

Our primary outcomes were maternal utilization of prenatal care, preterm birth, and neonate low birth weight. We measured prenatal care utilization by constructing a binary measure of inadequate prenatal care defined as care that is fewer than five prenatal visits and care that is not initiated in the first trimester (<13 weeks), following the Mexican practice guidelines for number of visits[18] modeled on the Kotelchuk index.[19] We identified weeks of gestation at birth as late prematurity (34–37 weeks), moderate prematurity (between 32 and 34 weeks), very premature (between 28 and 32 weeks), and extreme prematurity (<28 weeks). For multivariable modeling we compared preterm births to term births (<37 weeks or not). We evaluated birth weight, subcategorized as low birth weight (1500–2500 g), very low birth weight (1000–1499 g), and extremely low birth weight (<1000 g). For multivariable modeling, we used a binary indicator of low birth weight (<2500 g or not).

Maternal age was categorized into four categories: 20–34, 35–39, 40–44, and 45–49 years. The age group 20–34 years served as a reference group for all comparisons because this represents the ages when most births occur and with less risk of adverse birth outcomes. Other maternal characteristics included education; marital status; health insurance status; region of maternal residence; municipality population size; *grado de marginacion* (a municipality-level measure of structural vulnerability built by the Consejo Nacional de Población and including measures of education, income, household materials, and the proportion of the population that is rural[20]); parity; place of delivery; birth attendant (physician versus other provider); and mode of delivery (vaginal or cesarean section). We described maternal education as none, completion of primary school, secondary school (reference), high school, or completion of professional-level or higher schooling, and marital status as married or cohabiting, single, or separated/divorced/widowed. We classified health insurance following previous literature as via social security institutions, which cover those working in the formal sector (reference), Seguro Popular or IMSS Oportunidades, which covers those in the informal sector, unemployed, none, or other, which includes the small population with private-sector insurance.[21] We described parity as 1 (first live birth) (reference), 2, 3, 4, and 5 or more. We defined the population size of maternal residence following Mexican government standard classifications: less than 2500 inhabitants, 2500–14 999 inhabitants, 15 000–99 999 inhabitants, or 100 000 or more inhabitants.[22] We classified maternal state of residence into regions: central, north, south, Zona Metropolitana del Valle de México (ZMVZ) (the area that constitutes the greater Mexico City metropolitan area), or other country. We classified municipality-level (a jurisdiction similar to a county in the USA) marginalization as very high, high, medium, low, or very low (reference) using *grado de Marginacion* where higher values indicate higher marginalization (more socio-structural vulnerability).[20] We analyzed mode of delivery (vaginal or cesarean section) and noted

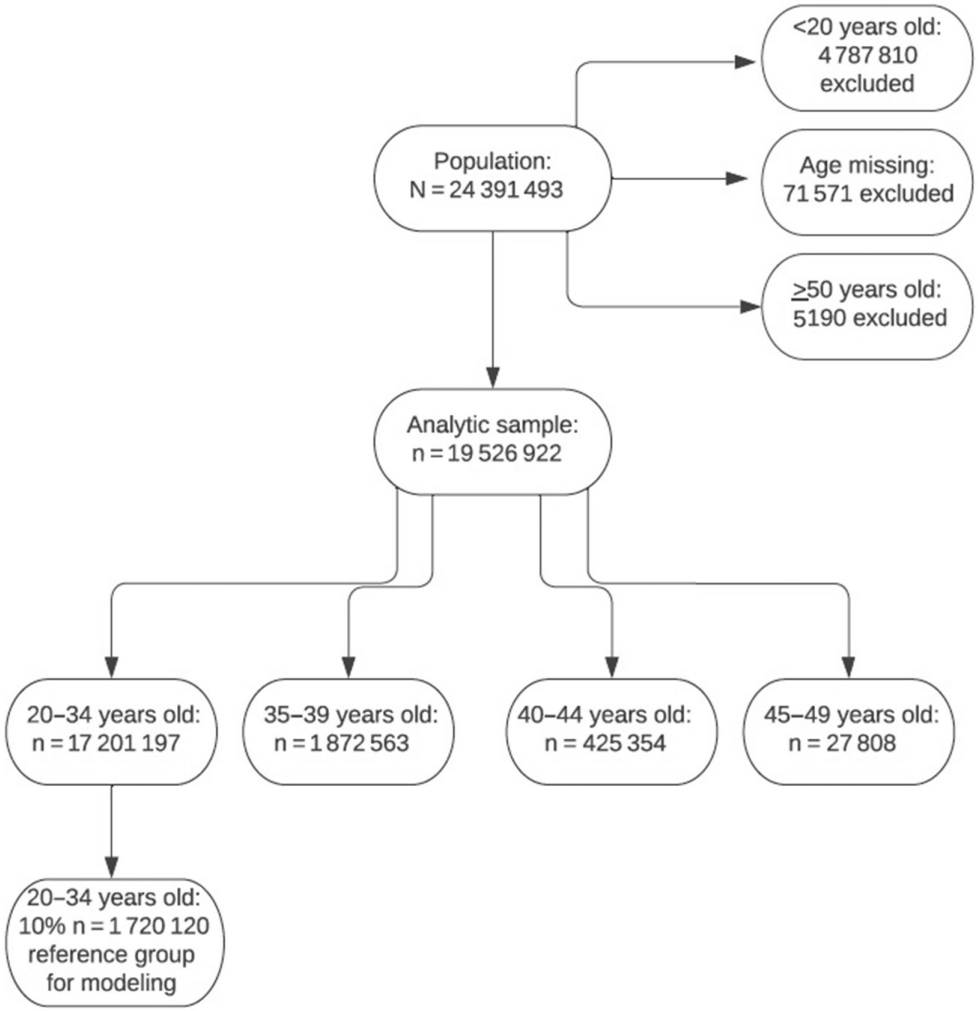

FIGURE 1 Analytic sample flow chart. We identified births through the Birth Information Subsystem (Subsistema de Información sobre Nacimientos, SINAC). We included all births in order to calculate the proportion of births for all age groups; we then restricted all analyses to women aged 20–49 years at the time of birth. We excluded birth records missing maternal age.

the health professional who attended the delivery (physician or other provider, which includes nurses and midwives). Finally, we included maternal state of residence (Mexico has 32 states) and year of birth.

We described missing data for all variables and present a heat map[23] of missing variables by year in Figure S1. Low birth weight represents the variable with the most missing values; however, completeness of the data has improved over time. We compared sociodemographic characteristics of women missing any data to those with complete data (Table S1); a larger proportion of women with any missing data had low levels of education, higher marginalization, and resided in southern Mexico. Missing variables are slightly higher among the oldest groups. These factors are all associated with lower socioeconomic status. In order to retain these women in our analyses, we included "Missing" as a category in all models (described below). We first included all births and calculated the proportion of births to all age groups; we then restricted all further analyses to women aged 20–49 years at the time of birth. We described the woman's individual, geographic, and clinical characteristics by age categories (20–34, 35–39, 40–44, 45–49 years). We define α level of significance at 0.05 or less. Next, we described clinical and birth outcomes and prenatal care utilization by age groups. Then, we built three logistic regression models with dichotomous outcomes: inadequate prenatal care, preterm birth, and low birth weight. We adjusted for education, parity, insurance status, state, year, and municipality-level marginalization. Due to the computational challenges of modeling the full sample of the reference group (births to women 20–34), we selected a 10% simple random sample of that group for modeling. Descriptive characteristics of this 10% simple random sample are shown in Table S2 and did not differ from the full sample (Table 1).

Finally, we calculated adjusted predicted probabilities (average marginal effects at the mean) for each outcome (inadequate prenatal care, preterm birth, and low birth weight) and plotted the predicted probabilities by age categories. All analyses were conducted in R (R Core Team, 2022). This analysis was deemed non-human participants

TABLE 1 Sociodemographic, geographic, and clinical characteristics of women who gave birth in Mexico, 2008–2019.[a]

Characteristic	Overall (*N* = 19 526 922)	20–34 years (*N* = 17 201 197)	35–39 years (*N* = 1 872 563)	40–44 years (*N* = 425 354)	45–49 years (*N* = 27 808)
Sociodemographic characteristics					
Education					
Primary	3 201 282 (17%)	2 776 453 (16%)	335 740 (18%)	83 456 (20%)	5633 (21%)
Secondary	6 905 694 (36%)	6 257 951 (37%)	527 350 (29%)	113 961 (27%)	6432 (24%)
High school	4 455 733 (23%)	4 095 712 (24%)	295 947 (16%)	60 746 (15%)	3328 (12%)
Professional	3 211 139 (17%)	2 650 445 (16%)	467 266 (25%)	88 461 (21%)	4967 (18%)
None	1 473 838 (7.7%)	1 178 110 (6.9%)	217 447 (12%)	71 392 (17%)	6889 (25%)
Missing[b]	279 236	242 526	28 813	7338	559
Marital status					
Married	17 507 098 (91%)	15 402 983 (91%)	1 699 712 (92%)	379 723 (91%)	24 680 (91%)
Single	1 545 218 (8.1%)	1 392 147 (8.2%)	119 661 (6.5%)	31 317 (7.5%)	2093 (7.7%)
Separated/widowed/divorced	115 327 (0.6%)	89 601 (0.5%)	19 223 (1.0%)	6091 (1.5%)	412 (1.5%)
Missing	359 279	316 466	33 967	8223	623
Insurance status					
IMSS/ISSSTE/PEMEX/SEDENA/SEMAR[c]	6 381 442 (34%)	5 512 681 (33%)	715 699 (39%)	145 276 (35%)	7786 (29%)
IMSS Oportunidades/Seguro Popular[d]	8 252 198 (43%)	7 418 108 (44%)	658 522 (36%)	164 400 (40%)	11 168 (42%)
Other	388 149 (2.0%)	315 249 (1.9%)	59 387 (3.3%)	12 788 (3.1%)	725 (2.7%)
None	3 967 986 (21%)	3 484 525 (21%)	386 259 (21%)	90 002 (22%)	7200 (27%)
Missing	537 147	470 634	52 696	12 888	929
Geographic characteristics					
Region					
Central	7 179 983 (37%)	6 330 548 (37%)	680 954 (36%)	158 115 (37%)	10 366 (37%)
North	5 004 353 (26%)	4 427 600 (26%)	471 920 (25%)	99 115 (23%)	5718 (21%)
South	4 259 582 (22%)	3 775 293 (22%)	386 006 (21%)	91 310 (22%)	6973 (25%)
ZMVM[e]	3 021 133 (16%)	2 612 476 (15%)	328 509 (18%)	75 517 (18%)	4631 (17%)
Other country	4568 (<0.1%)	3834 (<0.1%)	561 (<0.1%)	155 (<0.1%)	18 (<0.1%)
Missing	57 303	51 446	4613	1142	102
Municipality population size					
<2500	63 401 (0.3%)	55 430 (0.3%)	6167 (0.3%)	1678 (0.4%)	126 (0.5%)
2500–14 999	1 082 753 (5.5%)	954 260 (5.5%)	100 612 (5.4%)	25 929 (6.1%)	1952 (7.0%)
15 000–99 999	5 705 949 (29%)	5 071 134 (29%)	504 039 (27%)	121 717 (29%)	9059 (33%)
≥100 000	12 674 819 (65%)	11 120 373 (65%)	1 261 745 (67%)	276 030 (65%)	16 671 (60%)
Municipality-level marginalization					
Very high	667 254 (3.4%)	579 264 (3.4%)	66 104 (3.5%)	20 037 (4.7%)	1849 (6.7%)
High	1 463 093 (7.5%)	1 298 933 (7.6%)	128 039 (6.9%)	33 493 (7.9%)	2628 (9.5%)
Medium	2 711 167 (14%)	2 410 081 (14%)	239 352 (13%)	57 313 (14%)	4421 (16%)
Low	3 014 522 (16%)	2 684 944 (16%)	265 535 (14%)	59 932 (14%)	4111 (15%)
Very low	11 564 494 (60%)	10 134 422 (59%)	1 163 410 (62%)	252 080 (60%)	14 582 (53%)
Missing	106 392	93 553	10 123	2499	217
Clinical characteristics					
Parity					
1	5 976 020 (31%)	5 631 869 (33%)	278 842 (15%)	60 093 (14%)	5216 (19%)
2	6 844 336 (35%)	6 246 525 (36%)	503 791 (27%)	89 543 (21%)	4477 (16%)

TABLE 1 (Continued)

Characteristic	Overall (N = 19 526 922)	20–34 years (N = 17 201 197)	35–39 years (N = 1 872 563)	40–44 years (N = 425 354)	45–49 years (N = 27 808)
3	4 194 246 (22%)	3 564 418 (21%)	525 298 (28%)	99 782 (23%)	4748 (17%)
4	1 510 119 (7.7%)	1 162 924 (6.8%)	277 558 (15%)	65 944 (16%)	3693 (13%)
5+	978 864 (5.0%)	574 836 (3.3%)	284 920 (15%)	109 496 (26%)	9612 (35%)
Missing	23 337	20 625	2154	496	62
Place of delivery					
Public	14 732 399 (75%)	13 142 143 (76%)	1 275 850 (68%)	295 669 (70%)	18 737 (67%)
Private	4 436 970 (23%)	3 751 994 (22%)	559 778 (30%)	117 845 (28%)	7353 (26%)
Out-of-facility	349 213 (1.8%)	299 840 (1.7%)	36 032 (1.9%)	11 636 (2.7%)	1705 (6.1%)
Missing	8340	7220	903	204	13
Birth attendant					
Physician	19 054 791 (98%)	16 791 681 (98%)	1 825 726 (98%)	411 374 (97%)	26 010 (94%)
Other provider	461 194 (2.4%)	399 938 (2.3%)	45 755 (2.4%)	13 724 (3.2%)	1777 (6.4%)
Missing	10 937	9578	1082	256	21
Mode of delivery					
Cesarean section	9 193 020 (47%)	7 879 832 (46%)	1 052 739 (56%)	245 588 (58%)	14 861 (54%)
Vaginal	10 304 034 (53%)	9 295 103 (54%)	816 950 (44%)	179 072 (42%)	12 909 (46%)
Missing	29 868	26 262	2874	694	38

[a]Data are presented as number (percentage). Note: all *P* values were <0.001 by Pearson χ^2 test (not shown).

[b]All missing data are <2% except for insurance status which is 2.8% (see Figure S1 for heat map of data missingness).

[c]ISS/ISSSTE/PEMEX/SEDENA/SEMAR: this comprises the Mexican Institute of Social Security (IMSS)/Institute of Security and Social Services for State Workers (ISSSTE)/Mexican Petroleum (PEMEX)/Secretary of National Defense (SEDENA)/Secretary of the Navy (SEMAR).

[d]Mexico's universal health insurance program for people in the informal sector.

[e]Zona Metropolitana del Valle de México (ZMVZ), the area that constitutes Mexico City and the surrounding municipalities.

by the Oregon Health and Science University Institutional Review Board.

3 | RESULTS

There were 24 391 493 singleton live births in Mexico between 2008 and 2019 (Figure 1). Births to women 35 years and older represented 9.6% of all births. Our analytic sample included 19 526 922 live births to women aged 20–49 years at time of birth: 17201197 (88.1%) aged 20–34; 1 872 563 (9.6%) aged 35–39; 425 354 (2.2%) aged 40–44; and 27 808 (0.14%) aged 45–49 years (Figure 1). Overall, women aged 45–49 years were more structurally vulnerable as measured by education, insurance, and municipality-level marginalization. Older women tended to have lower levels of education, and the proportion of women with no education increased with increasing age: 6.9% among women aged 20–34, 12% among women aged 35–39, 17% among women aged 40–44, and 25% in women aged 45–49 years reported no education (P < 0.001; Table 1). A larger proportion of older women were uninsured (45–49 years old, 27%) compared with younger women (20–34 years old, 21%; P < 0.001). Older women also tended to come from less densely populated and more highly marginalized municipalities (P < 0.001). All three age groups of women over 35 years old had higher parity compared with women aged 20–34 years (P < 0.001) with nearly half of women aged 45–49 years (48%) already having four or more children at the time of birth. The proportion of out-of-facility births as well as the proportion of deliveries attended by non-medical providers increased with age (P < 0.001) (Table 1). Overall, nearly half of all births were by cesarean delivery (47%); women aged 40–44 years had the highest proportion of cesarean births (58%). The full descriptive table including state and year of birth are shown in Table S3.

In bivariate analyses, the oldest women (45–49 years) had the highest crude proportions of inadequate prenatal care (38%) compared with women aged 20–34 years (30%) as well as with other age groups: 35–39 (26%) and 40–44 (30%) (P < 0.001) (Table 2). The 45–49 age group also had the highest proportion of preterm births (11%) compared with the 20–34 (6%), 35–39 (8%), and 40–44 (10%) age groups (P < 0.001) as well as the highest proportion of low birth weight neonates (10%) compared with the 20–34 (5%), 35–39 (7%), and 40–44 (8%) age groups (P < 0.001) (Table 2).

In multivariable analyses, the adjusted predicted probability of receiving inadequate prenatal care was highest for the oldest women (45–49 years) (29.3%; 95% confidence interval [CI] 28.7%–29.9%) but lowest for women aged 35–39 years (22.1%; 95% CI 21.9%–22.4%) and 40–44 years (24.4%; 95% CI 24.1%–24.7%) compared with 20–34 years (26.9%; 95% CI 26.7–27.2%) (Figure 2). Other factors associated with inadequate prenatal care included municipality-level

TABLE 2 Clinical and birth outcomes: Prenatal care utilization, low birth weight, and preterm birth in Mexico, 2008–2019.[a]

Characteristic	Overall (N = 19 526 922)	20–34 years (N = 17 201 197)	35–39 years (N = 1 872 563)	40–44 years (N = 425 354)	45–49 years (N = 27 808)
Initiated prenatal care					
First trimester	14 862 081 (77%)	13 033 289 (77%)	1 489 206 (81%)	320 556 (77%)	19 030 (70%)
Second trimester	3 334 267 (17%)	2 984 147 (18%)	271 993 (15%)	72 465 (17%)	5662 (21%)
Third trimester	631 876 (3.3%)	565 862 (3.3%)	50 359 (2.7%)	14 314 (3.4%)	1341 (4.9%)
None	424 067 (2.2%)	375 525 (2.2%)	35 803 (1.9%)	11 518 (2.7%)	1221 (4.5%)
Missing[b]	274 631	242 374	25 202	6501	554
Number of prenatal visits					
0	424 589 (2.2%)	376 009 (2.2%)	35 828 (2.0%)	11 531 (2.8%)	1221 (4.5%)
<5	2 346 775 (12%)	2 104 936 (13%)	186 904 (10%)	50 598 (12%)	4337 (16%)
5	1 909 242 (10%)	1 713 394 (10%)	154 733 (8.5%)	38 343 (9.3%)	2772 (10%)
6–10	12 200 278 (64%)	10 745 120 (64%)	1 183 121 (65%)	256 698 (62%)	15 339 (57%)
11+	2 113 273 (11%)	1 792 225 (11%)	261 472 (14%)	56 365 (14%)	3211 (12%)
Missing	532 765	469 513	50 505	11 819	928
Received inadequate prenatal care[c]	5 865 946 (30%)	5 237 583 (30%)	488 062 (26%)	129 632 (30%)	10 669 (38%)
Preterm birth categories[d]					
Extreme prematurity	44 438 (0.2%)	37 151 (0.2%)	5723 (0.3%)	1458 (0.3%)	106 (0.4%)
Very premature	102 578 (0.5%)	84 504 (0.5%)	13 986 (0.7%)	3808 (0.9%)	280 (1.0%)
Moderate prematurity	139 090 (0.7%)	114 707 (0.7%)	18 818 (1.0%)	5193 (1.2%)	372 (1.3%)
Late prematurity	926 157 (4.8%)	776 964 (4.5%)	115 914 (6.2%)	31 010 (7.3%)	2269 (8.2%)
Full term	18 248 211 (94%)	16 129 703 (94%)	1 711 639 (92%)	382 259 (90%)	24 610 (89%)
Missing	66 448	58 168	6483	1626	171
Low birth weight[e]					
Extreme	36 950 (0.2%)	30 404 (0.2%)	5084 (0.3%)	1364 (0.3%)	98 (0.4%)
Very low	69 980 (0.4%)	56 939 (0.3%)	10 011 (0.6%)	2822 (0.7%)	208 (0.8%)
Low	890 877 (4.8%)	758 868 (4.6%)	101 995 (5.8%)	27 878 (7.0%)	2136 (8.3%)
Not low birth weight	17 555 817 (95%)	15 514 778 (95%)	1 651 765 (93%)	366 060 (92%)	23 214 (90%)
Missing	973 298	840 208	103 708	27 230	2152

[a]Data are presented as number (percentage). Note: all *P* values for each variable were <0.001 by Pearson χ^2 test (not shown).

[b]All missing data are <2% except number of prenatal visits and received inadequate prenatal care which were 2.7% and low birth weight which was 5% (see Figure S1 for heat map of data missingness).

[c]Inadequate prenatal care: fewer than five prenatal visits and care that is not initiated in the first trimester (<13 weeks).

[d]Preterm birth: extreme prematurity <28 weeks; very premature 28–32 weeks; moderate prematurity 32–34 weeks; and late prematurity 34–37 weeks.

[e]Low birth weight: extreme <1000 g; very low 1000–1499 g; low 1500–2500 g; not low >2500 g.

vulnerability (marginalization) and education. Women living in municipalities with very high marginalization (versus very low) had greater odds of receiving inadequate prenatal care (adjusted odds ratio [aOR] 1.28; 95% CI 1.26–1.29) (Table 3). Having a high school (aOR 0.78; 95% CI 0.77–0.79) or professional (aOR 0.47; 95% CI 0.47–0.48) education (versus secondary school education) was associated with lower odds of receiving inadequate prenatal care (Table 3).

In multivariable analyses, the patterns of preterm birth and low birth weight increased with age in a dose-dependent pattern. The adjusted probability of preterm birth was 7.9% (95% CI 7.8%–8.1%) for the 20–34 age category, compared with 11.2% (95% CI 11.0%–11.4%) for women aged 35–39 years, 13.3% (95% CI 13.0%–13.5%) for women aged 40–44 years, and 15.0% (95% CI 14.4%–15.5%) in the 45–49 years age categories, holding all other covariates at the mean. The adjusted probability of a low birth weight neonate similarly increased with age: it was 7.4% (95% CI 7.2%–7.6%) for the 20–34 years age category, compared with 9.9% (95% CI 9.7%–10.1%) for the 35–39 years, 11.9% (95% CI 11.7%–12.2) for 40–44 years, and 13.9% (95% CI 13.4%–14.5) for the 45–49 years age categories, holding all other covariates at the mean (Figure 2). Additional factors associated with decreased odds of preterm birth and low birth weight were insurance status (Seguro Popular, other, and none), parity, and municipality-level marginalization. Coming from a more marginalized (higher vulnerability)

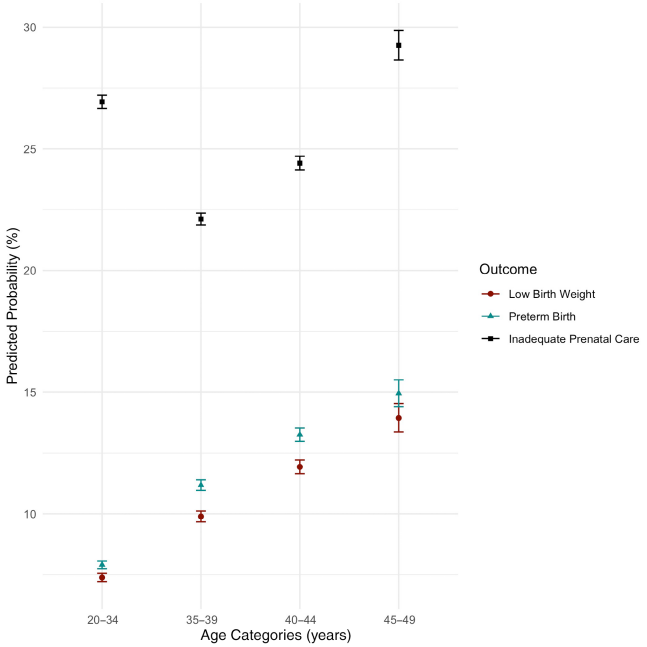

FIGURE 2 Adjusted predicted probability of inadequate prenatal care utilization, preterm birth, and low birth weight by age categories of women in Mexico 2008–2019. We show adjusted predicted probabilities (average marginal effects at the mean) for each outcome (inadequate prenatal care, preterm birth, and low birth weight) by age categories. All variables are adjusted for education, parity, insurance status, state, year, and municipality-level marginalization.

municipality was associated with lower odds of preterm birth or low birth weight (aOR 0.59; 95% CI 0.57–0.60 and aOR 0.73; 95% CI 0.71–0.75, respectively). Receiving inadequate prenatal care was associated with increased odds of preterm birth or low birth weight (aOR 1.23; 95% CI 1.22–1.24 and aOR 1.27; 95% CI 1.26–1.28, respectively). The full models and adjusted odds ratios are listed in Table 3.

4 | DISCUSSION

Our study reveals that women who gave birth at 35 years or older are a heterogeneous group. Our results start to explain the differences among age groups and further describe relationships between age, access to services, education, and other socio-structural factors. The oldest women in our study (aged 45–49 years at delivery) had the highest adjusted probabilities of receiving inadequate prenatal care, experiencing a preterm birth, and delivering a low-birth-weight neonate compared with women aged 20–34 years. Women aged 45–49 years also had the lowest levels of education, were more likely to be uninsured, and came from highly marginalized municipalities. Women aged 35–39 years also had higher adjusted probabilities of preterm birth and low birth weight compared with 20- to 34-year-old women, despite having more advantaged sociodemographic conditions compared with women aged 45–49 years.

Our results show that collapsing together all births to women aged 35 years and older obscures important differences in the risk of adverse outcomes by age as well as other differences in life circumstance or structural vulnerability. Overall, these results suggest that people with higher levels of education from wealthier communities may be delaying births, a relatively novel phenomenon in Mexico. Clinicians should understand that pregnant women over 35 include a combination of people with and without resources, people delaying births and people with several children already, and that the evidence we have about pregnancy over 35 (which is mainly biologic)[24] should be considered in the context of social factors as well.

Our findings confirm the impact of maternal age on preterm birth and low-birth-weight neonates. This is consistent with existing literature, that has shown older age to be associated with adverse perinatal outcomes, including preterm delivery, low birth weight, and worse Apgar scores.[2,7] However, by evaluating several age categories above 35 years, we add that as maternal age increases, so does the prevalence of these outcomes with a dose-dependent effect, even when controlling for individual, health system, and contextual confounders.

Inadequate prenatal care utilization does not follow the same dose-dependent pattern with age. Prenatal care is an important part of a healthy pregnancy and birth; however, strong evidence on the link between prenatal care utilization and pregnancy outcomes is difficult to generate because patients who receive more prenatal care tend to be different from those who do not.[25] Mexican woman over 40—who are also at higher risk of adverse birth outcomes—are more vulnerable to receiving inadequate prenatal care. The oldest women in our study (aged 45–49) had the highest probability of receiving inadequate prenatal care; however, women aged 35–40 years (the most educated group) had the lowest probability, even lower than the youngest (aged 20–34 years) comparison group. This is consistent with previous studies that have shown an association between inadequate prenatal care utilization with low levels of education, poor social support, unplanned pregnancy, and poverty,[26] and that higher education is protective.[27] Additionally, a study in the USA showed that perinatal outcomes were better for pregnant women just over the 35-year cut-off when compared with those just under this age, suggesting that the additional age-related pregnancy monitoring may play a role in improving outcomes.[5] Together these studies highlight that many factors influence utilization of prenatal services.

Strengths of our study include a standardized data source, national birth certificates (SINAC) and a census of all births in Mexico, resulting in a large analytical sample. However, our study has limitations. First, one of our outcomes (prenatal care utilization) is from self-reported data; however, they are registered within close proximity to data collection at delivery. Our data set only includes data on live births, so we are unable to report on other pregnancy outcomes such as miscarriage, abortion, or still birth. This may explain, for example, why coming from a more marginalized municipality was associated with lower odds of low birth weight and preterm birth. It is possible that in less resourced

TABLE 3 Factors associated with receiving inadequate prenatal care (fewer than five visits, initiated after first trimester) preterm birth, and low birth weight.

	Inadequate prenatal care		Preterm birth		Low birth weight	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
Age categories (reference 20–34 years)						
35–39 years	0.77	0.76–0.77	1.47	1.45–1.48	1.38	1.36–1.39
40–44 years	0.87	0.87–0.88	1.78	1.76–1.80	1.70	1.68–1.72
45–49 years	1.12	1.09–1.15	2.05	1.97–2.13	2.03	1.95–2.12
Education (reference Secondary)						
Primary	1.27	1.27–1.2815	0.99	0.98–1.00	1.01	1.00–1.02
High school	0.78	0.77–0.79	1.00	0.99–1.01	0.97	0.96–0.99
Professional	0.47	0.47–0.4753	1.01	1.00–1.02	0.99	0.98–1.00
None	1.75	1.73–1.76	0.99	0.97–1.00	0.99	0.98–1.01
Missing	1.54	1.52–1.57	1.12	1.08–1.15	1.08	1.04–1.12
Parity (reference 1)						
2	1.06	1.05–1.07	0.84	0.83–0.84	0.74	0.73–0.75
3 or more	1.37	1.36–1.38	0.82	0.82–0.83	0.70	0.70–0.71
Missing	2.54	2.39–2.70	1.62	1.49–1.76	1.55	1.41–1.70
Insurance Status (ref: IMSS/ ISSSTE/ PEMEX/ SEDENA/ SEMAR)[a]						
IMSS Oportunidades/ Seguro Popular[b]	1.85	1.84–1.87	0.83	0.82–0.84	0.93	0.92–0.94
Other	0.88	0.86–0.90	1.00	0.98–1.03	1.00	0.97–1.02
None	1.39	1.38–1.40	0.77	0.76–0.78	0.84	0.83–0.85
Missing	1.95	1.92–1.98	0.93	0.91–0.95	1.06	1.03–1.08
Municipality-level marginalization (reference very low)						
Very high	1.28	1.26–1.29	0.59	0.57–0.60	0.73	0.71–0.75
High	0.92	0.91–0.93	0.72	0.70–0.73	0.77	0.75–0.78
Medium	0.92	0.92–0.93	0.80	0.79–0.81	0.82	0.81–0.83
Low	1.00	0.99–1.00	0.88	0.87–0.89	0.88	0.86–0.89
Missing	1.11	1.06–1.16	1.40	1.31–1.48	1.43	1.34–1.53
Inadequate prenatal care[c]	NA	NA	1.23	1.22–1.24	1.27	1.26–1.28

Note: Model adjusted for year 2008–2019 and state (not shown).

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

[a]IMSS/ISSSTE/PEMEX/SEDENA/SEMAR: This comprises of the Mexican Institute of Social Security (IMSS)/Institute of Security and Social Services for State Workers (ISSSTE)/Mexican Petroleum (PEMEX)/Secretary of National Defense (SEDENA)/Secretary of the Navy (SEMAR).

[b]Mexico's universal health insurance program for people in the informal sector.

[c]Inadequate prenatal care: Fewer than five prenatal visits and care that is not initiated in the first trimester (<13 weeks).

settings, preterm and low birth weight infants did not survive. Moreover, we can only analyze the limited variables (clinical and sociodemographic) included in the register form and are unable to evaluate other factors that could impact outcomes such as quality of care, intendedness of pregnancy,[28] and previous contraceptive use. Finally, while the quality of SINAC data has improved over time, (Figure S1), we excluded more than >75 000 births (0.3%) due to missing or questionable data.

In conclusion, women in Mexico giving birth over 35 years old are a heterogeneous group. Birth at 35 years and older is associated with preterm birth and low-birth-weight neonates and the probability increases with age, up to 49 years old. Inadequate utilization of prenatal care is greatest for the oldest women, 45–49 years, but lowest for those aged 35–39 years.

AUTHOR CONTRIBUTIONS

LJ conducted analyses and drafted the article; EF conducted analyses and reviewed the article; BD conceived the study design, supervised analyses, and reviewed the manuscript; RS conceived the study design and reviewed the manuscript.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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