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Gestational Weight Gain-for-Gestational Age Z-Score Charts Applied across U.S. Populations

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Abstract

Background—Gestational weight gain may be a modifiable contributor to infant health outcomes, but the effect of gestational duration on gestational weight gain has limited the identification of optimal weight gain ranges. Recently developed *z*-score and percentile charts can be used to classify gestational weight gain independent of gestational duration. However, racial/ethnic variation in gestational weight gain and the possibility that optimal weight gain differs among racial/ethnic groups could affect generalizability of the *z*-score charts. The objectives of this study were (1) to apply the weight gain *z*-score charts in two different U.S. populations as an assessment of generalisability and (2) to determine whether race/ethnicity modifies the weight gain range associated with minimal risk of preterm birth.

Methods—The study sample included over 4 million live, singleton births in California (2007–2012) and Pennsylvania (2003–2013). We implemented a noninferiority margin approach in stratified subgroups to determine weight gain ranges for which the adjusted predicted marginal risk of preterm birth (gestation <37 weeks) was within 1 or 2 percentage points of the lowest observed risk.

Results—There were minimal differences in the optimal ranges of gestational weight gain between California and Pennsylvania births, and among several racial/ethnic groups in California. The optimal ranges decreased as severity of prepregnancy obesity increased in all groups.

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Supporting Information

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Conclusions—The findings support the use of weight gain *z*-score charts for studying gestational age-dependent outcomes in diverse U.S. populations and do not support weight gain recommendations tailored to race/ethnicity.

Keywords

weight gain; pregnancy; growth charts; gestational age; premature birth; ethnic groups

Preterm birth is a leading cause of infant death and long-term disabilities in the United States, and worldwide.¹ Weight gain during pregnancy has long been of interest as a potentially modifiable contributor to preterm birth and related outcomes, but has been difficult to study because women gain more weight as the duration of pregnancy increases.^{1–3} To address the need for a weight gain classification independent of gestational duration, our research team developed maternal weight gain-for-gestational age *z*-score and percentile charts for each week of gestation using serial weight measurements of women with healthy pregnancy and birth outcomes in Pittsburgh, Pennsylvania.^{4,5} We found that the *z*-score charts enabled estimation of the association between total gestational weight gain and preterm birth in Pennsylvania birth data that is unconfounded by length of pregnancy.^{6,7}

The external validity of the *z*-score charts, however, has been questioned because the source population for the *z*-scores was not nationally representative.^{5,8} In particular, the convenience sample that we used lacked women of Hispanic and Asian race/ethnicity, who make up nearly one-third of births in the United States.⁹ Racial/ethnic variation in gestational weight gain and the possibility that optimal weight gain differs among racial/ethnic groups could affect the generalisability of the *z*-score charts.^{9,10} Indeed, in 1990, the Institute of Medicine (IOM) recommended that non-Hispanic black women gain at the upper end of the recommended ranges of gestational weight gain to improve infant outcomes.¹¹ The updated 2009 IOM report, however, cited a lack of evidence to support this recommendation and a recent multinational study limited to women who were normal weight before pregnancy concluded that separate gestational weight gain recommendations for different racial/ethnic groups are not needed.^{12,13} Understanding racial/ethnic differences across prepregnancy BMI groups in the United States would inform both the application of the *z*-scores in diverse populations and future national recommendations for weight gain during pregnancy.

This study had two objectives: (1) apply the gestational weight gain *z*-score charts to the outcome of preterm birth separately in California and Pennsylvania birth data as an assessment of generalisability, and (2) determine whether maternal race/ethnicity modifies the gestational weight gain range associated with minimal risk of preterm birth by comparing several racial/ethnic groups in California.

Methods

Study Aim 1: Generalisability of *z*-score charts to California and Pennsylvania births

California and Pennsylvania study populations were drawn from the 3 208 204 (2007–2012) and 1 565 921 (2003–2013) recorded live births that occurred in these respective states

beginning when each state adopted the 2003 Revision of the U.S. Standard Certificate of Live Birth. We retained singleton births with complete, plausible values for gestational age, prepregnancy weight, height, body mass index (BMI), delivery weight and gestational weight gain (Figure S1).¹⁴ Characteristics of included and excluded subjects were compared. The final California sample included 2 744 741 births, and the Pennsylvania sample included 1 310 920 births. The State of California Committee for the Protection of Human Subjects, the University of California, Berkeley Committee for the Protection of Human Subjects, and the University of Pittsburgh Human Research Protection Office approved the study.

Preterm birth was defined as a delivery before 37 weeks of pregnancy, using obstetric estimates of gestational age from the birth certificates. Maternal prepregnancy BMI was calculated by dividing prepregnancy weight by the square of height (kg/m^2), as reported on the birth certificates, and classified as underweight (<18.5), normal weight (18.5 and <25), overweight (25 and <30), obese class 1 (30 and <35), obese class 2 (35 and <40) and obese class 3 (40). Gestational weight gain was the difference between delivery weight and prepregnancy weight. We converted gestational weight gain to weight gain-for-gestational age z -scores using z -score charts specific to prepregnancy BMI group.^{4,5} For each pregnancy, a z -score was calculated as follows: $([\ln(x + c)] - \mu)/\sigma$, where c is a constant used to ensure non-negative observations, x is the observed weight gain in kg, and μ and σ are the log-transformed mean and standard deviation, respectively, of weight gain at a given week of gestation in the same prepregnancy BMI group. Confounding variables were determined a priori using prior evidence and directed acyclic graphs. These variables were selected from available birth certificate fields and included maternal race/ethnicity, age at delivery, height, parity, education level, expected method of payment for delivery, cigarette smoking in the 3 months before pregnancy and trimester of entry to prenatal care.^{1,15–23}

We used noninferiority margins as a quantitative, systematic and reproducible approach to determine ranges of optimal gestational weight gain for the lowest risk of preterm birth.²⁴ First, we prespecified a noninferiority risk difference (RD) margin of 1% based on the Healthy People 2020 goal to reduce the prevalence of preterm birth in the United States.²⁵ This noninferiority margin represented the range of weight gain z -scores for which the predicted risk of preterm birth was not more than 1 percentage point higher than the lowest observed risk. A noninferiority RD margin of 2% was used as a secondary approach. Second, multivariable logistic regression models with robust standard errors were used to model the association between weight gain z -score and preterm birth. All regression models were stratified by state (California and Pennsylvania) and prepregnancy BMI category (because weight gain recommendations vary by BMI).^{12,18–20,22} Normality of the gestational weight gain z -score distributions was assessed using Q-Q plots and histograms. Stabilised inverse probability weights accounted for missing covariate data in the models. To capture nonlinear relationships, continuous variables (weight gain z -score, height, and age) were fit with restricted cubic splines using Akaike and Bayesian information criteria to determine the number of knots using Harrell's default placements.²⁶

As the third analysis step, we used the regression models to predict the marginal probability of preterm birth across weight gain z -scores. The probabilities were multiplied by 100 for

preterm birth risk per 100 livebirths, and the weight gain value at the nadir of preterm birth risk (the referent) was identified for each model. Fourth, we calculated RDs and 95% confidence intervals to compare preterm birth risk at weight gains above and below the referent weight gain value. Fifth, we identified the *z*-scores on the lower and upper sides of the nadir at which the upper limit of the 95% confidence interval exceeded the prespecified margin of noninferiority. Finally, using the *z*-score charts, we calculated total gestational weight gain amounts at 28 and 40 weeks' gestation that corresponded to the noninferiority margin *z*-scores. These amounts reflected the ranges of gestational weight gain associated with minimal risk of preterm birth.

Study Aim 2: Assessing effect modification by maternal race/ethnicity

For the second aim, we used California birth certificate data linked to infants' hospital discharge records that were previously generated via probabilistic linkage by the California Office of Statewide Health Planning and Development. We followed the same inclusion criteria as for the first aim, except we additionally excluded births that had congenital anomalies (identified using patient discharge data), did not have linked records, or were missing maternal race and ethnicity information (Figure S2). Patient discharge data were only available in California and enabled identification of congenital anomalies and spontaneous preterm births. The final sample comprised 2 280 206 births in California.

For stability of statistical models, we combined racial/ethnic subgroups and obesity classes (BMI ≥ 30) with the goal of at least 100 preterm birth cases in each model. Race/ethnicity groupings were based on U.S. Census and United Nations regional groupings and included non-Hispanic white, non-Hispanic black, Mexican, other Latin American/Caribbean, Eastern Asian (Chinese, Hmong, Japanese, Korean), South/South-eastern Asian/Pacific Islander (Indian, Cambodian, Filipino, Laotian, Thai, Vietnamese, Guamanian, Hawaiian, Pacific Islander, Samoan) and American Indian/Alaskan Native.^{27,28} We duplicated Aim 1 analytical procedures for this aim, but additionally stratified analyses by maternal race/ethnicity and adjusted models for maternal nativity (available only in California).

In a secondary analysis, we tested whether optimal ranges of gestational weight gain differed between spontaneous and provider-initiated preterm births because weight gain could affect these preterm birth subtypes differently.²⁹ We used birth certificate data and patient diagnosis codes in the form of *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) to classify preterm birth with premature labour (ICD-9-CM code 644) or premature rupture of membranes (ICD-9-CM code 658.1) as spontaneous and all other preterm births as provider-initiated. We used multivariable logistic regression models adjusted for all confounding variables, including maternal race/ethnicity and nativity, and stratified by all categories of prepregnancy BMI for this analysis. All analyses were performed using Stata version 13.1 (StataCorp, College Station, Texas).

Results

Study Aim 1

In California, 51% of women were Hispanic, 30% were non-Hispanic white, 13% were Asian/Pacific Islander and 6% were non-Hispanic black (Table S1). In contrast, 73% of women in Pennsylvania were non-Hispanic white, 13% were non-Hispanic black, 9% were Hispanic and 4% were Asian/Pacific Islander. In both California and Pennsylvania, approximately half of women were normal weight prepregnancy, 45% were overweight or obese and 70% had a gestational weight gain *z*-score from -1 to $+1$ standard deviations. The prevalence of preterm birth was 6.3% in California and 7.7% in Pennsylvania. In both states, excluded subjects tended to have lower socio-economic indicators, a lower proportion were non-Hispanic white, and rates of preterm birth and extreme maternal weight values were higher compared to included subjects (Tables S2 and S3).

The results for the 1% RD noninferiority margin analyses in California and Pennsylvania are shown in Table 1. As an example, in women who were normal weight and delivered in California, the lowest risk of preterm birth was 5.2 per 100 live births and occurred at a gestational weight gain *z*-score of 0.03, equivalent to 10.5 kg at 28 weeks of pregnancy and 16.6 kg at 40 weeks of pregnancy. The 95% confidence interval included the 1% RD noninferiority margin from -0.72 to $+0.68$ *z*-scores. This range would be equivalent to 7.6–13.3 kg at 28 weeks of pregnancy and 12.5–20.7 kg at 40 weeks of pregnancy. In women who were normal weight and delivered in Pennsylvania, the lowest preterm birth risk was 5.1 per 100 live births and occurred at a *z*-score of 0.24, equivalent to 11.4 kg at 28 weeks of pregnancy and 17.8 kg at 40 weeks of pregnancy. The 1% RD noninferiority margin ranged from -0.44 to $+0.87$ *z*-scores, which corresponds to 8.6–14.2 kg at 28 weeks of pregnancy and 14.0–22.0 kg at 40 weeks of pregnancy. In summary, the adjusted risk of preterm birth among women who were normal weight before pregnancy did not increase by more than 1 percentage point if total weight gained during pregnancy was equivalent at 28 weeks' gestation to 7.6–13.3 kg among Californian deliveries and 8.6–14.2 kg among Pennsylvanian deliveries. Figure 1 illustrates these findings.

Weight gain ranges at term corresponding to the 1% RD noninferiority margins in California and Pennsylvania women are shown in Figure 2. The ranges were similar in width and overlapped in all prepregnancy BMI groups, except for underweight and obese class 3, for which there was insufficient statistical power in the Pennsylvania sample to determine the 1% RD noninferiority margins. However, the predicted marginal probability plots for women who were underweight or obese class 3 were similar in the California and Pennsylvania samples (Figure S3) and the 2% RD noninferiority margins in underweight women were similar in both samples (Table S4). The optimal weight gain ranges for minimal risk of preterm birth consistently decreased with increasing BMI above normal weight in California and above overweight in Pennsylvania. There were differences in the width of the ranges among subgroups, which were likely due in part to differences in statistical power. In subgroups with higher statistical power, 95% confidence intervals were narrower causing noninferiority margins to be wider. The weight gain ranges were also slightly lower in California compared to Pennsylvania across BMI groups. Noninferiority

margins for 2% risk differences corresponded to weight gain ranges at 40 weeks of pregnancy that were approximately 4–5 kg wider than for 1% RD noninferiority margins (Table S4).

Study Aim 2

Maternal characteristics and preterm birth prevalence varied across maternal racial/ethnic groups within the California linked birth certificate and infant hospital discharge sample (Table 2). Eastern Asian women had the highest prevalence of prepregnancy underweight and American Indian/Alaskan Native women had the highest prevalence of prepregnancy obesity. Gestational weight gain z -score < -1 standard deviation was most common in the Hispanic and Asian groups, and weight gain > 1 standard deviation was most common in the American Indian/Alaskan Native and non-Hispanic black groups. The prevalence of preterm birth ranged from 5.2% in Eastern Asian women to 9.2% in non-Hispanic black women.

Among the maternal racial/ethnic groups, the gestational weight gain ranges established by the noninferiority margins largely overlapped. In women who were normal weight before pregnancy, the total z -score range across racial/ethnic groups for a noninferiority margin of 1% RD was -0.72 – 0.68 , equivalent to 11.8–22.2 kg at 40 weeks of pregnancy (Figure 3; Table S5). Racial/ethnic groups with larger sample sizes had wider noninferiority margins because of narrower 95% confidence intervals. For detailed results and additional optimal weight gain range plots comparing racial/ethnic groups in California, see Tables S5 and S6 and Figure S4. Statistical power was insufficient to estimate the noninferiority margins in several combinations of prepregnancy BMI and maternal race/ethnicity, which were therefore excluded. However, Figure S5 shows the adjusted predicted marginal probabilities of preterm birth in all prepregnancy BMI-racial/ethnic groups in California. There was no indication of meaningful differences between races/ethnicities, except for extreme weight values in American Indians/Alaskan Natives, which were too sparse to be reliable. As for the first study aim, noninferiority margins of 2% RD resulted in optimal weight gain ranges that were generally wider by 4–5 kg than for noninferiority margins of 1% RD (Table S6).

For the secondary analysis separating spontaneous preterm birth from provider-initiated preterm birth, optimal weight gain ranges were slightly wider for both outcomes and tended to encompass the ranges found for preterm birth overall (Table S7). For example, in women who were normal weight before pregnancy, the equivalent weight gain ranges at 40 weeks of pregnancy were 12.3–22.5 kg for spontaneous preterm birth (prevalence 4.5%) and 6.3–24.5 kg for provider-initiated preterm birth (prevalence 1.9%).

Comment

Principal findings

In this population-based study, gestational weight gain z -score charts provided a method unconfounded by length of gestation for studying the association between gestational weight gain and preterm birth in diverse U.S. populations. Optimal gestational weight gain ranges for minimal risk of preterm birth, determined using noninferiority margins and the z -score charts, differed by prepregnancy BMI, but did not meaningfully differ between two

fundamentally different state populations or among maternal racial/ethnic groups in California. These findings suggest that the weight gain *z*-score charts can be used in diverse U.S. populations and do not support weight gain recommendations specific to maternal race/ethnicity.

Interpretation

Serial, measured weights in pregnancy are the gold standard for weight gain classification, but are only available in limited research cohorts.^{4,15–17} Total gestational weight gain is the most widely available measure at the population level and has been used in numerous studies on weight gain and preterm birth.^{12,18–21} These studies have classified total weight gain using inconsistent approaches, which have been found to overestimate associations between low weight gain and preterm birth.⁶ Our research team developed the weight gain-for-gestational age *z*-score and percentile charts as a new way to classify gestational weight gain independent of gestational duration, akin to the well-established use of fetal and paediatric weight-for-age *z*-score and percentile charts. We created the *z*-scores using serial, measured prenatal weights from women with healthy pregnancy and birth outcomes in Pittsburgh, Pennsylvania.⁴ This study is the first to apply the *z*-scores to populations with diverse racial/ethnic make-up. The *z*-scores had similar distributions and were similarly associated with preterm birth in two states with highly different population characteristics and among several racial/ethnic groups. As national or statewide data are not available to generate gestational weight gain *z*-scores, these findings serve as support for the generalisability of the existing *z*-scores to diverse U.S. populations.

The risk of preterm birth and the amount of weight gained during pregnancy differ among racial/ethnic groups.^{9,10} Such differences prompted the IOM in 1990 to recommend that non-Hispanic black women gain at the upper end of the recommended gestational weight gain ranges,¹¹ but this recommendation was abandoned in the 2009 IOM revision because of insufficient evidence.¹² A few studies that assessed gestational weight gain and preterm birth in relation to race/ethnicity have reported modest and inconsistent differences between non-Hispanic black and white women.^{17,18,21,30,31} In the current analysis, we extended our assessment of gestational weight gain and preterm birth to seven racial/ethnic groups. There were considerable differences in weight gain amounts and the prevalence of preterm birth among racial/ethnic groups; however, differences in the optimal ranges of gestational weight gain for minimal risk of preterm birth were small and do not substantiate tailoring weight gain recommendations to race/ethnicity. Our findings corroborate those of Cheikh Ismail *et al.*,¹³ who recently developed international *z*-score charts for gestational weight gain in normal-weight women and concluded that racial/ethnic differences observed in prior studies were likely caused by sociocultural and medical factors.

This study, although limited to the outcome of preterm birth, may be informative for future revisions of the IOM guidelines for gestational weight gain. We applied a unique, quantitative approach to determine optimal weight gain ranges for minimal risk of preterm birth in six prepregnancy BMI categories. Weight gain ranges that corresponded to preterm birth risk within one percentage point of minimum risk, in alignment with the Healthy People 2020 goal for preterm birth, was very comparable to the IOM recommended ranges

for women who are not obese.¹² The upper limits of the ranges found in this study were higher than the upper limits of the IOM recommended ranges; however, the upper range limits in the IOM guidelines were based primarily on reducing risk of Caesarean delivery and large-for-gestational age births, not preterm births.¹² Revisions to the IOM guidelines would require consideration of several health outcomes, in addition to preterm birth, and consensus by policymakers on a tolerable level of risk of such outcomes, as that would affect the width of recommended weight gain ranges.

Limitations of the data

The validity of prepregnancy weight reported on the birth certificate varies by prepregnancy BMI and likely caused some misclassification of prepregnancy BMI and gestational weight gain in this study.^{32,33} However, there is little evidence of error in birth certificate-derived delivery weight and a recent systematic review concluded that error in self-reported prepregnancy weight largely did not bias associations with birth outcomes.^{32,33} As recommended by the World Health Organization, we used the same BMI cut-offs in all racial/ethnic groups;³⁴ however, these cut-offs may not have categorised amount of overweight the same across racial/ethnic groups, particularly in Asians. Statistical power in some combinations of BMI and racial/ethnic groups prevented analysis in all subgroups of interest, which need more research. We were also unable to validly distinguish spontaneous and provider-initiated preterm births or exclude infants with congenital anomalies using birth certificate data in the study aim with Pennsylvania births,²³ but did not find any differences after differentiating preterm birth type and excluding congenital anomalies using the California patient discharge data. There were differences between included and excluded subjects, likely indicating some selection bias and reflecting the exclusion of implausible weights and gestational ages. Use of *z*-scores required the pattern of weight gain during gestation to be similar in the study population and the *z*-score standard population. We believe this assumption was reasonable based on the similar patterns of weight gain in other study populations.^{12,13} Our observational study can only demonstrate associations and may not extend to other populations.

Strengths of the study

This study used two contemporary population-based samples that comprised over 4 million births. Large sample sizes and diverse characteristics enabled us to study wide ranges of gestational weight gain and prepregnancy BMI, and to make comparisons across several racial/ethnic groups. The noninferiority margin method demonstrated an approach to identifying optimal ranges of weight gain during pregnancy that is quantitative, systematic and reproducible.²⁴ Preterm birth was classified using the obstetric estimate of gestational age on the birth certificates, which has been found to have excellent validity.³⁵ Hospital discharge data linked to birth certificate data in California also enabled valid differentiation of spontaneous and provider-initiated preterm birth in a secondary set of analyses.

Conclusions

This study provides evidence to support the use of existing gestational weight gain *z*-score and percentile charts in diverse U.S. populations. The charts may be useful tools to further our understanding of optimal gestational weight gain and gestational age-dependent health

outcomes, which could inform future interventions and weight gain recommendations.⁷ Using the z-score charts, we found that low and high weight gain was associated with increased risk of preterm birth and that optimal weight gain ranges for minimal risk of preterm birth decreased as severity of prepregnancy overweight/obesity increased. Additionally, the present findings add to limited evidence that gestational weight gain recommendations tailored to maternal race/ethnicity are not warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Adjusted predicted marginal risks of preterm birth per 100 live births in (a) California and (b) Pennsylvania women who were normal weight (BMI 18.5–24.9 kg/m²) before pregnancy. Solid curved lines represent point estimates and dashed curved lines represent 95% confidence intervals. The inside vertical lines represent the noninferiority margins for a 1% risk difference and the outside vertical lines represent the noninferiority margins for a 2% risk difference.

Figure 2.

Optimal gestational weight gain ranges at term (40 weeks' gestation) for lowest preterm birth risk corresponding to noninferiority margins of 1% risk difference. Solid lines represent California and dashed lines represent Pennsylvania. Data for low and high weight gains in Pennsylvania underweight and obese class 3 were sparse.

Figure 3.

Optimal gestational weight gain ranges at term (40 weeks' gestation) for lowest preterm birth risk corresponding to noninferiority margins of 1% risk difference in California births to women who were normal weight (BMI 18.5–24.9 kg/m²) before pregnancy.

Table 1.

Adjusted^a results in California ($n = 2\,744\,741$), 2007–2012, and Pennsylvania ($n = 1\,310\,920$), 2003–2013, pregnancies using noninferiority margins of one percentage point in marginal risk

Pregnancy body mass index and U.S. state	Lowest risk per 100 Live Births	Lower Margin		Upper Margin		Corresponding weight gain at 28 weeks (kg)	Corresponding weight gain at 40 weeks (kg)
		Weight-gain Z-score of lowest risk	Risk difference (95% confidence interval)	Weight gain Z-score	Risk difference (95% confidence interval)		
Underweight							
California	6.1	0.20	0.29 (0.11, 0.48)	-0.30	0.31 (0.13, 0.49)	8.8 – 12.9	13.7 – 19.7
Pennsylvania	8.5	0.28	NA	NA	NA	NA	NA
Normal weight							
California	5.2	0.03	0.44 (0.38, 0.49)	-0.72	0.42 (0.36, 0.49)	7.6 – 13.3	12.5 – 20.7
Pennsylvania	5.1	0.24	0.40 (0.30, 0.49)	-0.44	0.37 (0.24, 0.49)	8.6 – 14.2	14.0 – 22.0
Overweight							
California	5.1	-0.11	0.39 (0.29, 0.49)	-0.87	0.38 (0.29, 0.48)	5.4 – 11.4	9.8 – 17.9
Pennsylvania	5.2	0.13	0.33 (0.18, 0.48)	-0.49	0.31 (0.13, 0.49)	7.2 – 15.3	12.3 – 23.4
Obese Class 1							
California	6.1	-0.46	0.33 (0.18, 0.47)	-1.20	0.36 (0.23, 0.49)	1.4 – 8.7	4.4 – 14.1
Pennsylvania	5.9	0.13	0.27 (0.07, 0.48)	-0.34	0.22 (-0.03, 0.48)	5.8 – 10.8	10.2 – 16.8
Obese Class 2							
California	6.2	-0.39	0.26 (0.04, 0.49)	-0.96	0.32 (0.15, 0.49)	-0.6 – 5.9	2.1 – 11.1
Pennsylvania	5.9	0.05	0.16 (-0.16, 0.49)	-0.37	0.14 (-0.19, 0.49)	2.7 – 7.1	6.6 – 12.8
Obese Class 3							
California	6.9	-0.33	0.17 (-0.15, 0.49)	-0.67	0.26 (0.03, 0.48)	-1.9 – 3.3	0.3 – 7.4
Pennsylvania	NA	NA	NA	NA	NA	NA	NA

^aAdjusted for maternal race/ethnicity, maternal age at delivery, height, parity, education level, expected method of payment for delivery, cigarette smoking in the 3 months prior to pregnancy, and trimester of entry to prenatal care.

Characteristics of women delivering live births in California ($n = 2\,280\,206$), 2007–2012

Table 2.

	Mexican $n = 1\,015$ 386 %	Non-Hispanic white $n = 664$ 456 %	Latin American/ Caribbean $n = 227$ 453 %	South/South- eastern Asian/ Pacific Islander n = 132 550 %	Non Hispanic black $n = 121\,386$ %	Eastern Asian n = 110 478 %	American Indian/ Alaskan native $n =$ 8497 %
Prepregnancy body mass index (kg/m^2)							
Underweight (<18.5)	2.7	4.3	2.9	8.4	4.1	12.0	2.9
Normal weight (18.5 to <25)	42.0	57.2	44.7	63.8	41.9	72.6	36.7
Overweight (25 to <30)	30.2	22.1	28.5	18.1	26.3	11.8	26.4
Obese (≥ 30)	25.1	16.4	23.9	9.7	27.7	3.7	34.0
Gestational weight gain z -score							
<-1 SD	24.0	14.8	22.4	21.6	18.9	24.3	15.1
-1 to +1 SD	69.2	74.6	70.0	71.3	67.8	71.5	70.4
>+1 SD	6.8	10.7	7.7	7.1	13.3	4.3	14.5
Maternal age at birth							
10–19 years	12.5	4.0	12.2	2.7	13.0	1.2	12.1
20–24 years	26.6	15.9	25.9	11.5	29.4	5.6	29.1
25–29 years	27.3	27.7	27.1	25.2	25.6	19.0	28.1
30–34 years	20.5	30.0	21.3	33.2	19.1	40.0	19.3
35 years	13.2	22.3	13.6	27.5	13.0	34.1	11.4
Primiparous	34.0	44.7	39.1	41.5	41.1	48.9	34.1
Maternal education at birth							
Less than high school	42.3	5.8	32.4	6.1	16.7	3.6	23.4
High school	30.9	21.2	31.3	20.9	34.6	10.9	37.6
Some college	19.6	28.6	24.4	30.3	34.9	18.0	28.5
College	7.2	44.4	12.0	42.7	13.9	67.6	10.5
Expected payment for delivery							
Private insurance	28.0	71.7	32.7	66.8	35.4	72.6	35.7
Other	72.0	28.3	67.4	33.2	64.6	27.4	64.3
Mother born in the U.S.	43.7	87.3	54.7	22.7	90.4	18.8	98.3
Smoked in 3 months before pregnancy	1.2	7.3	1.9	2.1	6.0	1.0	14.2
Prenatal care entry							

	Mexican <i>n</i> = 1 015 386 %	Non-hispanic white <i>n</i> = 664 456 %	Latin American/ Caribbean <i>n</i> = 227 453 %	South/South- eastern Asian/ Pacific Islander <i>n</i> = 132 550 %	Non Hispanic black <i>n</i> = 121 386 %	Eastern Asian <i>n</i> = 110 478 %	American Indian/ Alaskan native <i>n</i> = 8497 %
1st trimester	80.5	87.7	82.3	83.7	78.1	88.7	69.5
2nd trimester	15.9	10.2	14.4	13.7	17.5	9.4	23.2
3rd trimester or none	3.6	2.1	3.3	2.7	4.4	1.9	7.3
Preterm birth	6.3	5.6	6.9	8.1	9.2	5.2	7.6
Spontaneous preterm birth	4.3	4.0	4.8	5.7	6.4	3.9	5.1
Provider-initiated preterm birth	1.9	1.6	2.1	2.4	2.8	1.3	2.6

SD, standard deviation.