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Association of COVID-19 pandemic societal closures with gestational weight gain among women in South Carolina, 2018–2021

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Abstract

Purpose: During the early COVID-19 pandemic, an increase in weight gain among the general population was observed; however, gestational weight gain (GWG) was not thoroughly evaluated. We evaluated changes in GWG during the pandemic closures in South Carolina.

Methods: We used live, singleton birth records to compare GWG outcomes among three pregnancy groups occurring before (January 2018–February 2020), during (March–May 2020), and after (June 2020–December 2021) pandemic closures. GWG categories were defined by the Institute of Medicine (IOM) recommendations. We used multinomial logistic regression models to calculate prevalence ratios (PRs) of GWG categories stratified by prepregnancy body mass index (BMI) category.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Results: We analyzed 177,571 birth records. Women with normal weight (n = 64,491, 36%) had a slightly lower prevalence of excessive GWG during and after the pandemic closures (PR 0.94; 95% CI: 0.91–0.98 and PR 0.95; 95% CI: 0.93–0.98, respectively). We observed no changes in GWG patterns for women with overweight and obesity.

Conclusions: We found limited changes in GWG patterns for a subset of pregnant women during and after pandemic closures, compared with prepandemic period in South Carolina, countering findings of weight changes among the general population.

Keywords

Gestational Weight Gain; Pandemic Closures; Maternal Child Health; Obesity; COVID-19

Introduction

Gestational weight gain (GWG) is a useful health measure during pregnancy because values outside the recommended ranges are associated with adverse maternal and child health outcomes(1–4). GWG has been increasing in the United States [1] during the last two decades. Excessive GWG (i.e., weight gain above recommendations) is associated with fetuses that are large for gestational age and postpartum weight retention [2,3]. Inadequate GWG (i.e., weight gain below recommendations) is associated with small for gestational age, preterm birth [1], and others [1,2,4]. The Institute of Medicine (IOM) established guidelines for GWG in 2009, defining the recommended weight gain based on prepregnancy body mass index (BMI), and these standards have been endorsed by the American College of Obstetricians and Gynecologists [5]. Both individual and environmental factors are associated with excessive GWG, including personal physical activity and place of residence [6,7]. In South Carolina (SC), 48.5% of pregnant women had excessive or above recommended GWG, and 21.5% had inadequate or below recommended GWG in 2013 [8]. South Carolina has a high prevalence of overweight and obesity in women of childbearing age, last reported as 55% in 2015 [8]. Understanding environmental factors that might have affected GWG or other maternal child health indicators during the COVID-19 pandemic is necessary for mitigating current and future public health problems.

The COVID-19 pandemic initially presented numerous public health challenges and more so among persons at increased risk for illness, including pregnant women. The societal closures implemented in March 2020 to slow the spread of the virus that causes COVID-19 had lasting secondary effects on pregnancies, including increased stress and poor mental health for expecting parents [9–12]. However, the effects on GWG have not been thoroughly explored. Compared with other states and certain countries, South Carolina had relatively modest pandemic restrictions during the spring 2020, primarily shorter duration of closures and fewer statewide mandates that might affect health [13]. COVID-19 was not widespread in SC until June 2020. Still, pandemic closures might have differentially affected pregnant persons through interruptions to routine medical care and lifestyle or health habits [14]. The decreased access to places for routine physical activity, changes in eating patterns (e.g., increased emotional eating of high-density caloric foods), alterations in sleep habits, financial difficulties, and increased stress might have affected the weight of the adult population [15,16]. Studies of nonpregnant adults reported greater odds for unhealthy

behaviors [15] and atypical weight gain [17] among persons with obesity, compared with healthy weight peers during May–August 2020, and these findings might be consistent among pregnant persons as well [14,18].

In this study, we compared prevalence of inadequate and excessive GWG before and during the COVID-19 pandemic closures in SC. We hypothesized that within BMI categories, the proportion of women gaining inadequate or excessive GWG was higher during and after the pandemic closures, compared with before the pandemic. Understanding effects of pandemic closures on aspects of maternal child health might provide evidence to improve and support ongoing public health programs.

Methods

Data came from the South Carolina birth certificates restricted to all birthing persons who delivered a singleton live birth during January 2018–December 2021. These records included only births >500 grams after 20 weeks of gestation. We excluded 2,226 records with missing data regarding prepregnancy weight, weight at delivery, or prepregnancy BMI. Records with implausible prepregnancy BMI values (<10, >80) and with implausible gestational weight change (loss of ≥30 pounds or gain of ≥97 pounds) were also excluded (1,320 records). A total of 185,948 records met inclusion criteria to assess for exposure (Figure 1). Data were deidentified before acquisition.

Exposure

We evaluated three time periods as a proxy for exposure to pandemic closures, including stay-at-home orders, sheltering in place, business closures, and other changes in human movement or interactions on gestational weight gain [19,20]. We considered births before March 2020 as unexposed (i.e., prepandemic). We considered the time from the beginning of March 2020 to the end of May 2020 as a three-month period representing the highest burden of closures in South Carolina based on a timeline of orders and actions from the state government [13]. Because gestational weight gain in the first trimester is minimal and increases almost linearly starting from the second trimester, we sequentially categorized pregnancies into two exposure groups. Using delivery date and length of gestation, we established dates to estimate the beginning of the second trimester and beginning of the third trimester. Those whose second or third trimester started during March–May 2020 were considered exposed to pandemic closures and those whose second trimester started in June 2020 or later were considered exposed postclosures. This second exposure group represents persons with a prepregnancy or very early pregnancy exposure that might influence BMI and other maternal factors (i.e., lingering environmental stressors, employment, and changes in healthcare access). In total, 8,377 records did not meet criteria for one of the exposure groups, for example, births occurring in late March 2020.

Covariates

We included the maternal covariates of age, race and ethnicity (White non-Hispanic, Black non-Hispanic, Hispanic, Other non-Hispanic [Inclusive of multiracial, American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Island, and Unknown race people]). We

included maternal education (some high school, completed high school, some college, bachelor's degree, or graduate school), parity (none, 1, 2, 3+), prepregnancy BMI categories (underweight, normal, overweight, and obesity), pregnancy complications (prepregnancy or gestational hypertension or diabetes mellitus), and infant sex. We included maternal smoking during pregnancy, initiation of prenatal care during the first trimester, source of payment for delivery (private insurance, Medicaid, other public insurance, or self-pay), and urban or rural location of delivery.

Outcome

Based on the 2009 IOM recommendations regarding GWG, we classified GWG into three categories: inadequate, adequate, or excessive (5). Weight gain below the recommended range was considered inadequate and, if above the recommendation, excessive. GWG was calculated by subtracting weight at delivery from prepregnancy weight, measured in pounds. IOM recommendations outline GWG for pregnant persons based on standard prepregnancy BMI categories: underweight, normal weight, overweight, and obesity.

Additionally, considering that pregnancy duration is closely associated to the total GWG, we created another measure of GWG: the weekly rate of gestational weight gain in the second and third trimesters. We subtracted a BMI-specific average weight gain (1.1–4.4 lbs) (5) for the first trimester from the total GWG then divided that by the number of weeks in the second and third trimesters (i.e., gestational age in weeks at delivery minus 13 weeks). This weekly rate was then categorized as inadequate, adequate, or excessive weekly gestational weight gain following IOM recommendations. This weekly GWG categorization served as a sensitivity analysis for actual GWG categorization.

Statistical Analysis

We describe the pregnant persons and covariates with descriptive statistics, including percentages, mean, or median as applicable. We used multinomial logistic regression models to predict the outcome of having inadequate or excessive total weight gain or weekly rate of weight gain, compared with adequate weight gain. We included covariates in our adjusted models as confounders based on existing literature (6,21) and theoretically plausible interactions after examining for collinearity. We considered prepregnancy BMI category as a potential effect modifier based on existing literature (7) and statistical analysis. We used an interaction term for prepregnancy BMI and the exposure groups (P value <0.001). We presented prevalence ratios (PRs) and 95% CIs from the adjusted models. Statistical analysis was completed using SAS® 9.4 (SAS Institute, Incorporated, Cary, North Carolina).

Ethics

This study received Institutional Review Board approval from the University of South Carolina. This activity was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy (See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq).

Results

Cohort Description

We analyzed 177,571 birth records. In total, 24,157 (13.6%) birth records were reported during the pandemic closure period and 50,251 (28.3%) during the postclosure period. The remaining 103,163 (58.1%) birth records were during the prepandemic period (Table 1). Mean age of persons was similar across exposure periods. Approximately 57% of women were White non-Hispanic and 31% were Black non-Hispanic. Women of other non-Hispanic racial groups (Asian, Native American, Native Hawaiian and Pacific Islander) compromised approximately 7% of the study population. A high prevalence of high pre-pregnancy BMI in this study was reported. In each exposure period, >25% of women had prepregnancy overweight and >34% had prepregnancy obesity. Percentage of women using WIC after pandemic closures began was 30.6%, and during the prepandemic period was 37.9%. Percentage of women using tobacco before or during pregnancy was 8.0% during the prepandemic period and 5.6% after pandemic closures began. Limited variation in the prevalence of gestational age at birth and pregnancy medical comorbidities of hypertension and diabetes mellitus across study periods was reported.

GWG Outcomes

Based on calculated GWG categorized into IOM standards, 24% of pregnancies had inadequate gestational weight gain, 29% had adequate gestational weight gain, and 47% had excessive gestational weight gain. Categorization of calculated weekly weight gain was less evenly distributed; 25% of pregnancies had inadequate, 13% had adequate, and 62% had excessive weekly GWG. The mean GWG within BMI categories was similar over time (Figure 2). The mean GWG for women with underweight and normal weight fell within the recommended IOM GWG range, but the mean GWG for women with overweight and obesity was above the IOM recommendations across all exposure periods. Women with overweight and obesity had the highest percentages of excessive GWG at all time points (Figure 3), and this was unchanged during and after the pandemic closures.

The adjusted PRs estimate the risk for having inadequate or excessive GWG compared with adequate weight gain for the pandemic closure periods. Small changes in prevalence during and after pandemic closures for subgroups of pregnancies were noted, but overall, the effect size was limited or null. For women with overweight and obesity, prevalence of excessive GWG was not changed during or after pandemic closures (Table 2). Prevalence of inadequate weight gain increased for women with normal weight during and after the closure periods relative to the time before pandemic closures (PR 1.06; 95% CI: 1.02–1.10; PR 1.09 95% CI: 1.06–1.12, respectively). Prevalence of excessive weight gain was not statistically different for women with obesity or overweight during the study period. Women with normal weight had a slightly lower prevalence of excessive GWG during and after the pandemic closures (PR 0.94; 95% CI: 0.91–0.98 and PR 0.95; 95% CI: 0.93–0.98, respectively).

Similar results were observed in the analysis of weekly weight gain in the second and third trimesters (Supplemental Table). Women with prepregnancy overweight and obesity were

less likely to have inadequate GWG during and after the pandemic closures but no change was reported in prevalence of excessive weight gain. Women with normal weight were slightly more likely to have inadequate GWG and slightly less likely to have excessive GWG during and after pandemic closures. No changes in GWG were identified among women who were underweight.

Discussion

Our study found largely null or minor changes in the prevalence of excessive and inadequate gestational weight gain during and after pandemic closures. Pandemic closures were highly disruptive to many aspects of life and were shown to affect the weight of nonpregnant persons (22). Our findings do not support that pandemic closures had clinically significant effects on GWG. Although GWG is only one measure of maternal child health, it is reassuring that a highly disruptive event like the pandemic closures did not greatly affect this one measure in an at riskpopulation. Minor increases in inadequate and excessive GWG in persons of normal prepregnancy weight were reported, but the clinical significance of this is not known. Overall, the mean weight changes were fractions of one kilogram.

Despite a high prevalence of overweight and obesity in South Carolina, few negative effects of pandemic closures were reported concerning GWG among this population subgroup. Pregnancy is an time of rapid weight gain dependent on many factors; relevant factors that influence weight gain in the nonpregnant person, such as exercise, access to nutritious food, and medical conditions. However, public health and medical interventions are needed to reduce the burden of excessive prepregnancy weight and to support adequate weight gain during pregnancy. Therefore, monitoring and supporting healthy weight is of public health importance before and during pregnancy.

Our study did not examine causal mechanisms that might have influenced gestational weight during and after pandemic closures. For example, there might have been balancing forces of increased attention to exercise (positive) and stress eating (negative) among the population. We observed a decrease in WIC enrollment during and after the pandemic which might signify decreased access to nutritional food for many families, although this might have been offset by economic stimulus from the federal government. We are unable to causally explain the increase in inadequate GWG among women with normal weight during and after pandemic closures. Causal mechanisms are other areas for future study to understand because weight gain was observed among the general nonpregnant population at the start of the pandemic. However, weight gain in pregnancy may be of greater public health importance because of the long-lasting effects on pregnant persons and their babies that can happen in a short period.

This study has similar findings to other studies that did not demonstrate significant changes to GWG during or after the pandemic(19,23). However, our study presents a more nuanced approach to the exposure through careful selection of pregnancy trimester overlayed onto closure time periods, compared with those studies that examined annual trends. Other studies analyzing weight gain associated with closures in nonpregnant persons saw average body weight increases greater than half a kilogram (16) during pandemic closures and

increased caloric intake among persons with obesity (15) and greater reported weight gain (17). Studies examining other maternal child health outcomes found that home quarantine was associated with higher GWG and poor neonatal outcomes in women with gestational hypertension (10,19,24,25).

Our study has limitations. We used time as a proxy for pandemic closures which might not have captured any lagged effect of pandemic closures, although the postclosure period was also separately examined. Additionally, the pandemic closures in South Carolina had fewer restrictions and enforcement mechanisms than other states and did not have strict lockdowns like in other countries. The degree of stress and effects of closures on each pregnant person might have manifested in other ways besides changes to weight, which is the only outcome we analyzed. We were unable to include the effect of COVID-19 disease on GWG at the person level, which would have had the most significant influences among the after closures group.

In this analysis we were able to represent a state's birthing population across multiple years and provide a more precise classification of the pandemic closure exposure for the state, representing a more nuanced approach than may be possible at a national level. Our results do not support that GWG was significantly affected by pandemic closures at the population level. We observed small GWG changes in women of normal weight, and the clinical implications of small GWG changes are questionable. Nonetheless, our observation of minor changes in GWG in a state with other maternal child health challenges is reassuring. Continued monitoring of weight gain before and during pregnancy is needed in South Carolina to improve maternal child health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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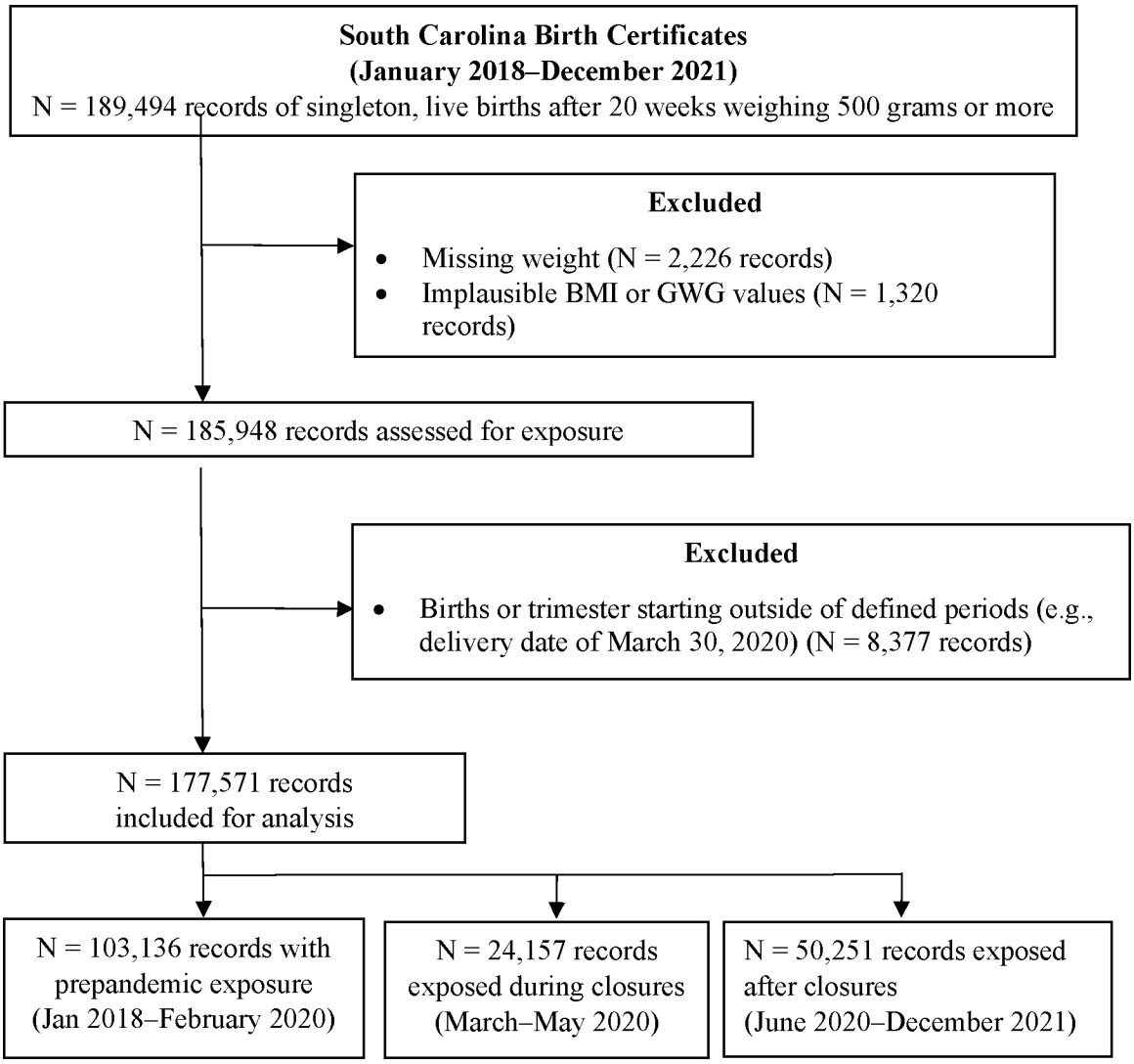

Fig 1.
Sample attrition of this study

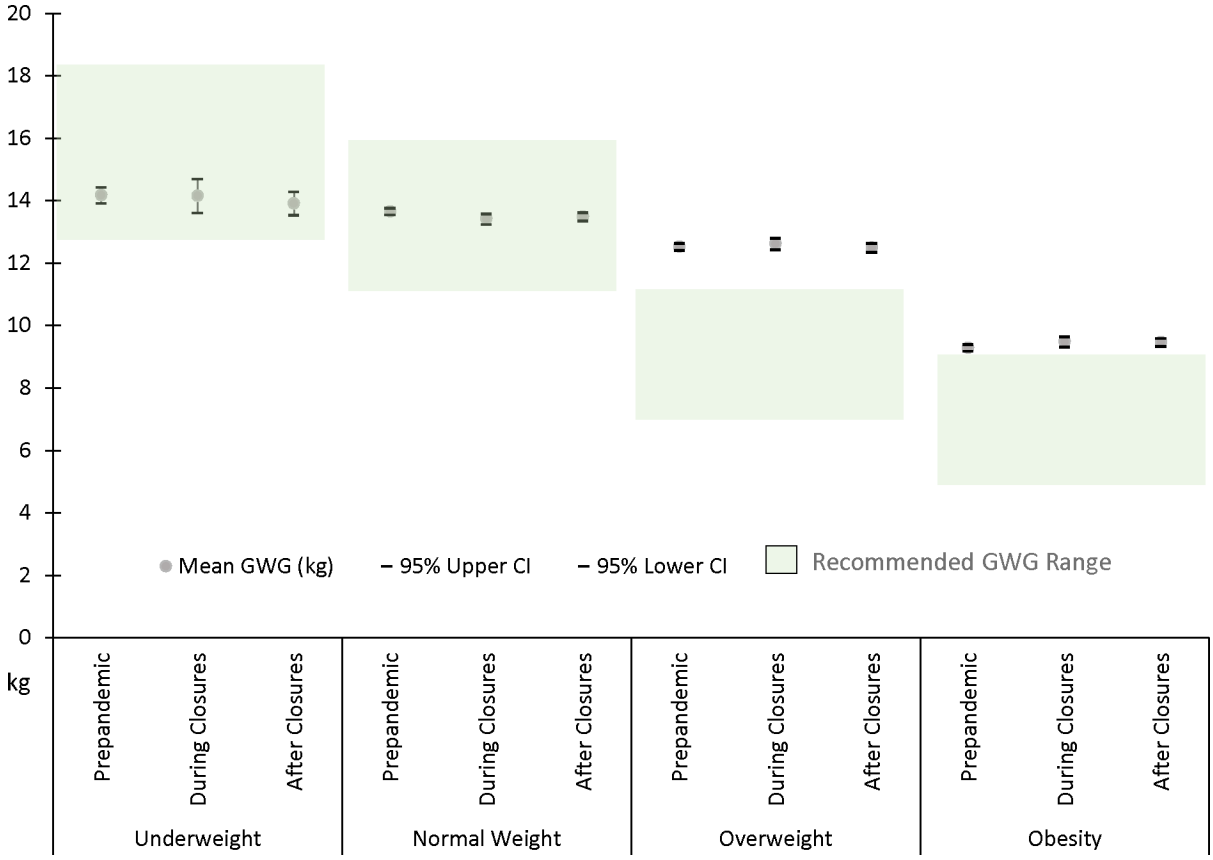

Figure 2:

Adjusted Mean Gestational Weight Gain Before, During, and After COVID-19 Pandemic Closures by Prepregnancy BMI, South Carolina 2018–2021

*Adjusted for age, race and ethnicity, maternal education, parity, length of gestation, medical complications (prepregnancy or gestational hypertension or diabetes mellitus), maternal smoking during pregnancy, initiation of prenatal care in first trimester, source of payment for delivery, urban or rural location of delivery, and infant sex.

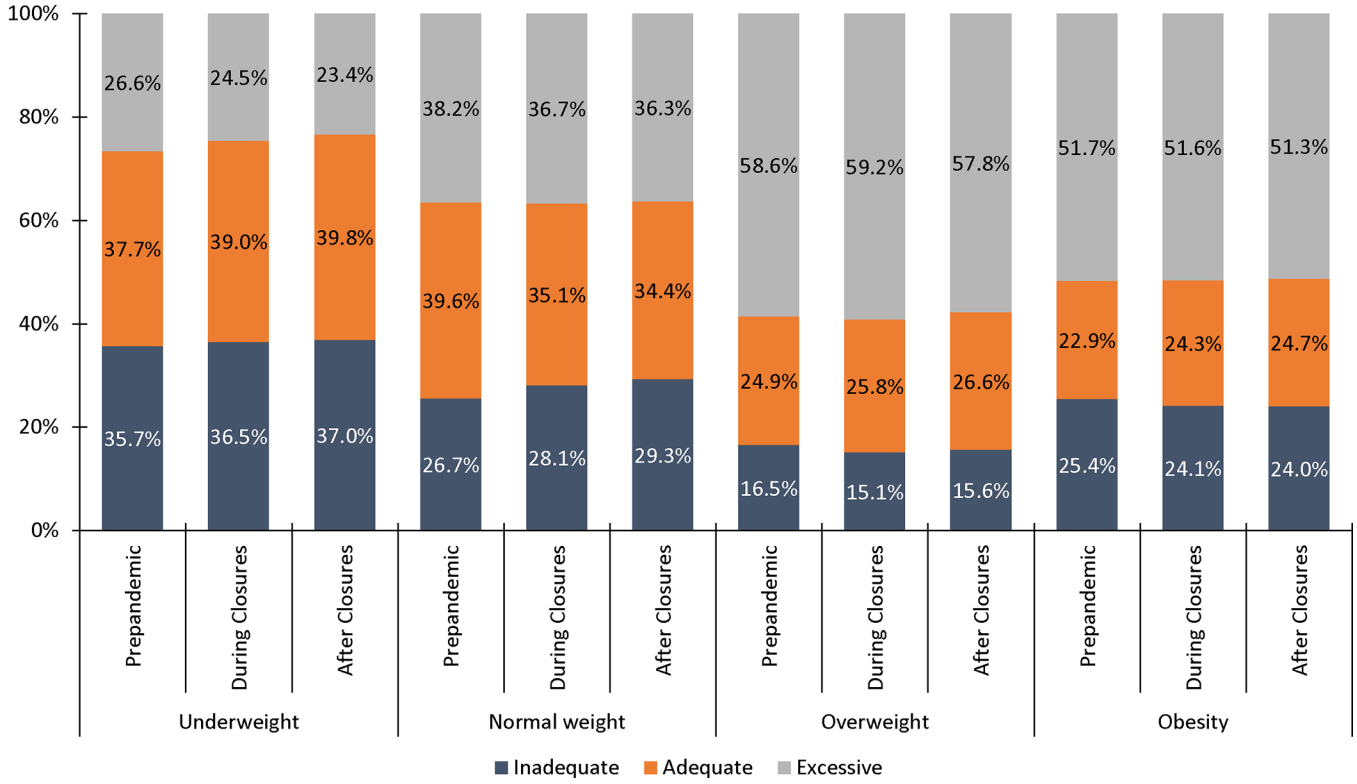

Figure 3:
Gestational Weight Gain Before, During, and After COVID-19 Pandemic Closures by Prepregnancy BMI, South Carolina 2018–2021

Table 1

Maternal characteristics for singleton deliveries in South Carolina before, during, and after COVID-19 pandemic closures, 2018–2021

Characteristic	Prepandemic (Jan 2018–February 2020) (n = 103,136)	During Closures* (March–May 2020) (n = 24,157)	Postclosures# (June 2020–December 2021) (n = 50,251)
Maternal age, yrs	28.0 ± 5.7	28.2 ± 5.7	28.5 ± 5.8
Race and Ethnicity			
White Non-Hispanic	59,298 (57.5)	13,711 (56.8)	29,350 (58.4)
Black Non-Hispanic	32,015 (31.0)	7,486 (31.0)	14,919 (29.7)
Hispanic	4,645 (4.5)	1,153 (4.8)	2,437 (4.9)
Other Non-Hispanic^	7,205 (7.0)	1,807 (7.5)	3,545 (7.1)
Previous pregnancies			
None	40,425 (39.2)	9,602 (39.8)	19,895 (39.6)
1	32,457 (31.5)	7,634 (31.6)	16,208 (32.3)
2	18,098 (17.5)	4,111 (17.0)	8,496 (16.9)
3+	12,183 (11.8)	2,810 (11.6)	5,652 (11.2)
Prepregnancy BMI			
<18.5 (underweight)	3,253 (3.2)	656 (2.7)	1,404 (2.8)
18.5–24.9 (normal weight)	38,340 (37.2)	8,562 (35.4)	17,589 (35.0)
25–29.9 (overweight)	26,270 (25.5)	6,301 (26.1)	13,069 (26.0)
≥30 (obesity)	35,300 (34.2)	8,638 (35.7)	18,189 (36.2)
Maternal education			
Some high school	13,600 (13.2)	2,965 (12.3)	5,702 (11.4)
Completed high school	26,148 (25.4)	6,430 (26.6)	13,083 (26.0)
Some college	34,591 (33.5)	7,848 (32.5)	16,203 (32.2)
Bachelor's degree	18,573 (18.0)	4,445 (18.4)	9,695 (19.3)
Graduate school	10,251 (9.9)	2,469 (10.2)	5,568 (11.1)
Initiation of care in 1st trimester	76,561 (75.3)	18,307 (76.9)	37,819 (75.5)
Payment for delivery			
Private Insurance	40,030 (39.4)	9,826 (41.2)	20,766 (42.0)
Medicaid	45,373 (44.7)	10,162 (42.6)	21,501 (43.5)
Other Public Insurance	14,162 (14.0)	3,377 (14.1)	6,228 (12.6)
Self Pay	1,963 (1.9)	476 (2.0)	911 (1.8)
WIC Participation	39,131 (37.9)	8,162 (33.8)	15,367 (30.6)
Delivery at urban facility (%)	84,841 (83.5)	20,010 (83.9)	41716 (84.4)
Maternal smoking (%)	8,225 (8.0)	1,619 (6.7)	2,802 (5.6)

Characteristic	Prepandemic (Jan 2018–February 2020) (n = 103,136)	During Closures* (March–May 2020) (n = 24,157)	Postclosures# (June 2020–December 2021) (n = 50,251)
Female infant sex (%)	50,452 (48.9)	11,802 (48.9)	24,643 (49.0)
Gestational week at childbirth	38.4 ± 1.9	38.3 ± 1.8	38.2 ± 1.9
Medical complications$			
Preexisting or gestational hypertension	12,431 (12.1)	3,154 (13.1)	6,789 (13.5)
Preexisting or gestational diabetes mellitus	7,797 (7.6)	2,211 (9.2)	4,463 (8.9)

BMI, body mass index; WIC, Women Infants Children Supplemental Nutrition Program

Note: data presented as mean ± standard deviation or number (%),

*Second or third trimester beginning during this period.

#Second trimester beginning during this period.

^Other racial groups include multiracial, American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Island, and Unknown

$Hypertension or diabetes mellitus diagnosed prepregnancy or during the gestation.

Table 2

Adjusted* prevalence ratio of inadequate and excessive gestational weight gain, compared with adequate gestational weight gain by pandemic exposure and prepregnancy BMI Category, South Carolina, 2018–2021

	Actual GWG					
Prepregnancy BMI Category	**Exposure Category**	**Inadequate No. (%)**	**Adequate No. (%)**	**Excessive No. (%)**	**PR (CI) Inadequate**	**PR (CI) Excessive**
Underweight	Prepandemic	1,168 (35.9)	1223 (37.6)	862 (26.5)	1.0 (ref)	1.0 (ref)
	During closure	237 (36.1)	258 (39.3)	161 (24.5)	0.99 (0.87–1.10)	0.96 (0.80–1.11)
	Postclosure	510 (36.3)	559 (39.8)	335 (23.9)	1.02 (0.93–1.10)	0.90 (0.79–1.00)
Normal Weight	Prepandemic	10,201 (26.6)	13473 (35.1)	14666 (38.3)	1.0 (ref)	1.0 (ref)
	During closure	2,395 (28.0)	3726 (35.3)	3141 (36.7)	**1.06 (1.02–1.10)**	**0.94 (0.91–0.98)**
	Postclosure	5,034 (28.6)	6072 (34.5)	6483 (36.9)	**1.09 (1.06–1.12)**	**0.95 (0.93–0.98)**
Overweight	Prepandemic	4,315 (16.4)	6534 (24.9)	15421 (58.7)	1.0 (ref)	1.0 (ref)
	During closure	942 (15.0)	1622 (25.7)	3737 (59.3)	**0.92 (0.86–0.98)**	1.01 (0.99–1.04)
	Postclosure	2,013 (15.4)	3429 (26.2)	7627 (57.4)	0.97 (0.93–1.02)	0.99 (0.97–1.00)
Obesity	Prepandemic	8,936 (25.3)	8068 (22.9)	18296 (51.8)	1.0 (ref)	1.0 (ref)
	During closure	2,080 (24.1)	2093 (24.2)	4465 (51.7)	**0.95 (0.91–0.99)**	1.00 (0.97–1.03)
	Postclosure	4,373 (24.0)	4454 (24.5)	9362 (51.5)	**0.94 (0.92–0.97)**	1.00 (0.98–1.02)

BMI, body mass index; PR, prevalence ratio

Note: Percentages shown are row percentages, PR bolded if statistically significant

*Adjusted for age, race and ethnicity, maternal education, parity, length of gestation, medical complications (prepregnancy or gestational hypertension or diabetes mellitus), maternal smoking during pregnancy, initiation of prenatal care in first trimester, source of payment for delivery, urban or rural location of delivery, and infant sex.