THE JOURNAL OF MATERNAL-FETAL & NEONATAL MEDICINE

http://informahealthcare.com/jmf
ISSN: 1476-7058 (print), 1476-4954 (electronic)

J Matern Fetal Neonatal Med, 2014; 27(16): 1652–1655

DOI: 10.3109/14767058.2014.898058

informa healthcare

ORIGINAL ARTICLE

The association between maternal weight gain and spontaneous preterm birth in twin pregnancies

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Abstract

Objective: To estimate the association between maternal weight gain and SPTB in twin pregnancies.
Methods: A case-control study of patients with twin pregnancies and a normal prepregnancy BMI (18.5–24.9 kg/m^2) in one maternal-fetal medicine practice from 2005 to 2013. We reviewed maternal weight in six time periods: prepregnancy, 12–15 6/7 weeks, 16–19 6/7 weeks, 20–23 6/7 weeks, 24–27 6/7 weeks and 28–31 6/7 weeks. We compared maternal weight gain patterns across pregnancy between patients who did and did not have SPTB <32 weeks. Student's *t*-test and chi-square were used for analysis.
Results: In total, 382 patients were included, 29 (7.6%) of whom had SPTB <32 weeks. The baseline height, weight and BMI did not differ between the groups, nor did maternal age, IVF status, race or chorionicity. Patients with SPTB <32 weeks had significantly less weight gain as early as 15 6/7 weeks (2.9 ± 4.6 versus 7.3 ± 6.6 lb, $p < 0.001$), and this continued until 31 6/7 weeks (25.3 ± 8.7 versus 30.8 ± 10.9 lb, $p = 0.037$).
Conclusions: In twin pregnancies with a normal prepregnancy BMI, there is a significant association between SPTB <32 weeks and lower maternal weight gain, particularly prior to 16 weeks. Future studies are needed to test if prepregnancy or early nutritional interventions in twin pregnancies can reduce the risk of preterm birth and improve neonatal outcomes in this high-risk population.

Keywords

Nutrition, pregnancy, prematurity, twins, weight gain

History

Received 8 November 2013
Revised 15 January 2014
Accepted 21 February 2014
Published online 20 March 2014

Background

The number and rate of twin births has risen from 1.9% of all US live births in 1980 to 3.3% of all US live births in 2011 [1]. Although twins account for 3.3% of all live births in the United States, they account for a greater proportion of neonatal morbidity and mortality, principally due to the increased risk of prematurity. In the United States in 2011, 57.3% of twins delivered <37 weeks and 11.3% deliver prior to 32 weeks [2].

In 1990, the Institute of Medicine (IOM) defined optimal weight gain in twin pregnancies to be 35–45 lb in a term twin pregnancy [3]. Subsequently, a number of studies demonstrated that gestational weight gain in twin pregnancies is positively associated with birth weight [4–7]. Further studies also demonstrated that, similar to singleton pregnancies, normal weight gain in twin pregnancies is influenced by prepregnancy maternal body mass index (BMI) [8]. However, the 1990 IOM recommendations did not take into account maternal BMI. Without taking into account maternal BMI, only 25% of women with twin pregnancies gain 35–45 lb, which was recommended by the IOM in 1990 [8].

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Based on the increasing knowledge that maternal BMI influences the optimal weight gain in twin pregnancies, in 2009 the IOM revised their recommendations for optimal weight gain in twin pregnancies [9]. The 2009 IOM guidelines for weight gain in twin pregnancy recommend BMI-specific weight gains: for normal weight women (BMI 18.5–24.9 kg/m^2) 17–25 kg (37–54 lb), overweight women (BMI 25–29.9 kg/m^2) 14–23 kg (31–50 lb) and obese women (BMI $\geq$30 kg/m^2) 11–19 kg (25–42 lb). They concluded that there was insufficient evidence to make recommendations for underweight women (BMI <18.5 kg/m^2). These recommendations were made assuming a term (37–42 week) delivery. Although the IOM referred to these recommendations as ''provisional'', these recommendations were used in a recent comprehensive review of nutrition in twin pregnancies [10].

Recent data suggest that patients with twin pregnancies who meet or exceed the revised IOM guidelines have improved pregnancy outcomes compared with patients with twin pregnancies who do not meet the IOM weight gain guidelines [11,12]. One intriguing finding was that, among patients with a normal prepregnancy BMI, poor weight gain was associated with an increased risk of spontaneous preterm birth (SPTB) <32 weeks (11.5% versus 3.4%, $p = 0.025$) [11]. However, this analysis only considered the weight gain over the course of the entire pregnancy and not weight gain at specific time periods in pregnancy.

The objective of this study was to estimate the association between SPTB and maternal weight gain across gestation in women with twin pregnancies.

Methods

We performed a case-control study to compare the differences in weight gain patterns between patients with twin pregnancies who did and did not have a SPTB <32 weeks. After Biomedical Research Alliance of New York Institutional Review Board approval was obtained, the charts of all patients with twin pregnancies >22 weeks delivered by a single maternal-fetal medicine practice between June 2005 (when our electronic medical record was established) and June 2013 were reviewed. We excluded patients with monochorionic-monoamniotic placentation, patients with twin–twin transfusion syndrome and patients who had prenatal care elsewhere but transferred care to our practice for delivery only. Baseline characteristics and pregnancy outcomes were obtained from our computerized medical record. Gestational age was determined by last menstrual period and confirmed by ultrasound in all patients. The pregnancy was re-dated if there was a >5 d discrepancy up to 14 weeks or a >7 d discrepancy after 14 weeks [12,13]. If the pregnancy was the result of *in vitro* fertilization (IVF), gestational age was determined from IVF dating.

At the initial prenatal visit, all of our patients are asked to provide their prepregnancy weight. Maternal height is measured by a registered nurse or certified medical assistant. The prepregnancy BMI was calculated using these two values in kilogram per meter squared. At each prenatal visit, the maternal weight is measured on a scale by a registered nurse or certified medical assistant.

The prepregnancy BMI was reviewed for each patient. In order to control for the fact that weight gain recommendations are different based on the starting BMI [9], for this study, we only included patients with a normal prepregnancy BMI (18.5–24.9 kg/m^2). We then looked at whether the patient had a spontaneous preterm birth <32 weeks, defined as preterm birth resulting from preterm labor or premature rupture of membranes. Patients with an indicated preterm birth <32 weeks, such as for preeclampsia or fetal growth restriction, were excluded from analysis.

We compared weight gain across pregnancy between women with twin pregnancies who did and did not have SPTB <32 weeks. To do this, we used the measured maternal weight in six time periods: prepregnancy, 12–15 6/7 weeks, 16–19 6/7 weeks, 20–23 6/7 weeks, 24–27 6/7 weeks, and 28–31 6/7 weeks. If a patient had more than one weight measurement in any time period, the first measurement was used for analysis. Student's *t*-test and chi-square were used when appropriate (SPSS for Windows 16.0, 2007, Chicago, IL). A *p* value of <0.05 was considered significant.

Results

A total of 578 patients met the initial inclusion criteria, 387 (67%) of whom had a normal prepregnancy BMI. Five women in this group had indicated preterm birth <32 weeks, leaving 382 patients for analysis. 29 (7.6%) patients in this population of women with twin pregnancies and with normal prepregnancy BMI had a SPTB <32 weeks. They were compared with the 353 patients without SPTB <32 weeks.

Table 1. Baseline characteristics of patients with twin pregnancies with normal prepregnancy BMI, based on SPTB <32 weeks or not.

	SPTB <32 weeks $N = 29$	No SPTB <32 weeks $N = 353$	p value
Maternal age	33.9 ± 7.0	34.5 ± 6.5	0.704
IVF (%)	79.3	66.0	0.143
Height (inches)	65.3 ± 2.8	64.5 ± 2.5	0.142
Prepregnancy weight (lb)	134.0 ± 18.2	127.6 ± 13.8	0.072
Prepregnancy BMI (kg/m^2)	22.0 ± 1.8	21.5 ± 1.7	0.299
White race (%)	86.2	89.2	0.616
Chorionicity			0.621
Dichorionic (%)	89.7	86.4	
Monochorionic (%)	10.3	13.6	

Table 2. Total maternal weight gain in pregnancy in patients with twin pregnancies, based on SPTB <32 weeks or not.

	SPTB <32 weeks $N = 29$	No SPTB <32 weeks $N = 353$	p value
Total maternal weight gain (lb)			
Prepregnancy to 15 6/7 weeks	2.9 ± 4.6	7.3 ± 6.6	< 0.001
Prepregnancy to 19 6/7 weeks	7.4 ± 6.8	12.8 ± 7.6	0.001
Prepregnancy to 23 6/7 weeks	14.6 ± 7.2	19.6 ± 8.5	0.002
Prepregnancy to 27 6/7 weeks	19.5 ± 9.1	25.2 ± 9.6	0.006
Prepregnancy to 31 6/7 weeks	25.3 ± 8.7	30.8 ± 10.9	0.037

The baseline height, weight, BMI, age, IVF status, race and chorionicity did not differ between the groups (Table 1). We compared weight gain patterns between the two groups and the results are shown in Table 2. Patients with SPTB <32 weeks had less weight gain. This difference was evident even as early as the first weight measurement at 12–15 6/7 weeks (2.9 ± 4.6 versus 7.3 ± 6.6 lb, $p < 0.001$) and persisted through 32 weeks (25.3 ± 8.7 versus 30.8 ± 10.9 lb, $p = 0.037$). At any point in pregnancy prior to 32 weeks, the patients who would have SPTB <32 weeks demonstrated less weight gain than patients who would deliver >32 weeks. The discrepancy in weight gain between the groups over the course of pregnancy is depicted in Figure 1.

We then compared the difference in weight gain in each successive time period and the results are shown in Table 3. The largest difference was seen prior to 16 weeks (2.9 ± 4.6 versus 7.3 ± 6.6 lb, $p < 0.001$). There was also a significant difference from prior to 15 6/7 weeks to 19 6/7 weeks (3.8 +/0 3.3 versus 5.4 ± 3.3 lb, $p = 0.049$) as well as from 23 6/7 weeks to 27 6/7 weeks (4.4 ± 3.6 versus 6.0 ± 4.0 lb, $p = 0.049$).

To examine if this was a measure-related response between early weight gain and spontaneous preterm birth, we looked at all patients with a weight measurement at 12–15 6/7 weeks ($n = 276$) and divided them into quartiles, based on the weight gain from prepregnancy, rounded to the nearest whole number. We compared the likelihood of SPTB <32 weeks across the four quartiles and the results are shown in Table 4. As patients gained more weight prior to 16 weeks, the risk of

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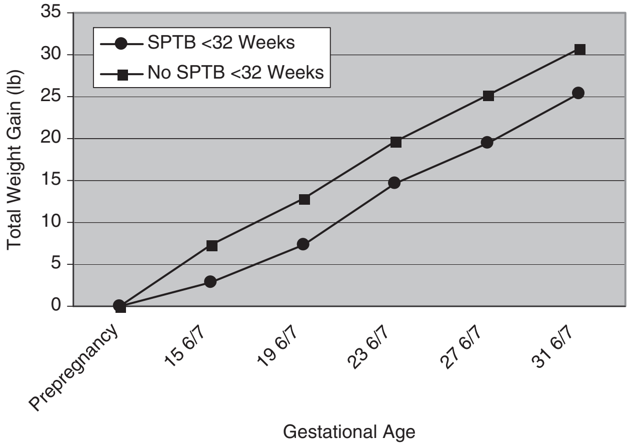

Figure 1. Weight gain across gestation in women with twin pregnancies who did and did not have SPTB <32 weeks.

Table 3. Interval maternal weight gain in pregnancy in patients with twin pregnancies, based on SPTB <32 weeks or not.

	SPTB <32 weeks $N=29$	No SPTB <32 weeks $N=353$	p values
Interval maternal weight gain (lb)			
Prepregnancy to 15 6/7 weeks	2.9 ± 4.6	7.3 ± 6.6	<0.001
15 6/7 to 19 6/7 weeks	3.8 ± 3.3	5.4 ± 3.3	0.049
19 6/7 to 23 6/7 weeks	8.1 ± 4.1	6.9 ± 3.2	0.180
23 6/7 to 27 6/7 weeks	4.4 ± 3.6	6.0 ± 4.0	0.049
27 6/7 to 31 6/7 weeks	4.2 ± 4.0	5.6 ± 4.4	0.208

Table 4. Likelihood of SPTB <32 weeks in twin pregnancies, based on weight gain in pregnancy.

	Weight gain from prepregnancy to 12–15 6/7 weeks				
	≤2.0 lb $N=68$	2.1–5.5 lb $N=65$	5.6–10.0 lb $N=70$	≥10.1 lb $N=73$	p value
SPTB <32 weeks (%)	14.7	9.2	4.3	2.7	0.004

SPTB <32 weeks decreased from 14.7% in the lowest weight gain quartile to 2.7% in the highest weight gain quartile ($p = 0.004$).

Discussion

In this study, we found that among women with twin pregnancies and a normal prepregnancy BMI, patients with spontaneous preterm birth <32 weeks experienced significantly less weight gain as early as <16 weeks, compared with women who delivered after 32 weeks. We also found that the weight gain prior to 16 weeks was negatively correlated with the risk of SPTB <32 weeks with the patients who gained the least amount of weight having the highest risk or SPTB and the patients who gained the most amount of weight having the lowest risk of SPTB. We previously published our findings that total weight gain in twin pregnancies was associated with preterm birth [11]. However, one limitation to our findings was that weight gain was calculated for the entire pregnancy, as opposed to measurements across pregnancy. Therefore, our findings in this study are valuable as they provide further insight into the association between weight gain and preterm birth in twin pregnancies. It appears that there is a strong association between SPTB and gestational weight gain in the first and early second trimester, particularly prior to 16 weeks, suggesting that early gestational weight gain can potentially have an effect on pathways that eventually lead to preterm birth. The fact that the differences in weight gain were seen many weeks before preterm birth also suggests that poor weight leads to preterm birth (cause–effect relationship), as opposed to preterm birth being associated with less weight gain simply due to earlier gestational ages at delivery for those who deliver preterm (effect–cause relationship).

Although we did not note any differences at baseline between patients who did and did not have SPTB <32 weeks, it is possible that there are other variables that affect both maternal weight gain as well as spontaneous preterm birth, which could be an alternative explanation for our findings. It is also possible that low weight gain is a marker for another process that affects the likelihood of prematurity, as opposed to a cause–effect relationship. In general, prospective study design with randomization reduces these potential biases. However, it would not be feasible to do our analysis in a randomized fashion given that weight gain itself is a byproduct of several factors, including genetic variation, caloric intake and energy expenditure and is not subject to randomization. Prospective studies would likely need to focus on nutritional interventions in early pregnancy or prepregnancy and their effects on preterm birth. Given that our efforts to prevent preterm birth in twin pregnancies have mostly been ineffective, this potential for nutrition and adequate weight gain to reduce the risk of prematurity in twin pregnancies is exciting and warrants prospective studies. There are data in singleton pregnancies supporting the positive effects of early nutritional intervention, including increased birth weight and a reduced risk of stillbirth [14]. Data in sheep models also suggest that early nutritional deprivation around the time of conception results in accelerated maturation of the fetal hypothalamic–pituitary–adrenal axis, a precocious fetal cortisol surge and preterm birth [15].

Adequate early weight gain in twin pregnancies has been associated with other improved pregnancy outcomes as well, particularly in regard to increased birth weight [4–7]. Therefore, patients with twin pregnancies should be encouraged to achieve adequate weight gain early in pregnancy for several reasons and our findings in this study indicate that there may be additional benefits to this aside from birth weight. However, the potential exists that excessive weight gain early in pregnancy can also be associated with adverse outcomes. In singleton pregnancies, excessive weight gain prior to 18 weeks has been associated with an increase in gestational diabetes and excessive fetal growth [16]. However, it is unknown if the same would be true in twin pregnancies. For example, we previously published, based on a retrospective study of twin pregnancies, that excessive total gestational weight gain was not associated with adverse outcomes, including gestational diabetes and was actually associated with improved birth weights [12]. Therefore, at this time it is unknown if there are any negative effects of excessive early gestational weight gain in twin pregnancies.

Strengths of our study include the uniform and supervised measurements of height and weight, as opposed to a reliance on birth certificate data, which is notoriously flawed. We calculated weight gain from actual recorded measurements only. Therefore, our weight gain data should be as accurate as possible. Additionally, because we cared for all of these patients, there were no differences in pregnancy management between patients that could have impacted prematurity rates. Also, because we delivered all of the patients, we are able to accurately report whether a preterm birth was indicated or spontaneous. The maternal prepregnancy BMI is a potential confounding variable for weight gain and prematurity. Rather than trying to adjust for this statistically in a relatively small sample size, we decided the analysis would be more reliable if we only included women with a normal prepregnancy BMI. This had the effect of reducing our sample size, which is the resulting limitation of our decision. As we used maternal reporting to record the prepregnancy weight, this potentially introduces bias. However, typically when patients present for prenatal care if their current weight is many pounds different from the reported prepregnancy weight, this discrepancy would be addressed at that time. Therefore, we are confident that the prepregnancy weights are as accurate as possible. As not all patients were under our care prepregnancy, it was not possible to actually measure a prepregnancy weight.

The possibility that a focused intervention on maternal nutrition and weight gain in twin pregnancies could reduce the risk of spontaneous preterm birth deserves significant attention. Future prospective studies could assess nutritional interventions in twin pregnancies and their effect on the rate of preterm birth. This may uncover a simple way to reduce significant morbidity and mortality associated with prematurity in this high-risk population.

Declaration of interest

The authors report no conflicts of interest.

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