ORIGINAL ARTICLE

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

Nathan S. Fox1,2, Erica M. Stern1,2, Daniel H. Saltzman1,2, Chad K. Klauser1,2, Simi Gupta1,2, and Andrei Rebarber1,2

1Maternal Fetal Medicine Associates, PLLC, New York, NY, USA and 2Department of Obstetrics, Gynecology, and Reproductive Science, Icahn School of Medicine at Mount Sinai, New York, NY, USA

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/m²) 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.

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].

Keywords

Nutrition, pregnancy, prematurity, twins, weight gain

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/m²) 17–25 kg (37–54 lb), overweight women (BMI 25–29.9 kg/m²) 14–23 kg (31–50 lb) and obese women (BMI ≥30 kg/m²) 11–19 kg (25–42 lb). They concluded that there was insufficient evidence to make recommendations for underweight women (BMI <18.5 kg/m²). 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 >5d 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 measured 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/m²). We then looked at whether the patient had maternal weight gain recommendations based on the starting BMI for this study, we then looked at whether the patient had

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>SPTB &lt;32 weeks</th>
<th>No SPTB &lt;32 weeks</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age</td>
<td>33.9 ± 7.0</td>
<td>34.5 ± 6.5</td>
<td>0.704</td>
</tr>
<tr>
<td>IVF (%)</td>
<td>79.3</td>
<td>66.0</td>
<td>0.143</td>
</tr>
<tr>
<td>Height (inches)</td>
<td>65.3 ± 2.8</td>
<td>64.5 ± 2.5</td>
<td>0.142</td>
</tr>
<tr>
<td>Prepregnancy weight (lb)</td>
<td>134.0 ± 18.2</td>
<td>127.6 ± 13.8</td>
<td>0.072</td>
</tr>
<tr>
<td>Prepregnancy BMI (kg/m²)</td>
<td>22.0 ± 1.8</td>
<td>21.5 ± 1.7</td>
<td>0.299</td>
</tr>
<tr>
<td>White race (%)</td>
<td>86.2</td>
<td>89.2</td>
<td>0.616</td>
</tr>
<tr>
<td>Chorionicity</td>
<td>0.621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dichorionic (%)</td>
<td>89.7</td>
<td>86.4</td>
<td></td>
</tr>
<tr>
<td>Monochorionic (%)</td>
<td>10.3</td>
<td>13.6</td>
<td></td>
</tr>
</tbody>
</table>

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

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.

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 ± 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 6.9 ± 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...
gain quartile to 2.7% in the highest weight gain quartile
the risk of SPTB
weight gain prior to 16 weeks was negatively correlated with
women who delivered after 32 weeks. We also found that the
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 prepreg-
nancy 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 cor-
tisol 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 encour-
aged 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 retrospect-
ive 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.

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

<table>
<thead>
<tr>
<th>Interval maternal weight gain (lb)</th>
<th>SPTB &lt;32 weeks</th>
<th>No SPTB &lt;32 weeks</th>
<th>p values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepregnancy to 15 6/7 weeks</td>
<td>2.9 ± 4.6</td>
<td>7.3 ± 6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>15 6/7 to 19 6/7 weeks</td>
<td>3.8 ± 3.3</td>
<td>5.4 ± 3.3</td>
<td>0.049</td>
</tr>
<tr>
<td>19 6/7 to 23 6/7 weeks</td>
<td>8.1 ± 4.1</td>
<td>6.9 ± 3.2</td>
<td>0.180</td>
</tr>
<tr>
<td>23 6/7 to 27 6/7 weeks</td>
<td>4.4 ± 3.6</td>
<td>6.0 ± 4.0</td>
<td>0.049</td>
</tr>
<tr>
<td>27 6/7 to 31 6/7 weeks</td>
<td>4.2 ± 4.0</td>
<td>5.6 ± 4.4</td>
<td>0.208</td>
</tr>
</tbody>
</table>

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 signifi-
cantly 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

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

<table>
<thead>
<tr>
<th>Weight gain from prepregnancy to 12–15 6/7 weeks</th>
<th>SPTB &lt;32 weeks (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤2.0 lb</td>
<td>14.7</td>
</tr>
<tr>
<td>2.1–5.5 lb</td>
<td>9.2</td>
</tr>
<tr>
<td>5.6–10.0 lb</td>
<td>4.3</td>
</tr>
<tr>
<td>≥10.1 lb</td>
<td>2.7</td>
</tr>
<tr>
<td>p value</td>
<td>0.004</td>
</tr>
</tbody>
</table>
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.

References