Research Article

Part of the Fat Component in the Structure of Gestational Weight Gain

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Abstract

Gestational weight gain (GWG), which is more or less of the recommended guidelines, has serious short- and long-term negative consequences for the health of the mother and children. Determining the dynamics of body composition during pregnancy is important for full antenatal care in order to prevent pathological weight gain and prevention of gestational complications.

Objective: Our goal was to determine the proportion of fat component in the structure of GWG in women with normal body weight before pregnancy.

Design: 153 pregnant women aged 18-43 years with normal pre-pregnancy body mass index (pBMI) were examined. BMI was calculated by using the standard formula of person’s weight in kilograms divided by the square of his height in meters (kg/m²). Total weight gain was calculated by subtracting the pre-pregnancy weight from the last measured weight before delivery. The body composition (fat mass (FM), fat-free mass (FFM), and the percentage of fat mass (%FM) was calculated on the basis of bioelectrical impedance analysis (BIA) using the ‘DIAMANT-AIST’ analyzer (St. Petersburg). Statistical analyses were carried out using Statistical program "Statistica 5.5".

Results: It has been established that in women of normal weight before pregnancy, GWG was directly proportional to an increase in the fraction of FM (r=0.87; p<0.001). In pregnant with the recommended GWG, FM increased monotonous in the first and second trimesters and subsequently stabilized. In patients with insufficient GWG, fat component increased similarly (p>0.05), however, it was accompanied by low growth of the FFM, especially in the third trimester (p<0.05). Pregnant women with excessive GWG were more likely to gain weight in the first trimester mainly due to the accumulation of FM (p<0.05), and this tendency remained until delivery r=0.99 (p<0.01).

Conclusion: In women with normal GWG there is a monotonous increase in fat component in the first and second trimesters, and subsequently stabilized, which promotes adequate weight reduction after childbirth. In patients with high GWG, the excessive increase in the proportion of FM and, consequently, a rapid increase in weight in the first trimester of pregnancy, initiates further accumulation of adipose tissue and slows down its reduction in the postpartum period. In pregnant women with low weight gain there is adequate increase of FM but an insufficient increase of FFM, especially in the third trimester, which leads to the development of placental hypoplasia and small-for-gestational age.

Keywords

pregnancy; body composition; gestational weight gain; fat mass

Problem statement and analysis of the recent research

During pregnancy, the body exhibits dynamic changes in weight and body composition to support the harmonious development of the fetus. These changes are defined as gestational weight gain and include both fat and fat-free parts. The Institute of Medicine (IOM) guidelines the optimal pre-pregnancy BMI and the limits of GWG, aim to optimize maternal and fetal health indicators during pregnancy and in the postpartum period [5]. Pathological weight gain increase the risk of macrosomia, gestational hypertension, glucose intolerance, the frequency of operative delivery, weight retention and the development of obesity after childbirth [2].

The literature provides various methods for determining the components of GWG. There are two-, three-, and four-component models for the division of body composition, which, in different ratios, are based on the contents of FM, FFM, total body water (TBW), minerals and proteins. The Institute of Medicine has indicated that these models are ‘satisfactory’ for estimating body composition changes in pregnancy [5], the Food and Agriculture Organization, World Health Organization and the United Nations University have also issued a similar joint statement regarding ‘acceptability’ of these models [3].

There are several methods for estimating body composition. Anthropometric measurements of the thickness of the skin and mid-upper arm circumferences assess changes in muscle mass and FM [8]. TBW is typically measured using the dilution principle with isotope-labeled water labeled with
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deuterium (2H2O) or Oxygen 18 (18O) [7]. Body density can be estimated using hydrodensitometry, but this method is not able to estimate the density of the body of pregnant women, regardless of the fetus and surrounding tissues [6]. Imaging methods, including computed tomography (CT), magnetic resonance imaging (MRI), and three-dimensional photonic scanning (3DPS) can be also used to evaluate body composition, but 3DPS and MRI are still at the use for in pregnant women, and CT is contraindicated due to radiation exposure and is not used during pregnancy [1]. The most safe, non-invasive, rapid and inexpensive method for assessing body composition (FM, FFM, TBW, intracellular and extracellular water) is bioimpedansometry (BIM), which is based on the assumptions and relationships regarding electrical properties of various biological tissues at varying frequencies [4].

Nowadays, researchers admit that all permitted methods of measurement can not differentiate maternal and fetal components and consider them as one maternal-fetal unit. It is also impossible to obtain an accurate assessment of the weight before and at the start of pregnancy, and thus determine the exact BMI and the dynamics of the body composition. Consequently, it is important to weigh the woman and measure the pre-pregnancy body composition in close proximity to conception [10].

Objective. Our goal was to assess the part of the fat component in the structure of GWG in women with normal body weight before pregnancy.

1. Materials and Methods

We have been examined 153 pregnant women aged 18 to 43 years old who were observed in antenatal clinics and in the city maternal hospital in Ivano-Frankivsk. The exclusion criteria were age below 18 years, multiple pregnancy, severe chronic somatic diseases and diabetes mellitus. All pregnant women have issued "Informed consent to participate in the study". The design of the scientific work is approved by the Ethics Committee of the State University "IFNMMU" (protocol No. 93/16 dated 01.12.2016).

Examination of women began in the first trimester of pregnancy in 9.8±1.4 weeks (95%CI 9.6-10.1). BMI was calculated by using the standard formula of person’s weight in kilograms divided by the square of his height in meters (kg/m2). GWG was determined by trimesters and in general for pregnancy by subtracting the pre-pregnancy weight from the last measured weight before delivery and assessed according to IOM recommendations [5]. Information about pre-pregnancy body weight of women was taken from patients interviewing.

The diagnosis of body composition was carried out on the basis of bioelectrical impedance analysis using the biomimpedance analyzer ‘DIAMANT-AIST’ (St. Petersburg), connected to the computer, and a package of applied programs. The method is based on the assumptions and relationships regarding electrical properties of various biological tissues at varying frequencies. The resistance of fabrics to electric current is directly proportional to the content of liquid in them - a highly hydrated FFM is a good conductor, while a poorly hydrated FM is a good insulator. The FM, %FM and FFM were established.

Statistical analyses were carried out using Statistical program "Statistica 5.5".

2. Results

The pre-pregnancy body weight was 55.3±4.9 kg (95%CI 54.5-56.0), BMI 20.3±1.5 kg/m2 (95%CI 20.1-20.6). In 31 ((20, 3±3, 2) %) patients we have been diagnosed insufficient, in 77 ((50, 3±4, 0) %) - normal and in 45 ((29, 4±4, 9) %) - excessive GWG. Weight before pregnancy and pBMI in each group are shown in Table 1.

The results of the BIM demonstrated a strong correlation between GWG and %FM (r=0.87; p<0.001) in all pregnant women. However, during the pregnancy, the proportion of fat component in the structure of GWG in different groups significantly differed. Thus, in the group of women with normal pBMI and the recommended weight gain, the increase in FM occurred monotonous in the first and second trimesters and subsequently stabilized (Table 1, Fig.1).

In patients with insufficient weight gain the growth of the fat component was similar to that of women with normal GWG (p>0.05). Insignificantly increased %FM in the first half of pregnancy, and practically did not change until childbirth. No significant difference was found in %FM at the end of pregnancy compared with pregnant women with recommended GWG (p>0.05), which indicates no changes in fat stores during the last trimester. We also found that insufficient GWG was due to lagging growth of FFM, which is most pronounced in the third trimester (p<0.05).

Pregnant women with excessive GWG were more likely to gain weight in the first trimester mainly due to the accumulation of FM, the percentage of which was significantly higher than pregnant women with a recommended body weight gain (p<0.05 in three trimesters), and this tendency remained until the labor r=0.99 (p<0.01). There was no a significant difference in the increase in FFM compared with women with normal GWG (p>0.05).

3. Discussion

Body weight gain during pregnancy is a very important criterion for its duration and is considered an indicator of the woman’s adaptation reserve for pregnancy and fetal development. GWG is due to the growth of all major components of metabolic processes. The most variable component is fat, the accumulation of which is mainly due to sufficient energy supply of fetal growth and lactation. Our study showed that in women of normal weight before pregnancy, GWG is directly proportional to the increase in %FM (r=0.87; p<0.001), which coincides with the data of other scientific studies [8, 10]. The authors, who conducted the morphological study of adipocytes in women during pregnancy, have shown that the monotonous increase of FM in the first and second trimester...
Table 1. FM and FFM in women with normal body weight before pregnancy (Mean±SD)

<table>
<thead>
<tr>
<th>Body composition parameters</th>
<th>Gestational weight gain (n=153)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Insufficient (n=31)</td>
<td>Normal (n=77)</td>
<td>Excessive (n=45)</td>
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<td></td>
<td>(Mean±SD)</td>
<td>95% Cl</td>
<td>(Mean±SD)</td>
</tr>
<tr>
<td>Pre-pregnancy body weight, kg</td>
<td>53.8±4.3</td>
<td>52.3-55.3</td>
<td>55.1±4.0</td>
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<td>pBMI, kg/m²</td>
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<td>20.5-21.3</td>
<td>19.9±1.4</td>
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<td>GWG, kg/m²</td>
<td>8.13±1.74*</td>
<td>7.52-8.74</td>
<td>12.75±1.21</td>
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<tr>
<td>FM, kg</td>
<td></td>
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<tr>
<td>I trimester</td>
<td>10.3±1.0</td>
<td>10.0-10.7</td>
<td>11.3±1.1</td>
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<tr>
<td>II trimester</td>
<td>12.2±1.3</td>
<td>11.7-12.7</td>
<td>13.9±1.0</td>
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<tr>
<td>III trimester</td>
<td>13.2±1.6</td>
<td>12.6-13.8</td>
<td>15.6±1.0</td>
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<td>% FM</td>
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<tr>
<td>I trimester</td>
<td>19.1±2.0</td>
<td>18.4-19.8</td>
<td>20.1±1.2</td>
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<td>III trimester</td>
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<td>23.1±1.7</td>
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<td>FFM, kg</td>
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<tr>
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<td>43.6±2.0</td>
<td>42.9-4.43</td>
<td>45.0±2.1</td>
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<tr>
<td>II trimester</td>
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<td>45.0-4.58</td>
<td>47.5±2.5</td>
</tr>
<tr>
<td>III trimester</td>
<td>48.8±1.7*</td>
<td>48.4-49.2</td>
<td>52.2±1.3</td>
</tr>
</tbody>
</table>

Figure 1. Dynamics of %FM in pregnant women with normal pBMI and different GWG
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occurs due to hypertrophy of fat cells, enhanced fusion synthesis, and decreased lipolysis, which in aggregate manifests itself in an increase in fat depot. In late pregnancy, lipolytic activity increases, which leads to increased mobilization of fat with a progressive increase in fat deposits in the fetus and, consequently, their gradual decrease in the mother’s body [9]. In women with excessive GWG, excessive growth in the content of FM and, as a result, a rapid increase in weight occurs already in the first trimester of pregnancy, initiates further pathological accumulation of adipose tissue and slows down its reduction after delivery. Insufficient GWG occurs due to lagging growth of FFM with an adequate increase in %FM, which is most pronounced in the third trimester, promotes the development of placenta hypoplasia and small-for-gestational age.

4. Conclusions

Determination of the dynamics and structure of GWG is important for proper antenatal care in order to prevent the pathological weight gain and gestational complications. In women with normal GWG there is a monotonous increase in fat component in the first and second trimester with further stabilization, which contributes to adequate weight reduction after delivery. Excessive GWG, high growth of %FM and, consequently, rapid increase in weight in the first trimester of pregnancy, initiate further pathological accumulation of adipose tissue and slow down its reduction in the postpartum period. In pregnant women with low weight gain there is an adequate increase of FM but an insufficient increase of FFM, which is most characteristic in the third trimester. This leads to the development of placental hypoplasia and small-for-gestational age.

5. Prospects of further research

Additional research on postpartum weight reduction in women with different GWG is warranted.

References


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