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# The role of gestational weight gain rate in the development of maternal iron deficiency anaemia

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## ABSTRACT

**Aims:** Our aim is to analyze the effect of weight gain rates on the development of anaemia in a homogeneous group of pregnant women taking similar nutritional supplements in our own society and to emphasize the importance of weight control based on this hypothesis.

**Methods:** The study was conducted retrospectively with 127 pregnant women between 20 and 40 years old. Pregnant women in normal weight and having body mass index (BMI) between 18.5 and 24.9 were included in the study. These women were divided into two groups according to the amount of weight they gained during pregnancy: those who weighed less than 11 kg and those who gained 11 kg or more. Ages of patients, number of pregnancies and births, 1st and 3rd trimester weights, 1st and 3rd trimester weight differences, 1st and 3rd trimester hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV) measurements were recorded. The correlation of changes between weight gain and blood parameters was evaluated.

**Results**: No statistically significant change was observed between the 1st and 3rd trimester Hgb and Hct averages of pregnant women who gained less than 11 kg during pregnancy. 3rd Trimester Hb, Hct averages of the pregnant group who gained 11 kg or more were found to be statistically significantly lower than the outset Hb, Hct averages (p=0.001, p=0.001). No statistically significant difference was observed between the 1st Trimester and 3rd Trimester MCV averages of the <11 kg difference and >11 kg difference groups (p=0.271, p=0.183). No statistically significant difference was observed between the 1st trimester ferritin averages of the <11 kg difference and >11 kg difference groups (p=0.055). 3rd trimester ferritin averages of the >11 kg difference group were found to be statistically significantly lower than the <11 kg difference group (p=0.016).

**Conclusion**: As a result of our study, we can say that rapid weight gain during pregnancy deepens anaemia. Randomized studies continue to be the best source of evidence in testing hypotheses mentioning that early use of iron supplements and strengthening weight control may reduce the risk of iron deficiency anemia.

**Keywords**: Gestational weight gain rate, iron deficiency, anaemia, pregnancy, BMI.

## INTRODUCTION

Obesity shows a significant increase in worldwide. It is estimated that more than 21% of women shall be obese and 9% shall be severely obese in 2025.[1] On the other hand, the incidence of maternal obesity also increases and this situation becomes one of the most important health problems during pregnancy. Excessive weight gain causes various complications such as gestational hypertension, diabetes, anaemia, preeclampsia, premature birth and spontaneous abortus by affecting both the mother and the baby.[2] The risks in babies are babies who are large for gestational age, macrosomia, and overweight or obesity in childhood. Today, approximately 50% of women exceed their weight gain goals in terms of weight gain during pregnancy.

Anaemia is a comorbidity which is observed frequently during pregnancy. It is estimated that the prevalence of anaemia of pregnancy 38%, in worldwide and it means that 32 million pregnant women are affected.[3] More than 50% of these appear to be the result of iron deficiency.[3,4] Iron deficiency anaemia during pregnancy is preventable causes that can lead to serious negative consequences such as premature rupture of membranes, puerperal infection, fetal growth retardation, fetal hypoxia and premature birth.[3,5] Previous studies have identified several potential risk factors for iron deficiency anaemia, such as poor nutritional status, multiple pregnancies, poor socioeconomic status, age over 30 years, multiparity, and frequent interbirth interval.[6,7] However, the potential effect of body weight on iron deficiency anaemia has not been adequately analyzed. Our aim is to analyze the

effect of weight gain rates on the development of anaemia in a homogeneous group of pregnant women taking similar nutritional supplements in our own society and to emphasize the importance of weight control based on this hypothesis.

## METHODS

The study was carried out with the permission of Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Researches Ethics Committee (Date: 04.09.2023, Decision No: 2023-17). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki and documented declared permission was received from all women.

The study was conducted retrospectively with 127 pregnant women between 20 and 40 years old who were followed up in the same center due to pregnancy between January 2021 and May 2023. The pregnant women who smoke, have twin and multiple pregnancies, have a bleeding condition that complicates their pregnancies (placental abruption, placenta previa, etc.), have chronic disease anaemia, and are thalassemia carriers; have polycythemiavera, megaloblastic anaemia and chronic blood disease diagnosis, or who have received or are receiving bone marrow suppressant treatment were not included in the study.

Pregnant women in normal weight and having body mass index (BMI) between 18.5 and 24.9 were included in the study. These women were divided into two groups according to the amount of weight they gained during pregnancy: those who weighed less than 11 kg and those who gained 11 kg or more.

Ages of patients, number of pregnancies and births, 1. and 3rd trimester weights, 1st and 3rd trimester weight differences, 1st and 3rd trimester haemoglobin (Hb), haematocrit (Hct), mean corpuscular volume (MCV) measurements were recorded. The correlation of changes between weight gain and blood parameters was evaluated.

All patients were selected homogeneously from patients who used 100 mg elemental iron equally after the first trimester until birth.

### Statistical Analysis

In this study, statistical analyses were performed with the NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) package program.

In the evaluation of the data, in addition to descriptive statistical methods (mean, standard deviation, median, interquartile range), the distribution of the variables was examined with the Shapiro-Wilk normality test, paired t test was used in the 1st Trimester-3rd trimester comparisons of variables showing normal distribution and independent t test was used in the comparison of paired groups, Wilcoxon test was used for comparisons between the 1st Trimester and 3rd Trimester of variables not showing normal distribution, Mann Whitney U test was used for comparison of paired groups, and chi-square test was used for comparisons of qualitative data. The results were evaluated at the significance level of $p<0.05$.

## RESULTS

127 pregnant women were included in the study. Age, weight (kg), gravida, parity status, total weight gain in the 3rd trimester, 1st and 3rd trimester Hb, Hct, MCV and ferritin values of these pregnant women are given in Table 1. The weight of the patients when the first pregnancy was diagnosed and the weight measured at the time of birth in the 3rd trimester were recorded, and the difference was calculated as total weight gain. Accordingly, the amount of weight that patients should gain during pregnancy is considered to be approximately 10-12 kg. The average weight gain of pregnant women was calculated as an average of 11 kg during pregnancy and they were divided into two groups: those who gained less than 11 kg and those who gained 11 kg or more.

Table 1 shows that the initial weight of the patients was between 52-72 kg and the average for the whole group was 62.39±9.38 kg. The initial average weight of those who weighed less than 11 kg at the end of pregnancy was 63.52±9.21 kg, and the initial average weight of those who gained 11 kg or more at the end of pregnancy was 61.41±9.48 kg, and no statistically significant difference was observed ($p=0.207$). No statistically significant difference was observed between the 3rd Trimester weight averages ($p=0.058$). The mean age of the >11 kg difference group was found to be statistically significantly lower than the <11 kg difference group ($p=0.005$). 3rd Trimester weight average of the >11 kg difference group was found to be statistically significantly higher than the initial weight average ($p=0.0001$).

No statistically significant difference was observed between the 1st Trimester Hb averages of the <11 kg Difference and >11 kg Difference groups ($p=0.123$). 3rd Trimester Hb averages of the >11 kg Difference group were found to be statistically significantly lower than the <11 kg Difference group ($p=0.008$).

3rd Trimester Hb averages of the >11 kg Difference group were found to be statistically significantly lower than the initial Hb averages ($p= 0.001$)

No statistically significant difference was observed between the 1st Trimester Hct averages of the <11 kg difference and >11 kg difference groups ($p=0.753$) (Table I).

3rd Trimester Hct averages of the >11 kg Difference group were found to be statistically significantly lower than the <11 kg difference group ($p=0.033$) (Table I).

No statistically significant change was observed between the 1st Trimester and 3rd Trimester Hct averages of the <11 kg Difference group ($p=0.466$).

3rd Trimester Hct averages of the >11 kg Difference group were found to be statistically significantly lower than the initial Hct averages ($p=0.001$).

No statistically significant difference was observed between the 1st Trimester and 3rd Trimester MCV averages of the <11 kg difference and >11 kg difference groups ($p=0.271$, $p=0.183$) .

**Table 1: Characteristic features of patients**

| | | | Whole Group | <11 kg Difference | >11 kg Difference | p |
|---|---|---|---|---|---|---|
| Age | | Mean±SD | 33.75±3.89 | 34.78±4.19 | 32.85±3.38 | 0.005* |
| Gravida | | Mean±SD | 1.45±0.59 | 1.51±0.68 | 1.4±0.49 | |
| | | Median (IQR) | 1 (1-2) | 1 (1-2) | 1 (1-2) | 0.519† |
| Parity | | Mean±SD | 1.08±0.39 | 1.15±0.54 | 1±0 | 0.161† |
| | | Median (IQR) | 1 (1-1) | 1 (1-1) | 1 (1-1) | |
| Weight (kg) | Initial | Mean±SD | 62.39±9.38 | 63.52±9.21 | 61.41±9.48 | 0.207* |
| | 3.Trimester | Mean±SD | 75.07±9.81 | 73.30±9.61 | 76.60±9.79 | 0.058* |
| | p** | | | 0.0001 | 0.0001 | |
| Hb (g/dL) | 1.Trimester | Mean±SD | 12.26±0.88 | 12.13±0.94 | 12.37±0.81 | 0.123* |
| | 3.Trimester | Mean±SD | 11.66±1.24 | 11.97±1.18 | 11.39±1.24 | 0.008* |
| | p** | | | 0.349 | 0.001 | |
| Hct (%) | 1.Trimester | Mean±SD | 35.86±2.78 | 35.77±2.96 | 35.93±2.63 | 0.753* |
| | 3.Trimester | Mean±SD | 35.34±5.53 | 35.63±3.42 | 34.37±3.34 | 0.033* |
| | p** | | | 0.466 | 0.001 | |
| MCV(fL) | 1.Trimester | Mean±SD | 88.44±4.78 | 88.94±5.00 | 88.00±4.58 | 0.271* |
| | 3.Trimester | Mean±SD | 88.70±6.82 | 89.57±6.32 | 87.95±7.17 | 0.183* |
| | p** | | | 0.350 | 0.948 | |
| Ferritin (ng/mL) | 1st Trimester | Mean±SD | 48.17±21.97 | 53.27±25.59 | 43.75±17.27 | |
| | | Median (IQR) | 43 (29-68) | 45 (29-76) | 41 (29-57) | 0.055† |
| | 3rd Trimester | Mean±SD | 21.49±11.33 | 24.14±11.61 | 19.19±10.63 | |
| | | Median (IQR) | 21 (11-31) | 23 (13-31) | 17 (11-27) | 0.016† |
| | p‡ | | | 0.0001 | 0.0001 | |

*Independent t test, **Paired t test †Mann Whitney U test ‡Wilcoxon test, Hb (Hemoglobin) g/dL, Hct (Hematocrit) %, MCV (mean corpuscular volume) fL

No statistically significant change was observed between the 1st Trimester and 3rd Trimester MCV averages of the <11 kg difference group (p=0.350).

No statistically significant change was observed between the 1st Trimester and 3rd Trimester MCV averages of the >11 kg difference group (p=0.948).

No statistically significant difference was observed between the 1st Trimester ferritin averages of the <11 kg Difference and >11 kg difference groups (p=0.055).

3rd Trimester ferritin averages of the >11 kg Difference group were found to be statistically significantly lower than the <11 kg difference group (p=0.016).

Table 2 shows that 1st Trimester-3rd Trimester Hb difference averages of the >11 kg difference group were found to be statistically significantly higher than the <11 kg difference group (p=0.0001).

The 1st Trimester-3rd Trimester Hct difference averages of the >11 kg Difference group were found to be statistically significantly higher than the <11 kg difference group (p=0.018).

No statistically significant difference was observed between the 1st Trimester-3rd Trimester MCV difference averages of the <11 kg difference and >11 kg difference groups (p=0.414).

No statistically significant difference was observed between the 1st Trimester-3rd Trimester ferritin difference averages of the <11 kg difference and >11 kg difference groups (p=0.378).

**Table 2: Differences between 1st and 3rd trimester Hgb, Hct, MCV and Ferritin values according to the amount of weight gained by pregnant women**

| 1st Trimester-3rd Trimester Difference | | Whole Group | <11kg Difference | >11kg Difference | p† |
|---|---|---|---|---|---|
| Hgb (g/dL) | Mean±SD | 0.6±1.28 | 0.16±1.3 | 0.98±1.14 | |
| | Median (IQR) | 0.6 (-0.1-1.5) | 0.2 (-1-0.9) | 1.05 (0.3-1.7) | 0.0001 |
| Hct (%) | Mean±SD | 0.52±5.47 | 0.12±3.62 | 1.56±3.14 | |
| | Median (IQR) | 1.5 (-1.5-2.8) | 0.1 (-2.2-2.4) | 2.15 (-0.05-3.6) | 0.018 |
| MCV (fL) | Mean±SD | -0.31±6.45 | -0.73±5.91 | 0.05±6.9 | |
| | Median (IQR) | -1 (-4.68-5) | -1.55 (-5.05-2.15) | -0.8 (-4.08-5.6) | 0.414 |
| Ferritin (ng/mL) | Mean±SD | 26.68±16.23 | 29.13±18.97 | 24.56±13.2 | |
| | Median (IQR) | 23 (15-42) | 25 (13-44) | 21.71 (15-35) | 0.378 |

† Mann Whitney U test, Hb (Hemoglobin) g/dL, Hct (Hematocrit) %, MCV (mean corpuscular volume) fL

Table 3 and figure 1 shows that apositive, statistically significant correlation was observed between the Start-3rd Trimester weight difference values and the 1st-Trimester-3rd Trimester hemoglobin difference values (r=0.425 p=0.0001). A positive, statistically significant correlation was observed between the Baseline-3rd Trimester weight difference values and the 1st Trimester-3rd Trimester hematocrit difference values (r=0.224 p=0.011).

**Table 3: The relationship between 1st Trimester-3rd Trimester weight differences and Hb, Hct, MCV and ferritin differences**

| 1st Trimester-3rd Trimester Difference | | Weight Difference |
|---|---|---|
| Hb | r | 0.425 |
| | p | 0.0001 |
| Hct | r | 0.224 |
| | p | 0.011 |
| MCV | r | 0.304 |
| | p | 0.001 |
| Ferritin | r | -0.047 |
| | p | 0.600 |

Pearson Correlation test, Hb (Hemoglobin) g/dL, Hct (Hematocrit) %, MCV (mean corpuscular volume) fL

A positive, statistically significant correlation was observed between the initial-3rd Trimester weight difference values and the 1st Trimester-3rd Trimester MCV difference values (r=0.304 p=0.001).

No statistically significant correlation was observed between the initial-3rd Trimester weight difference values and the 1st-Trimester-3rd Trimester ferritin difference values (r=-0.047 p=0.600).

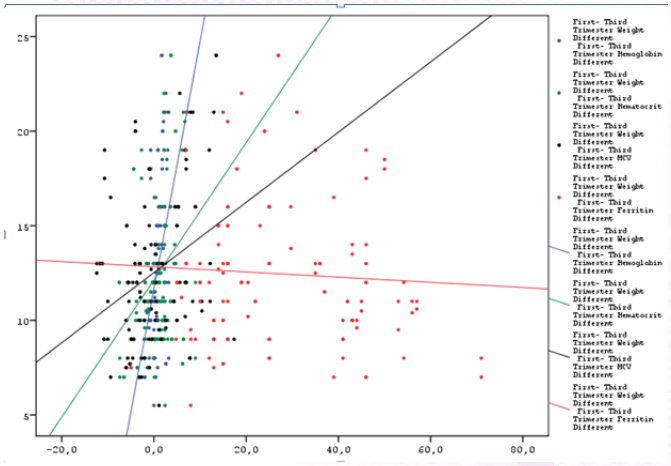

**Figure 1:** 1st and 3rd trimesters of all pregnant women. Change in weight, Hb, Hct, MCV and Ferritin values in the trimester.

## DISCUSSION

Maternal weight indicators, such as pre-pregnancy BMI and gestational weight gain, represent important measures of maternal metabolism and nutritional status. It is observed that the risks of iron deficiency and iron deficiency anemia (IDA) increase among pregnant women with obesity in developed countries,[8,9] but the risk of iron deficiency anaemia appears to be higher among low birth weight women in developing countries.[10,11] A woman's inadequate nutrition before pregnancy, insufficient calorie and protein intake, as well as lack of nutrients such as iron stored in the body, and low socio-economic status may be responsible for iron deficiency anaemia in underweight women. Meanwhile, it is well known that women with higher socio-economic status are more likely to control their body weight better.[12] In our study, unlike these studies, the effect of excess weight gain during pregnancy on anaemia in women with similar BMI was evaluated.

Weight gain in pregnant women is regulated according to BMI, based on the guideline accepted in 2009. According to this; weight gain should be 12.5-18 kg in those with low BMI (<18.5), should be 11.5-16 kg in those with normal BMI (18.5-24.9), 6.8-11,3 kg in those with overweight BMI (25-29.9) and should be 5-9 kg for pregnant women who are obese (BMI>30).[13] Our study group consisted of pregnant women with normal BMI (18.5 to 24.9). Accordingly, the groups were divided into 2 by taking 11 kg as basis. Anaemia was evaluated in those who weighed less than 11 kg and those who weighed 11 kg or more. In our study, while there was no difference between the Hb and Hct values of all our patients at the beginning of pregnancy, it was revealed that the risk of developing anaemia increased in those whose weight gain was 11 kg or more. Although all pregnant women were given 100 mg elemental iron supplement prophylactically after the 3rd month, ferritin values were found significantly lower than those who gained 11 kg or more in the 3rd trimester of pregnant women. No significant change was detected in the MCV value. The lack of change in MCV may be due to the iron supplements given. However, low ferritin may be attributed to the mother's rapid weight gain and iron insufficiency. It is known that there is increased IL-6 release, especially in patients with abdominal obesity.[14] Increased IL-6-related hepcidin production may also hinder the effective use of iron by the bone marrow.[14] This situation may have contributed to the formation of anaemia in these pregnant women. It was observed that iron deficiency continued in women who gained 11 kilos or more despite the iron supplements they used during pregnancy. Iron deficiency was defined as <15 µg/L serum concentration of ferritin level in most studies, as <12 µg/L serum concentration in some studies, and as <10 µg/L serum concentration in a few studies.[15] In our study, serum ferritin concentrations <13 µg/L were considered iron deficiency. The aetiologies and types of IDA development during pregnancy may possibly vary.[10] In addition to the development of IL-6-related anaemia, nutritional or socioeconomic reasons may also cause the development of anaemia. To understand how socioeconomic and nutritional factors affect gestational IDA among different women may help prenatal caregivers, midwives, and dietitians develop effective intervention programs to prevent gestational IDA.

Consequently, our study showed that women with normal BMI have a higher risk of gestational anaemia and IDA when weight gain increases, and this situation clearly emphasizes that rapid weight gain is undesirable during pregnancy. Weight control should be strengthened among pregnant women. Additionally, detailed studies are needed to see how it affects the weight of babies of these pregnant women.

### Limitation of the study

Despite obtaining valuable data in our study, it is important to acknowledge the limitations and areas for improvement. First of all, the study was conducted

retrospectively on a relatively small number of patients. To conduct prospective studies with larger participation shall provide more reliable research results. The fact that IL-6 level, which is known to be important in the pathogenesis of anaemia, could not be studied, should also be considered among the limitations.

## CONCLUSION

As a result of our study, we can say that rapid weight gain during pregnancy deepens anaemia. Randomized studies are needed in testing the hypotheses arguing that early use of iron supplements and strengthening weight control may reduce the risk of IDA.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** The study was carried out with the permission of Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Researches Ethics Committee (Date: 04.09.2023, Decision No: 2023-17).

**Informed Consent:** Because the study was designed retrospectively, no written informed consent form was obtained from patients.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Author Contributions:** All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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