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RESEARCH ARTICLE

Nutrition in pregnancy – impact on anaemia in pregnant women

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Aim: Most pregnant women can achieve their caloric and nutritional needs by careful food choices during pregnancy, but there are fairly common situations when pregnant women develop anaemia, which needs to be managed properly to avoid maternal-foetal complications. The main objective of the study was to identify the nutritional factors favoring the occurrence of iron deficiency anaemia in pregnant women. **Methods**: Data collection for the cross-sectional study was carried out using a questionnaire that provided information on nutrition and risk factors during pregnancy in a group of patients from Suceava. The questionnaire was given to pregnant women admitted to the Emergency County Hospital „Sfântul Ioan cel Nou" Suceava, Romania, between March and May 2017. **Results**: The anaemia occured in 46.3% of pregnant women. Although 22.2% of pregnant women received oral iron supplementation, effects on anaemia correction were not observed (p=0.02). We found that weight status did not influence anaemic status (p=0.51), and the presence of anaemia in pregnancy was independent of risk factors for pregnancy (smoking, p=0.05; alcohol consumption, p=0.66), iron absorption inhibitors in the diet (coffee, p=0.33; tea, p=0.53), water intake (p=0.52) or night eating (p=0.27). **Conclusions**: The results of dietary survey showed no direct link between the prevalence of anaemia and nutritional factors. Lower pre-pregnancy BMI was not associated with higher risk of iron deficiency anaemia, and daily iron supplementation during pregnancy did not meet the needs to counteract the anaemic syndrome. Nutrition education is particularly important for the prophylaxis of iron deficiency anaemia in pregnant women.

Keywords: nutritional factors, pre-pregnancy BMI, iron deficiency anaemia, iron supplementation

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Introduction

Pregnancy can be considered one of the most sensitive stage of life, as nutrients have a major impact on the foetus during this period. To ensure optimal health for both mother and baby, proper nutrition is vital before and during pregnancy.

Metabolic changes that allow pregnant women to use nutrients more efficiently (protein, fatty acids, etc.), absorb them better (calcium, iron) and/ or excrete themless (e.g. zinc, riboflavin) help to meet their calorie and nutrient needs during pregnancy. With the exception of iron, most women can meet this need by carefully choosing nutritionally dense foods [1].

The presence of risk factors for iron deficiency in pregnancy (vegetarian diet, smoking, alcohol consumption), iron absorption inhibitors (coffee and tea) [2-4], and lack of vitamin C-rich foods consumed daily [5] points to further hematological investigations and prophylactic management with iron administration.

Red meat is the major source of heme iron with higher bioavailability and absorbed up to three times better than non-heme iron from plants [6]. If heme iron sources are avoided or the amounts consumed are not adequate, they should be replaced with iron-fortified cereals, sardines, spinach, dried beans, lentils, peas, etc. [7]. A small amount of heme iron in the diet enhances the absorption of non-heme iron, thus increasing the amount of iron absorbed [6].

Iron absorption decreases or increases when combined with food. The absence of nutritional inhibitory factors and the presence of non-heme iron absorption-increasing factors are important for achieving iron requirements for people whose diet contains little heme iron [8]. Absorption of heme and non-heme iron is facilitated by organic compounds present in meat called meat factors [9]. Vitamin C-rich foods consumed with iron supplements or iron-containing foods help increase iron absorption [2,8]. The recommendation of iron supplements is made, as a priority, to pregnant women in the at-risk category, by the family doctor or obstetrician. For this it is important that all pregnant women are followed up during pregnancy. Foods that inhibit iron absorption should be eaten with in two hours of an iron-rich meal. This is one of the recommendations of the Romanian guidelines of obstetrics and gynecology [3], to be considered by doctors who need to inform pregnant women about the correct way to administer oral iron preparations and about the disadvantage of combining iron treatment with certain foods or medicines that reduce iron absorption. These inhibitors are phytates and tannins in foods of plant origin, milk proteins, carbonates, antacids (by reducing the amount of acid in the stomach), oxalates, bran (by its high fibre content), egg yolk (through phosvitin which binds to iron and inhibits its absorption by up to 28% per meal), flavonoids, phenol-

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ic acids and polyphenols and chlorogenic acid (a phenolic compound present in coffee) [10]. Avoiding coffee consumption is also necessary because it can induce satiety at the expense of a nutritionally rich meal and provides many calories without nutrients (if sweetened) [1]. Replacing tea and coffee consumed with meals with ascorbic acid-rich fruit juices may prevent a 35-64% reduction in non-heme iron absorption when these beverages are accompanied by solid foods. [11]. Regular smoking affects the level of serum hepcidin, a peptide hormone with a role in regulating iron homeostasis. Low iron and haemoglobin concentrations together with high erythropoietin levels indicate that smoking can lead to iron deficiency and chronic hypoxia in mothers and foetus [12]. Hemoglobin concentration, hematocrit, and red blood cell count decrease progressively during pregnancy [13]. These changes cause an adjustment in water requirements, to maintain the body fluid balance mechanism [14]. The adequate intake for women, 2.7 L/day, is based on a median intake of total water from fluids and foods [15]. One of the strategies to alleviate maternal discomforts is to drink at least eight glasses of water each day [16].

Dietary strategies to improve iron content and bioavailability are to ensure an adequate diet by increasing the total amount of iron to meet daily requirements, increasing the bioavailability of non-heme iron by increasing the intake of activators, and reducing the intake of absorption antagonists [3,17].

Our research aims to identify the nutritional factors favoring the occurrence of iron deficiency anaemia in the last two trimesters of pregnancy, in pregnant women admitted to the Emergency County Hospital „Sfântul Ioan cel Nou" Suceava, from which to result in practical preventive possibilities, by correcting the diet during pregnancy.

Methods

After getting approval from the „Sfântul Ioan cel Nou" Emergency County Hospital Suceava, Romania, pregnant women (N=54) admitted to the maternity ward – who wished to participate in the study and who signed informed consent – were given a questionnaire. The study followed the principles outlined in the Declaration of Helsinki and was conducted between March and May 2017.

The study methodology included a two-part questionnaire which was completed by the interviewer. For the first part we used general data from the "Pregnancy Diary" [18], which provided demographic and anthropometric parameters (age, residence, gestational age at birth, pre-pregnancy weight, height), hematological parameters (hemoleucogram) and iron deficiency-anaemia as condition occurring during pregnancy. These data were compared with those from admission medical records, and were confirmed by the pregnant women. For the second part we conducted face-to-face interviewing using items from a food frequency questionnaire [19] adapted to receive information about nutrition during pregnancy: number of meals and snacks, frequency of foods in the food groups over a week, vitamin C-rich foods consumed daily, water intake, food intolerances, night eating, dietary supplements, risk factors for pregnancy (smoking, alcohol), and iron absorption inhibitors (coffee and tea).

Anthropometric measurements like height, weight and body mass index (BMI) were done. In reference to WHO BMI standards [20], the nutritional status of women before pregnancy was defined as underweight (BMI < 18.5), normal (18.5 ≤ BMI < 25), overweight (BMI ≥ 25), or obese (BMI ≥ 30).

Hemoleucogram analysis was performed before childbirth in all pregnant women admitted to labor and delivery. The diagnosis of anaemia was made at a haemoglobin value below 11.5 g/dl.

Statistical analysis was performed using Medcalc 20.106. To characterise the two groups of pregnant women, with anaemia and without anaemia, we used the mean, standard deviation, minimum and maximum values recorded in the study. The independent samples t-test and Pearson correlation tests were used for comparison of quantitative variables. The limit for statistical significance was set at 0.05.

Results

The 54 patients included in the study ranged in age from 16 to 46 (mean age = 29.5 years; SD±6.7). A percentage of 48.1% (N=26) lived in urban areas. Gestational age ranged from 28 to 40 weeks, with a mean of 37.2 weeks (SD±3.1). Weight gain during pregnancy varied between 6 and 26 kg (mean weight = 12.7 kg; SD±4.4). Maternal pre-pregnancy BMI ranged from 16 to 42 kg/m^2, with an average of 23.9 kg/m^2 (SD±5.4), 5.6% (N=3) of pregnant women being underweight, 63% (N=34) normal weight, 14.8% (N=8) overweight, 13% (N=7) class 1 obesity, and 3.7% (N=2) class 3 obesity. These data are important to see if weight status can influence anaemic status. As regards the assessment of anaemia in pregnant women in the study group, haemoglobin values ranged from 7.7 to 14.5 g/dl. 46.3% (N=25) of pregnant women had anaemia during pregnancy (Hb<11.5 g/dl).

The dietary survey revealed that pregnant women had 2-3 main meals per day and a number of snacks that varied between 0 and 6 (Figure 1), thus high variability, but without a cause-effect association between number of daily snacks and weight gain during pregnancy (p=0.74, r=0.01, 95% CI -0.62 to 1.56).

The items in the food frequency questionnaire concerned food consumption in the last week (Table I) of the 3rd trimester of pregnancy. The responses highlighted the following: almost all pregnant women benefited from the vitamin, and mineral content of fresh fruits and vegetables consumed daily (98.1%, N=53), as well as from the protein and fat content of meat (85.2%, N=46) and dairy (92.6%, N=50). 94.4% (N=51) consumed vitamin C-rich foods. The intake of polyunsaturated fatty acids was provided by daily or occasional consumption of fish

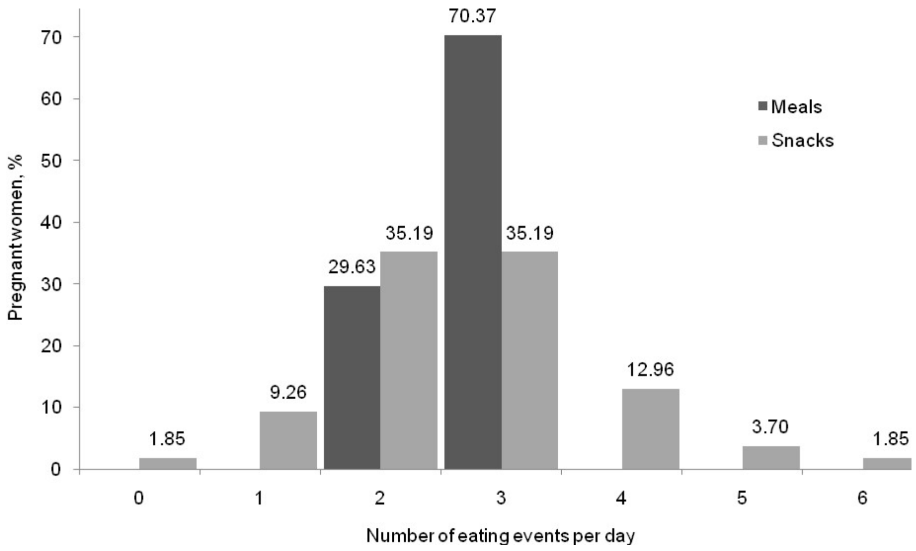

Fig. 1. Distribution of meals and snacks per day in our sample

(68.6%, N=26), and oil fruits (48.2%, N=26). Fast food was reported by 25.9% (N=14) of the patients in the study group.

The patients' water intake was at the lower limit of the recommended adequate intake, according to ranging from 1000 to 2500 ml (mean = 1829 ml; SD±522), 51.9% (N=28) of them consuming at least 2 liters of water a day. Independent samples t-test assuming equal variance was used to compare between the anaemia, and non-anaemia groups. The difference between the sample mean water in anaemic, and non-anaemic pregnant women 92 ml, with a 95% confidence interval from -195 to 380 ml; the t test statistic was 0.6 with 52 degrees of freedom, and an associated p value of p=0.52.

A percentage of 22.2% (N=12) of participants received oral iron supplementation, but 16.6% (N=9) of them had anaemia (Figure 2). Despite this intervention on anaemic pregnant women, iron medication during pregnancy failed to correct the value of laboratory parameters indicating the presence of anaemia in pregnant women admitted to the *maternity unit* (p=0.02, r=0.30, 95% CI 0.04 to 0.53).

Oral iron supplements were not tolerated by some patients (5.5%, N=3), because of gastrointestinal side effects. In addition, they listed several foods avoided during pregnancy (fish, cocoa, garlic, fried foods, onions, citrus, dairy, fruit, fresh fruit, meat, pork, meat preparations, smoked meats, cheese, butter and yoghourt), 40.7% of the pregnant women avoided one food (N=22), 9.3% not tolerated at least two foods (N=5). This list was relevant for our study because it allowed us to verify whether the absence of iron absorption-increasing factors (meat and fruit) influenced the anaemic status. The statistical result shows the absence of this correlation (p=0.40, r=0.01, 95% CI -0.35 to 0.14). 22.2% (N=12) of pregnant women admitted to consuming food during the night and 64.8% (N=35) took dietary supplements during pregnancy.

Given that smoking and alcohol consumption are risk factors for iron deficiency in pregnancy, also from the dietary survey we note that 5.6% (N=3) of pregnant women reported daily smoking, 18.5% (N=10) reported consumption of occasional quantities of alcohol, and 7.4% (N=4) preferred wine. Risk factors for pregnancy (smoking and alcohol consumption) were found in both pregnant women with and without anaemia (p=0.05, r=0.26, 95% CI -0,007 to 0,49, respectively p=0.66, r=-0.06, 95% CI -0,32 to 0,21).

Among iron absorption inhibitors, coffee was the occasional choice of 50.0% (N=27) of pregnant women and the daily choice of 7.4% (N=4), while tea was consumed occasionally by 48.1% (N=26) and daily by 16.7% (N=9).

Table I. Frequency of food intake in the last week

Food intake variables	Frequency (N=54)					
	No		Occasionally		Yes	
	N	%	N	%	N	%
Fresh vegetables	1	1.9	0	0	53	98.1
Vegetables	13	24.1	27	50.0	14	25.9
Fresh fruit	1	1.9	0	0	53	98.1
Oleaginous fruits	28	51.9	17	31.5	9	16.7
Vitamin C-rich foods	3	5.6	0	0	51	94.4
Diary	4	7.4	0	0	50	92.6
Fish	17	31.5	28	51.9	9	16.7
Meat	8	14.8	0	0	46	85.2
Fast food	40	74.1	10	18.5	4	7.4

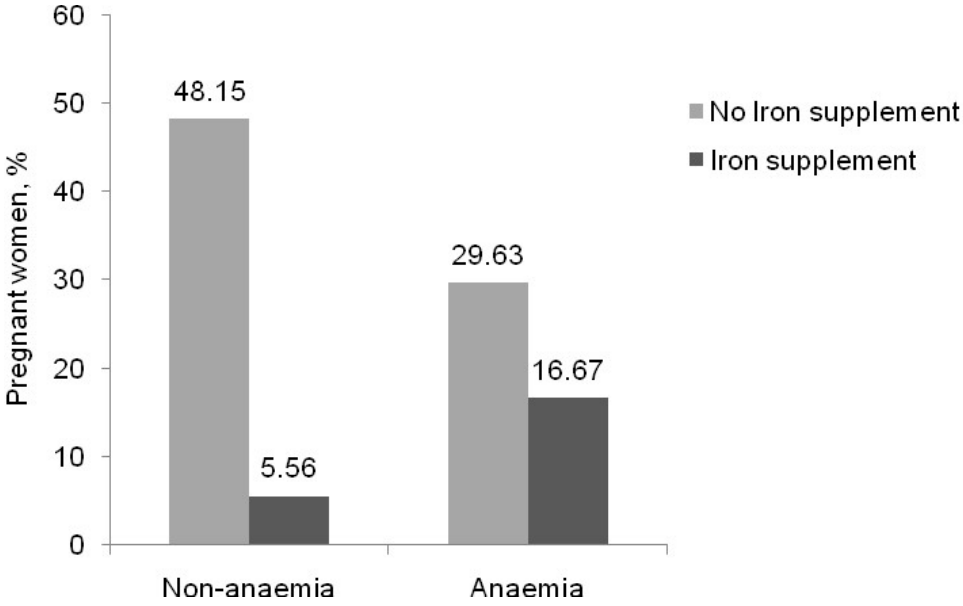

Fig. 2. Distribution of the non-anaemic and anaemic pregnant women with and without oral iron supplementation

The presence of those iron absorption inhibitors was also found in both groups. The presence of anaemia was neither associated with coffee consumption (p=0.33, r=-0.13, 95% CI -0.38 to 0,13), nor with tea consumption (p=0.53, r=0.08, 95% CI -0,18 to 0.34).

The independent samples t-test was used to show the maternal demographic, anthropometric and nutritional characteristics of pregnant women with anaemia compared to those without anaemia: age, residence, gestational age at birth, pre-pregnancy BMI, weight status, meals and snacks, foods, food intolerances, night eating and dietary supplements (Table II).

Although the results of our study did not show a direct connection between nutritional factors and the occurrence of anaemia in pregnant women, it was revealed a number of correlations between different variables using Pearson correlation tests. For example, night eating was reported by 22.2% (N=8) patients of which only 5.5% (N=3) had anaemic status, and it was negative associated with consumption of dietary supplements (p=0.001, r=-0.41, 95% CI -0.61 to -0.16), meat (p=0.019, r=-0.31, 95% CI -0.53 to -0.05), fresh fruits (p=0.003, r=-0.39, 95% CI -0.59 to -0.13), vegetables (p=0.003, r=-0.39, 95% CI -0.59 to -0.13) and vitamin C-rich foods (p=0.036, r=-0.29, 95% CI -0.51 to -0,01), and positive associated with water intake (p=0.005, r=0.37, 95% CI 0.11 to 0.58). These correlations are relevant to the current study because the variables listed are iron absorption-increasing factors, which pregnant women did not tend to consume during the night, except for water which has a beneficial role in maintaining body fluid balance, including hemoglobin concentration, hematocrit, and red blood cell count.

Discussions

Studies showed that anaemia occurs more frequently in underweight, and normal weight women [21,22]. The same

Table II. Demographic, anthropometric and nutritional characteristics of pregnant women with anaemia and pregnant women without anaemia

Characteristics	Pregnant women with anaemia (N=25)	Pregnant women without anaemia – control (N=29)	p-value
Age (years)	29.6±8.1 (26.3-33)	29.5±5.4 (27.4-31.5)	0.9308
Residence	0.4±0.5 (0.1-0.6)	0.5±0.5 (0.3-0.7)	0.2744
Gestational age at birth (weeks)	36.6±3.4 (35.2-38.1)	37.7±2.8 (36.6-38.8)	0.2147
Pre-pregnancy BMI (kg/m2)	23.1±3.8 (21.6-24.7)	24.5±6.5 (22-27)	0.3750
Weight status	1.5±1.2 (1.09-2.07)	1.4±0.6 (1.1-1.6)	0.5176
Meals	2.6±0.4 (2.4-2.8)	2.7±0.4 (2.5-2.9)	0.3505
Snacks	2.7±1.1 (2.2-3.1)	2.6±1.1 (2.1-3)	0.7477
Vegetables	1.2±0.7 (0.8-1.5)	0.8±0.6 (0.6-1.1)	0.0826
Oleaginous fruits	0.64±0.7 (0.35-0.92)	0.65±0.8 (0.34-0.96)	0.9422
Vitamin C-rich foods	0.96±0.2 (0.87-1.04)	0.93±0.2 (0.83-1.02)	0.6506
Diary	0.9±0.2 (0.8-1)	0.8±0.3 (0.7-1)	0.3842
Fish	0.6±0.6 (0.3-0.9)	1±0.6 (0.7-1.2)	0.0866
Meat	0.8±0.3 (0.7-1)	0.8±0.3 (0.6-0.9)	0.5970
Fast food	0.2±0.5 (-0.00-0.48)	0.4±0.6 (0.1-0.6)	0.3044
Food intolerances	0.4±0.6 (0.2-0.7)	0.6±0.6 (0.4-0.9)	0.2476
Night eating	0.2±0.5 (-0.03-0.4)	0.3±0.6 (0.1-0.6)	0.2799
Dietary supplements	0.76±0.43 (0.58-0.93)	0.72±0.45 (0.55-0.89)	0.7696

result was obtained when the impact of pre-pregnancy BMI on the risk of iron deficiency anaemia was investigated [23]. In our study, anaemia status has been statistically correlated with women's weight status before pregnancy. The statistical correlation was negative, the hypothesis was not verified. We found that in our study group there were both overweight and normal weight pregnant women with anaemia, and underweight pregnant women without anaemia. So, contrary to expectations, lower pre-pregnancy BMI was not associated with higher risk of iron deficiency anaemia. Not always weight status influences anaemic status, but nutritional deficiencies that are important.

Studies have shown that water intake may improve anaemia by increasing the hemoglobin index [24]. Our result did not confirm this hypothesis. Anaemic and non-anaemic women had a lower water intake than the recommended adequate intake of 2.7 L/day.

Although fresh fruit and vegetables, meat and vitamin C-rich foods are reported to play an important role in the diet of pregnant women, anaemia was found in almost half of the study group. Even though some of the pregnant women received oral iron supplementation, correctly recommended by the GP or obstetrician, the effects on anaemia correction were not observed. Iron supplementation was found to be positively correlated with the presence of anaemia. These results *confirm* previous findings, when daily supplementation with 30 mg iron during pregnancy did not significantly influence the overall prevalence of anaemia [25]. In the case of pregnant women participating in our study, this could be due to both nutritional misinformation and questionable patient compliance. A fact noted in medical practice is the lack of informed information on the importance and administration of oral iron therapy.

The findings support the idea that sleep quality is impaired in a significant portion of patients with iron deficiency anaemia [26] and that increased night-time energy intake is associated with lower intakes of dietary iron during pregnancy [27]. Night eating is also a parameter worth researching in pregnant women, but the number of cases in our study group is too small to be able to interpret the data in relation to anaemia. However, for the pregnant women in our study, night eating was an opportunity to hydrate and to supplement the intake of iron absorption-increasing factors, regardless of anaemic status.

Conclusions

The results of our study showed no direct link between nutritional factors and the occurrence of iron deficiency anaemia in the last two trimesters of pregnancy. Also we registered no association between lower pre-pregnancy BMI and higher risk of iron deficiency anaemia. Daily iron supplementation during pregnancy did not meet the needs to counteract the anaemic syndrome. More studies are required to verify on a greater number of pregnant women if there is any nutritional factor associated with anaemia in order to optimise the interventions during pregnancy as early as possible.

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Authors' contribution

OA - Study design, data analysis, critical revision and editing of manuscript, final approval for publication
PM - Study design, research implementation, drafting of manuscript, data collection, final approval for publication
BS - Study design, study validation and supervision, critical review of manuscript, final approval for publication
MT - Study design, data analysis, critical review of manuscript, final approval for publication

Conflicts of interest

Nothing to declare.

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