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Longitudinal Observational Study on Diet Quality during Pregnancy and Its Relation to Several Risk Factors for Pregnancy Complications and Outcomes

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Authors' contributions

This work was carried out in collaboration between all authors. Author IB designed the study, collected, analysed and interpreted the data, and prepared the manusript. Author DK participated in the study design, and interpretation of the diet quality data. Author MLM managed the literature search, and interpreted the data. Authors MG and JL recruited participants, and interpreted the clinical data. All authors read and approved the final manuscript.

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ABSTRACT

Aims: A mother's diet during pregnancy is considered one of the most important external factors affecting health of her child further in life. Unfavourable diet, together with advanced maternal age, high pre-pregnancy body mass index (BMI), and excessive pregnancy weight gain are considered to be significant risk factors for adverse pregnancy complications and outcomes. The aim of this study was to determine correlations between pre-pregnancy BMI, quality of nutrition during pregnancy, and pregnancy outcomes in pregnant women with an excessive weight gain during pregnancy.

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Study Design: Randomized, observational, prospective, long-term study.
Methodology: The study included pregnant women from the area of the city Osijek, eastern Croatia. The subjects were monitored throughout pregnancy to labour and 6 weeks postpartum. Analysis included anthropometry, blood glucose, incidence of gestosis (i.e. hypertension, gestational diabetes, edemas and proteinuria) and delivery outcomes (e.g. mode of delivery, birth weight) and a 24-hour dietary record was used to asses nutrition quality. Based on the risk factors for adverse pregnancy complications and outcomes, two groups of women were selected for the sub-group analysis. The first group of women with a normal pre-pregnancy BMI and an excessive pregnancy weight gain (n=47), and the second group of women with an overweight/obese BMI (BMI≥25 kg/m^2) and an excessive pregnancy weight gain (n=43).
Results: For women with a normal pre-pregnancy BMI, the balance of specific carbohydrates had the greatest importance on pregnancy complications and outcomes. On the other hand, for women starting pregnancy at-risk; with an overweight/obese BMI, the total dietary intake of fats and the balance in specific fatty acids had the greatest impact on pregnancy complications and outcomes.
Conclusion: The present study provides important data on how specific dietary components influence pregnancy complications and outcomes. This information may be useful in creating specific timed interventions for women of reproductive age, ensuring a healthy pregnancy, and a healthy child.

Keywords: Pregnancy; nutrition quality; macronutrient contribution; pregnancy outcomes.

1. INTRODUCTION

The quality of a pregnant woman's diet is of special concern, and it is considered that women during pregnancy tend to have better nutritional habits [1]; however, this remains a matter of discussion. Studies show that diets characterized by an unbalanced contribution of macronutrients to the total daily energy intake may be a risk factor for pregnancy complications [1-3]; this is especially the case for diets high in fat [2]. Additionally, diets characterized by a high intake of simple carbohydrates or low intake of complex carbohydrates have also been recognized as a risk factor for adverse pregnancy complications and outcomes [1,2].

The quality of a pregnant women's diet is significantly influenced by her socioeconomic and lifestyle characteristics. Younger women, of lower education, low income, from rural areas, with more children and higher pre-pregnancy BMI have diets of lower quality during pregnancy [1,3,4]. Primiparous women show high motivation to improve their nutritional habits [3,4].

In order to assess the risk of pregnancy complications and outcomes additional aspects need to be considered. Advanced maternal age [4], pre-pregnancy BMI [5,6], and excessive weight gain during pregnancy [7-9] are all considered important risk factors for pregnancy complications and adverse outcomes. Today pre-pregnancy overweight/obesity is considered as one of the most common high-risk obstetric situations [10] and Croatia is not an exception [6,11]. Extensive number of studies have shown a correlation between overweight/obese BMI with an increased risk of foetal macrosomia and medical complications, including pregnancy-induced hypertension, gestational diabetes (GDM), and caesarean delivery [5,6,12-15]. On the other hand, for women entering pregnancy with a normal BMI the higher concern is inadequate weight gain [9,12,13]. Choi et al. [9] and De Vader et al. [12] found that for normal weight and an underweight pregnant woman, excessive weight gain during pregnancy shows a significant association with adverse maternal and neonatal outcomes.

Based on our previously published results [11], and literature evidence, the following hypotheses were set:

1) Presence of a risk factor pre-pregnancy (i.e. overweight/obesity) increases the possibility of developing complications through pregnancy;
2) Unbalanced nutrition can trigger pregnancy complications even in women who were not considered to be at-risk at the beginning of the pregnancy;
3) Intake of fats increases the risk for adverse pregnancy outcomes.

In order to test these hypotheses, we wanted to determine correlations between pre-pregnancy BMI, quality of nutrition during pregnancy, and pregnancy outcomes in pregnant women with excessive weight gain during pregnancy.

2. MATERIALS AND METHODS

2.1 Participants' Recruitment

The inclusion criteria was a healthy pregnancy within 12 weeks of gestation (i.e. the 1st trimester), followed in two general gynaecologist offices from the area of the city Osijek, eastern Croatia. The time-frame of pregnancy in the 1st trimester was selected because the statistical reports for the research area in past several years show that for around 88% of women pregnancy is confirmed within 12 weeks of gestation [16,17]. Two hundred and fifty one pregnant women were enrolled during one year period, and monitored (throughout gestation to labour) from 2010 till the end of 2011. A total of 29 women were excluded in the final analysis for following reasons: forced abortion (n=3), preterm labour (n=2), newborn death (n=1), twin pregnancy (n=3), and lack of data (n=20). Dropout rate was 11.6%. The study was approved by the Ethical committee of the Faculty of Food Technology Osijek; an informed consent was obtained for all participating pregnant women. The recruited population is by all demographic and socio-economic characteristics representative for the overall population of pregnant women from the research area [16,17]. The final number of participants presents 14.8% of the total population of pregnant women for the study period, and the research area.

2.2 Data Collection

General data regarding age, education level, incomes, earlier pregnancies, smoking habits and supplement use were collected by a short questionnaire developed for this study. Basic data was collected at the first interview when the pregnancy was confirmed, i.e. within first 12 weeks of gestation.

A medical scale (Seca, UK) was used for the weight measurement (with the precision of ±0.1 kg), and height measurement (with head in Frankfurt position with the precision of ±0.1 cm). BMI was calculated for all women and it was considered as pre-pregnancy BMI. The World Health Organization criteria [18] was considered for the classification of women as underweight (BMI<19.0 kg/m^2), normal weighted (BMI=19.0-24.9 kg/m^2), overweight (BMI=25.0-29.9 kg/m^2) or obese (BMI≥30.0 kg/m^2).

The nutrition quality assessment was done by a 24-hour dietary recall completed in a multi pass protocol, and the method was repeated once during each trimester. All protocols known to be influential on under- or over-reporting were obeyed (e.g. avoiding weekends, holidays and special occasions, never completed on the same days, all seasons were covered). The computer program NutriPro (Faculty of Food Technology Osijek, Osijek, Croatia) which uses National Composition tables [19] was used to calculate energy intake and intake of macro and micronutrients, and the results were compared to the recommended intake for pregnant women [20].

When the pregnancy was confirmed venous blood samples were collected and analysed for plasma glucose by photomethric method with heksokinase on OLYMPUS AU400 according to the manufacturer's instructions. Glucose was evaluated according to the HAPO study recommendations [21], i.e. both fasting plasma glucose and oral glucose tolerance test (OGTT) were used. Incidence of disorders of pregnancy, i.e. edemas, GDM, hypertension, and proteinuria were noted, since they are followed by the gynaecologists for their significant influence on pregnancy outcomes [5,9,14]. These four disorders are termed as gestosis [11]. Weight gain was tracked (i.e. measured on each following appointment) and after the delivery it was compared to the recommended weight gain during pregnancy [18]. Data regarding delivery was collected 6 weeks postpartum in person (at the gynaecologist office) or via telephone, and included gestation (in weeks), baby's length (BL) and weight (BW) and mode of delivery (spontaneous, induced or caesarean). Ponderal index (PI) was calculated for each child based on formula: PI=(BW in g/BL3 in cm) x 100 [22]. According to a calculated PI, disproportions of foetal growth were noted (PI<2.32 or PI>2.85) [22].

2.3 Sub-group Selection

According to the pre-pregnancy BMI and risk factors for the adverse pregnancy outcomes cited in the literature, two groups of pregnant women were extracted for a further sub-group analysis. The first group of pregnant women selected had a normal pre-pregnancy BMI but have gained an excessive weight during pregnancy, Group 1 (G1, n=47). The second group consisted of an overweight/obese pre-pregnancy BMI women with an excessive pregnancy weight gain, Group 2 (G2, n=43). Despite of by-hand-sub-selection, the selected groups of women did not differ statistically in their age, education or income, number of earlier pregnancies, smoking habits or supplement use.

2.4 Statistical Analysis

The statistical analysis was performed with the software tool Statistica 12.0 (StatSoft, Tulsa, Oklahoma, USA), at significance level P=.05. Normality of data distribution was tested by the nonparametric Kolmogorov-Smirnov test for the comparison of medians and arithmetic mean, and histograms plotting. For the comparison of categorical data within and between groups Fishers exact test was used, and for the comparison of multiple variables based on categorical data Kruskal-Wallis test was used. Wilcoxon test was used to test two dependent variable groups, since overall data did not show normal distribution. Also, Spearman's test of correlations was used to calculate correlations between numerical data. MS Office Excel (Microsoft, Redmond, Washington, USA) was used for other calculations and graphs.

3. RESULTS

A higher incidence of gestosis was found in G2 (62.8%) (Table 1). Women with edemas also had hypertension, while proteinuria was not noted. Incidence of GDM was 8.51% in G1 (4/47) and 14.0% in G2 (6/43). Despite the lack of statistical significance, caesarean section was more prevalent in G2 (39.5% vs. 25.5%). A statistically significant higher prevalence of induced labour was found in G1 (14.9% vs. 7.0%, P<.001). Newborns of G2 women were significantly heavier (by 90 g, P=.026), but when analysed for PI, results proved statistically insignificant. The prevalence of a PI>2.85, which is considered as an adverse pregnancy outcome [22], in the G1 was 38.3% (18/47) and in the G2 48.8% (21/43).

Nutrition quality analysis showed a statistically significant increase in intake of energy and all macronutrients through gestation (P<.001, Table 2). The results demonstrate a high contribution of fat to the daily energy intake for both groups. A significant change in the contribution of carbohydrates is also visible in both groups. In G1, the contribution of fats increased from 35.9% to 39.2% (P<.001), while contribution of carbohydrate decreased from 52.4% to 50.6% (P<.001) by the end of gestation. On the other hand, G2 contribution of fats slightly decreased from 37.4% to 36.9% (P<.001), while contribution of carbohydrates increased from 50.1% to 52.5% by the end of gestation (P<.001). Importantly, the contribution of proteins to the daily energy intake increased slightly, but significantly, by the end of gestation in both groups (P<.001). The high contribution of fats and the shifted balance between fats and carbohydrates is obvious in both groups.

Based on the results presented in Table 2, we wanted to see the nutritional profile for each of the separate carbohydrates (including fibres and their ratios) and fats (i.e. fatty acids and their ratios) (Tables 3 and 4).

Table 1. Followed pregnancy variables in G1 and G2

Pregnancy variables	G1 (n=47)median (25%–75%)	G2 (n=43)median (25%–75%)	P
GUK 1 (mmol/L)	4.8(4.5–5.1)	5.0(4.7–5.2)	.080
GUK 2 (mmol/L)	4.6(4.4–4.8)	4.8(4.5–5.3)	*.009*
Gestation (weeks)	39.6(39.0–40.5)	39.6(39.0–40.2)	.521
Incidence of gestosis*	51.1(4/47)	62.8(6/43)	.293
GDM			
Mode of delivery*			
Natural	59.6	53.5	.671
Induced	14.9	7.0	*<.001*
Caesarean	25.5	39.5	.320
Weight gain (kg)	19.0(18.0–23.0)	15.0(13.0–16.5)	*<.001*
Birth weight (g)	3660(3320–3820)	3750(3480–4100)	*.026*
Birth length (cm)	51.0(49.0–52.0)	51.0(50.0–52.0)	.683
Ponderal Index (PI)	2.80(2.62–2.94)	2.84(2.72–3.00)	.106

*Wilcoxon test; *Fischer's exact test; values presented as percentages; GDM – gestational diabetes;expressed as a number of women in the group; GUK 1 – blood glucose by the 12th week of gestation; GUK 2 – blood glucose between 24th and 28th week of gestation*

Table 2. Daily intake of energy and macronutrients during pregnancy in G1 and G2

	G1 (n=47)		P	G2 (n=43)		P
	First trimester median (25%–75%)	**Third trimester median (25%–75%)**		**First trimester median (25%–75%)**	**Third trimester median (25%–75%)**	
Daily energy (kJ)	8364(6448–11427)	11100(8229–12929)	*<.001*	7452(5489–8703)	9205(8104–12590)	*<.001*
Proteins (g)	64.9(47.5–84.4)	77.7(62.6–103.7)	*<.001*	55.0(36.8–66.4)	68.5(56.9–88.9)	*<.001*
Contribution of proteins* (%)	12.7(11.0–14.3)	13.1(10.7–14.5)		12.0(10.0–14.5)	12.7(10.1–15.1)	
Fats (g)	85.3(49.8–121.5)	115.4(75.9–151.1)	*<.001*	66.7(47.8–92.7)	96.9(69.3–129.1)	*<.001*
Contribution of fats* (%)	35.9(32.2–41.9)	39.2(32.9–44.9)		37.4(31.9–42.3)	36.9(32.9–44.2)	
Carbohydrates (g)	249.9(207.5–327.1)	320.8(236.9–366.6)	*<.001*	223.7(178.3–279.3)	287.6(218.8–364.8)	*<.001*
Contribution of carbohydrates* (%)	52.4(46.2–56.2)	50.6(42.4–55.0)		50.1(46.1–58.4)	52.5(42.5–56.4)	

*Wilcoxon test; *values (%) present contribution of separate macronutrients to daily energy intake*

Table 3. Intake of separate carbohydrates and their ratio during pregnancy in G1 and G2

	G1 (n=47)		P	G2 (n=43)		P
	First trimester median (25%–75%)	**Third trimester median (25%–75%)**		**First trimester median (25%–75%)**	**Third trimester median (25%–75%)**	
Monosaccharides (g)	116.8(81.7–149.9)	131.2(93.2–174.6)	.088	97.6(60.2–159.4)	105.1(89.6–186.3)	*<.004*
Polysaccharides (g)	130.2(88.3–180.3)	156.0(126.0–197.7)	*.012*	111.4(77.3–145.0)	153.1(115.1–180.2)	*<.001*
Fibres (g)	22.4(15.2–28.3)	22.5(18.5–27.8)	.101	19.1(12.4–25.1)	22.3(16.4–28.4)	*.010*
Mono:Poly ratio	1:1.51(1.01–1.70)	1:1.44(0.97–2.22)	.193	1:1.14(0.76–2.26)	1:1.49(0.85–2.08)	.512

Wilcoxon test

Table 4. Intake of separate fatty acids and their ratio during pregnancy in G1 and G2

	G1 (n=47)		P	G2 (n=43)		P
	First trimester median (25%–75%)	**Third trimester median (25%–75%)**		**First trimester median (25%–75%)**	**Third trimester median (25%–75%)**	
Saturated fatty acids, SFA (g)	29.6(18.7–40.2)	38.1(24.0–49.2)	*.003*	19.8(15.8–32.4)	33.3(23.7–40.9)	*<.001*
Mono unsaturated fatty acids, MUFA (g)	27.2(15.4–35.2)	34.9(25.1–49.4)	*<.001*	18.5(15.0–26.5)	32.0(21.8–41.4)	*<.001*
Poly unsaturated fatty acids, PUFA (g)	22.1(12.6–34.1)	29.4(21.8–45.3)	*<.001*	19.4(15.0–31.4)	28.2(20.6–39.7)	*.003*
MUFA:SFA ratio	1:1.76(1.50–1.99)	1:1.93(1.60–2.33)	.159	1:1.89(1.55–2.23)	1:1.92(1.61–2.36)	.134
PUFA:MUFA ratio	1:0.91(0.65–1.11)	1:0.95(0.74–1.10)	.634	1:1.08(0.78–1.36)	1:0.94(0.65–1.24)	.137

Wilcoxon test

The intake of all separate carbohydrates increased significantly by the end of gestation only in G2 (Table 3). In G1 a statistically significant increase was determined only for polysaccharides (P=.012). Nevertheless, intake of fibres is below the recommended 28 g/day [20] in both groups of pregnant women.

A statistically significant increase for the intake of all separate fatty acids (FA) was found in both groups (Table 4). Even though the contribution of fats decreased slightly in G2 by the end of gestation (Table 2), the absolute intake of separate FA in G2 shows a greater increase (40.5% increase in SFA, 42.2% increase in MUFA, and 31.2% increase in PUFA);however, this resulted in unbalanced FA ratios (decreased PUFA:MUFA ratio by the end of gestation).

In order to determine which of the observed nutritional components, if any, affects pregnancy complications and outcomes, their contribution to the diet was compared to several pregnancy variables (Table 5). Spearman's correlation ranks suggest that for women in G1 nutrition quality in the first trimester has higher importance from the aspect of pregnancy complications and outcomes (8/11 found correlations). Significant positive correlation was found between pregnancy weight gain and the intake of total carbohydrates (r=.32) and monosaccharides (r=.29), and a negative correlation for the intake of polysaccharides (r=-.43) and Poly:Mono ratio (r=-.29). Therefore, for women in the G1, their dietary intake of carbohydrates had a greater correlation with pregnancy outcomes than fats.

Table 5. Spearman's ranks of correlations between nutrition quality throughout pregnancy and selected observed pregnancy variables in G1 and G2

Energy and nutritional components	Trimester	Pregnancy variables*							
		GUK 1st trimester		Weight gain		Birth weight		Ponderalindex	
		G1	G2	G1	G2	G1	G2	G1	G2
Energy	First							.31	
	Third						.31		.50
Fats	First								
	Third						.36		.49
SFA	First							.30	
	Third						.50		.37
MUFA	First							.30	
	Third						.42		.39
PUFA	First								
	Third								.50
MUFA:SFA ratio	First						.42		
	Third								
PUFA:MUFA ratio	First		–.40						
	Third								
Carbohydrates	First		.31	.32				.33	
	Third								.38
Monosaccharides	First		.32	.29				.37	
	Third							.35	.30
Polysaccharides	First							.33	
	Third			-.43					
Fibres	First								
	Third								.33
Poly:Mono ratio	First								
	Third			-.29					

GUK 1st trimester – blood glucose by the 12th week of gestation; SFA – saturated fatty acids; MUFA – mono unsaturated fatty acids; PUFA – poly unsaturated fatty acids; Note: Only variables that showed significant correlation ranks at P=.05 with nutritional components are presented. All rank values are available upon request

For women in the G2, the nutrition quality in the third trimester had higher importance from the aspect of pregnancy complications and outcomes (12/16 found correlations; Table 5). A significant positive correlation was found between the intake of fats and separate FA and the birth weight (r=.36 to .50) and the PI (r=.37 to .50), suggesting the greater influence of fats. However, for women entering pregnancy at-risk, intake of carbohydrates (r=.31), especially monosaccharides (r=.31) shows a significant correlation with the blood glucose level in the first trimester. In the same period of gestation, PUFA:MUFA ratio showed a significant negative correlation with the blood glucose level (r=-.40); therefore, for women in the G2 dietary intake of fats had a greater correlation with pregnancy outcomes than carbohydrates. Interestingly, for the pregnancy weight gain no correlation was found.

The overall results confirm the first two hypotheses, and partially confirm the third one; for women presented with a risk factor pre-pregnancy dietary intake of fats likely modulate the risk of pregnancy complications.

4. DISCUSSION

Diet during pregnancy is one of the most important external, environmental factors affecting growth and development of the foetus [23]. External factors account for 30% of the pregnancy outcome and infant's birth weight; more than any other determinant [24]. Along with the pre-pregnancy BMI, excessive weight gain was found to correlate with a higher probability of weight retention, especially in consecutive pregnancies [8,10] which creates a spiral of obesity-related-lifelong-complications.

As shown by Bertolotto et al. [25], pre-pregnancy BMI is a predictor of blood glucose. Chatzi et al. [26] determined that a 1-unit increase in pre-pregnancy BMI increases the relative risk of GDM by 6%. The presented results show that women with a higher pre-pregnancy BMI have higher blood glucose and a higher incidence of GDM, if compared to women with a normal pre-pregnancy BMI. Despite the lack of statistical significance, the results favour a trend between BMI and GDM reported numerically [6,14,25-27].

We have previously reported [28] that the overall quality of nutrition of pregnant women from the area of city Osijek is far from adequate. Analysis revealed that for the majority, intakes of macro and micronutrients are well below the recommendations [28]. These unfavourable dietary habits existed prior pregnancy [29,30], and continued throughout pregnancy and in lactation.

The determined shift between the contribution of fats and carbohydrates in the total daily energy intake is similar to Verbeke and De Bourdeaudhuij's study [3]. Several other researchers have also reported that macronutrient composition [1-3,31] and especially intake of fats [2] present a major nutritional factor in the overall risk for pregnancy complications. Intake of fats in our case appears to have a greater importance for women presented with a pre-pregnancy risk factor.

A study by Moses et al. [32] found the recurrence of GDM in women consuming diets high in fats. Women who developed GDM in a follow-up pregnancy consumed 41.4% of their diet from fat compared to 33.1% fat for the women who did not develop GDM [32]. Study by Bertolotto et al. [25] compared nutritional intakes of women who had either positive or negative OGTT. They did not find any difference in the energy intake or intake of macronutrients. Contribution of fats in the daily energy intake was 40–41% and intake of carbohydrates 44–45%. The reported intake of dietary fibres among these women (mean of 18.5–18.6 g/day) is below the findings in the current study. Additionally, Wang and colleagues [33] found that polyunsaturated fats have a strong protective effect on impaired glucose tolerance (IGT) and GDM. This may be the case in women from G2 as well, for whom a negative correlation between blood glucose in the first trimester and PUFA:MUFA ratio was found.

High contribution of fats to the daily energy intake in both trimesters that was determined can be compared to studies by Moses et al. [32] and Bertolotto et al. [25]. An optimal diet should consist of at least 55% of carbohydrates. The contribution of carbohydrates to the daily energy intake is approximately 50% for both groups of women, whilst the intake of fibres is below the recommendations. Both groups of women significantly increased their energy intake, which is in accordance to the recommendations, but we have determined a shift between fats and carbohydrates contribution in favour of fats. As emphasized by Saldana et al. [2], a diet with <30% fat and >50% carbohydrate, together with the increase in energy intake during pregnancy will reduce their risk of both IGT and GDM.

Saldana et al. [2] used prediction models to examine the likelihood of developing IGT or GDM (compared with normal glucose tolerance) associated with different macronutrient intakes while controlling for BMI, maternal age, and race. They used data from the Pregnancy, Infection and Nutrition (PIN) Study, a prospective cohort study conducted in North Carolina. Authors [2] determined that adding 100 kcal carbohydrates was associated with a 12% decrease in risk of IGT and a 9% decrease in risk of GDM. Based on another model they tested the hypothesis that substituting one macronutrient (fat) for another (carbohydrates), while holding calories constant, would increase the risk of IGT or GDM. Substitution of fats with carbohydrates could result in a significant increase in risk of both IGT and GDM; 7% increase of IGT and a 6% increase of GDM for each percentage increase in fat. On the other hand, a 6% decrease in risk of both IGT and GDM was found for each percentage increase in carbohydrates [2]. Significant negative correlation (r=-.43) was found between dietary intake of polysaccharides and weight gain in G1, suggesting a protective role for polysaccharides as shown by others [31]. A study by Park et al. [27] reported lower intakes of fats (27-28% of energy intake) than we did, but still women who had a higher intake of fats also had a higher risk of developing pregnancy complications (i.e. GDM). However, pregnant women without GDM had hypocaloric diets, while women with GDM had higher intake of both energy and fats [26]. It can be concluded that a change in dietary habits among pregnant women, just by changing contributing ratios of fats and carbohydrates in the total energy intake could significantly reduce risks of developing pregnancy complications, leading to positive pregnancy outcomes.

As shown by Flick et al. [15] excessive weight gain in obese women (BMI≥30 kg/m^2) led to a significant number of complications, with tendency to rise as BMI increases. We performed a cluster analysis on the same population of pregnant women from the city of Osijek and found that women with a higher pre-pregnancy BMI had a significantly higher probability for delivering a high birth weight baby, significantly higher probability for developing complications during pregnancy (gestosis), and a higher probability of induced or caesarean delivery [11]. Our findings on the higher probability of a caesarean or induced delivery are in accordance to the latest findings by Morken et al. [13]. Josefson et al. [34] found that women with excessive pregnancy weight gain, based on the recommendations [18] had neonates with 50% more fat mass (525 vs. 348 g) and 3% greater body fat (13.9 vs. 10.7%), if compared to women with normal pregnancy weight gain. Women presented with a risk factor pre-pregnancy had neonates of a higher birth weight (P=.026).

Our findings favour those reported by Choi et al. [9] and DeVader et al. [12], suggesting that for women entering pregnancy with a normal weight, excessive weight gain presents the highest risk factor for developing pregnancy complications.

The presented results favour the hypothesis of foetal programming; nutrition prior to and at the beginning of pregnancy is of special importance [10]. In order to prevent second generation obesity cases and obesity-related complications later in life of the children, more intensive preventative actions are needed to reverse the current negative trend in reproductive health and demographic indicators [35].

5. CONCLUSION

The diet of pregnant women is characterized by an unbalanced intake of fats and carbohydrates, which differs through trimesters. For women starting pregnancy without any known risk factors, the intake of carbohydrates, especially in the first trimester, has a greater influence on pregnancy complications and outcomes. In contrast, for women starting pregnancy with risk factors, the intake of fats, especially in the third trimester has greater influence on pregnancy complications and outcomes.

These results add more valid information to existing findings about optimal diet during pregnancy. As this was a population-based study, the presented findings can be applied to the general nutrition guidelines for the study population; this is both the strength and the limitation of the study. The study was not designed to observe specific pregnancy complications or nutrients, but rather focused on all parameters. The results can serve as a platform for other studies, preferably intervention studies, which will be designed to focus on the separate nutrients (e.g. fats or carbohydrates) and specific pregnancy complications (e.g. IGT or GDM).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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