Journal of Health Sciences

RESEARCH ARTICLE Open Access

The quality of pregnant women's nutrition throughout the pregnancy trimesters

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ABSTRACT

Introduction: Fertility, conception, and pregnancy are sensitive to nutritional deficiencies. Maternal nutritional status before pregnancy and weight gained during pregnancy are key factors influencing pregnancy outcomes and infant health. Balanced nutrition during pregnancy is of crucial importance for supporting optimal fetal growth and development and the physiological changes in the mother. The aim of this study is to assess changes in the dietary habits of pregnant women throughout the three trimesters of pregnancy.

Methods: The study conducted is a prospective, longitudinal, cohort, and comparative study. The study included 109 participants aged 18-40 years with permanent residence in the Sarajevo Canton area who attended prenatal check-ups at the Institute for Women's and Maternal Health Care from December 2024 to August 2025. The research instrument used was a modified, standardized survey questionnaire, the Prime Diet Quality Score (PDQS).

Results: The overall weighted PDQS-24 HR score was 26.5 ± 3.0. Significant trimester-related changes were observed in several food groups, including green leafy vegetables, citrus fruits, processed meat products, low-fat and full-fat dairy products, whole grains, sugar-sweetened beverages, fried foods consumed outside the home, and vegetable oils. The healthy-food component declined across pregnancy, while changes in the unhealthy-food component were less consistent. The internal consistency of the adapted instrument was acceptable (Cronbach's $\alpha = 0.678$), and Bartlett's test of sphericity was significant ($\chi^2 = 1229.204$, df = 253, $p < 0.001$).

Conclusion: Dietary quality changed significantly across pregnancy, particularly in the later trimesters, with reduced consumption of several favorable food groups, including green leafy vegetables, citrus fruits, dairy products, and whole grains. Repeated nutritional assessment during antenatal care may help identify unfavorable dietary changes as pregnancy progresses.

Keywords: Prime diet quality score; pregnancy; pregnancy trimester; quality of nutrition

INTRODUCTION

The quality of maternal nutrition throughout pregnancy is an important determinant of maternal health, fetal growth and development, and birth outcomes. The World Health Organization (WHO) emphasizes that a healthy diet during pregnancy should provide adequate amounts of energy, protein, vitamins, and minerals through a diverse range of nutrient-dense foods, including vegetables and fruits, whole grains, legumes, nuts, meat, fish, and dairy products. WHO recommends counseling on healthy eating and physical activity during pregnancy to support maternal health and reduce excessive gestational weight gain. In populations with substantial maternal undernutrition, additional nutrition education and balanced energy–protein supplementation are recommended due to their potential to improve fetal growth and reduce adverse birth outcomes (1,2).

Pregnancy and childbirth are unique physiological processes and major life events for women (3,4). Pregnancy represents a critical period characterized by extensive hyperplastic and hypertrophic processes, accompanied by profound metabolic adaptations that support fetal growth and development and prepare the maternal organism for the demands of childbirth and life after pregnancy (5). During pregnancy, the maternal body undergoes substantial anatomical and physiological changes across virtually all organ systems, beginning shortly after conception. In most women with an uncomplicated pregnancy, these changes gradually resolve following delivery (6). Adaptation to pregnancy also involves major alterations in maternal metabolism to meet the increasing demands associated with fetal growth and maternal physiological adaptation. Changes in

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Submitted: 19 September 2026/Accepted: 12 October 2026

DOI: https://doi.org/10.17532/jhsci.2026.3153

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glucose metabolism, and potentially in fatty acid metabolism, occur in parallel with the increasing energy requirements of the mother and fetus, while protein metabolism appears to adapt to meet anticipated maternal and fetal needs (7).

A healthy pregnancy is an important goal for couples planning to have children. However, many individuals may be unaware of the dietary and lifestyle practices that can contribute to optimal reproductive health and promote a healthy pregnancy. Preparing for pregnancy involves not only acquiring knowledge about pregnancy itself, but also establishing dietary and lifestyle habits that adequately prepare the body for conception and pregnancy, thereby potentially increasing the likelihood of a healthy pregnancy (8).

Fertility, conception, and pregnancy are sensitive to nutritional deficiencies, as well as to infections and exposure to toxic substances. Therefore, during the preconception period, both partners should consider their dietary and lifestyle habits and assess their nutritional status (9). Maternal nutritional status before conception, as well as gestational weight gain, is important determinants of pregnancy outcomes and newborn health (10).

Adequate and balanced nutrition during pregnancy is of crucial importance for supporting optimal fetal growth and development and meeting the physiological demands of the mother. Fundamental components of healthy dietary behavior during pregnancy include the consumption of foods providing adequate amounts of energy and macro- and micronutrients, achieving appropriate gestational weight gain, adhering to general and pregnancy-specific food-safety recommendations, and avoiding harmful substances. Studies have shown that inadequate dietary behavior during pregnancy is associated with an increased risk of adverse pregnancy outcomes, including pre-eclampsia, pre-term birth, and fetal neurodevelopmental abnormalities (11).

Increasing evidence indicates that the overall dietary pattern may be more informative than individual nutrients considered in isolation. A systematic review and meta-analysis of 21 studies found that healthy dietary patterns characterized by greater consumption of vegetables, fruits, legumes, and whole grains were associated with lower odds of pre-eclampsia (odds ratio [OR] 0.78, 95% confidence interval [CI] 0.70-0.86), gestational diabetes (OR 0.78, 95% CI 0.56-0.99), and preterm birth (OR 0.75, 95% CI 0.57-0.93) (12). Similarly, a 2024 systematic review and meta-analysis of randomized controlled trials (RCTs) reported a reduction in the risk of gestational diabetes associated with Mediterranean-diet interventions (relative risk 0.71, 95% CI 0.57-0.88), although the authors noted that the available evidence base remains relatively limited (13).

Adequate intake of essential micronutrients is another important component of maternal nutrition. A balanced diet should provide a broad range of essential nutrients through diverse food sources. Regular consumption of fish, for example, contributes to the intake of docosahexaenoic acid, while whole grains and other nutrient-dense foods contribute to the intake of essential vitamins and minerals. Iodine requirements also increase during pregnancy, and supplementation may be recommended to ensure adequate total intake (14). Both excessive intake and primary deficiencies of certain nutrients, vitamins, and minerals may adversely affect maternal and fetal health and have been associated with conditions such as pre-eclampsia, gestational diabetes, hypertension, and neural tube defects (15).

Consequently, appropriate dietary habits should ideally be established before conception and maintained throughout pregnancy to support optimal maternal and fetal health. Adequate maternal nutrition contributes to appropriate fetal growth and development and may influence pancreatic development and glucose homeostasis during pregnancy and later in life, potentially affecting the risk of metabolic syndrome and Type 2 diabetes mellitus (DM) (5). At the same time, diets that consistently and substantially restrict one or more macronutrients should be avoided during pregnancy. Popular diets promoted through the mass media may be particularly inappropriate during pregnancy because they can increase the risk of inadequate micronutrient intake and, in some circumstances, ketosis (16).

Adherence to a healthy dietary pattern before and during pregnancy has been associated with a reduced risk of several pregnancy-related disorders, including gestational diabetes mellitus (GDM), pre-term birth, obesity-related complications, and, in some populations, pre-eclampsia and gestational hypertension. Nutritional therapy represents a fundamental component of the management of GDM and is particularly important for pregnant women with obesity, those who have undergone bariatric surgery, and women with pre-existing DM. A balanced dietary pattern with an appropriate distribution of macronutrients may therefore contribute to a healthy pregnancy and favorable perinatal outcomes. A nutritious dietary pattern is generally characterized by adequate consumption of vegetables, fruits, whole grains, nuts, legumes, fish, and oils rich in monounsaturated fats and dietary fibre, together with lower consumption of fatty red meat and refined grains. A healthy diet also involves limiting simple sugars, highly processed foods, and trans fats (16).

More recent evidence further supports the relationship between dietary quality and pregnancy and birth outcomes. A 2026 systematic review and meta-analysis incorporating 33 studies and more than 180,000 pregnant women reported that greater adherence to a Mediterranean dietary pattern was associated with lower risks of gestational diabetes, pre-term delivery, low neonatal weight, and abnormal fetal growth. The certainty of evidence was moderate to high for several of these outcomes, although the evidence regarding pre-eclampsia was inconsistent (17).

Overall, the available evidence supports conceptualizing the quality of pregnant women's nutrition throughout pregnancy as a multidimensional construct encompassing dietary diversity, nutrient adequacy, overall dietary pattern, micronutrient status, and appropriate gestational weight gain. WHO recommendations provide an important clinical and public health framework for healthy nutrition during pregnancy, while systematic reviews and meta-analyses provide evidence that healthier maternal dietary patterns and appropriate management of gestational weight gain are associated with more favorable maternal and neonatal outcomes. Nevertheless, the strength of the available evidence varies according to the outcome studied and the methodological design of individual studies. In particular, associations identified in observational studies of dietary patterns

should not be interpreted as proof of causality, whereas RCTs provide stronger evidence regarding the effects of specific dietary interventions (18,19).

Although maternal dietary patterns and diet quality during pregnancy have been extensively investigated, evidence regarding changes in dietary habits throughout pregnancy remains limited and heterogeneous. Previous studies have assessed maternal dietary intake at different stages of pregnancy; however, differences in study populations, dietary assessment methods, and timing of measurements have limited the comparability of findings. Moreover, much of the existing literature has focused primarily on associations between maternal dietary patterns and specific pregnancy or birth outcomes, rather than on longitudinal changes in dietary habits within the same women throughout pregnancy.

Pregnancy is characterized by progressive physiological, metabolic, and nutritional changes that may influence appetite, food preferences, dietary intake, and nutritional requirements. Consequently, assessing dietary habits longitudinally in the same women from early to late pregnancy may provide a more comprehensive understanding of how maternal dietary behavior changes over the course of pregnancy than comparisons between independent groups of women at different gestational stages. Such an approach may also help identify periods during pregnancy when dietary quality or specific dietary behaviors change and when nutritional counseling or targeted interventions may be particularly beneficial.

Therefore, prospective longitudinal studies that systematically assess dietary habits within the same women across the three trimesters of pregnancy are warranted. In this context, the present nine-month prospective longitudinal study aimed to assess changes in the dietary habits of the same pregnant women throughout the three trimesters of pregnancy.

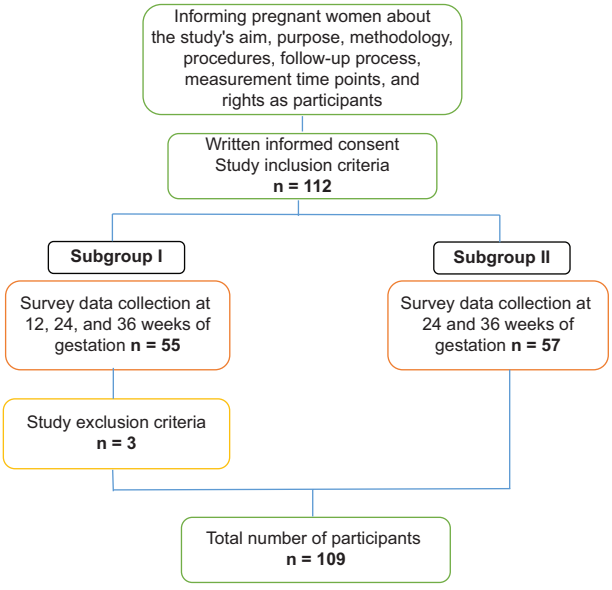
METHODS

This prospective, longitudinal cohort study with a comparative descriptive-analytical design was conducted among pregnant women attending routine antenatal care at the Institute for Women's and Maternal Health Care in Sarajevo Canton at three locations – Centar, NDC Otoka, and Ilidža – between December 2024 and August 2025. Participants were recruited using consecutive sampling among women who met the predefined eligibility criteria and attended the participating antenatal care during the study period. Because recruitment was based on consecutive enrolment of eligible women within a predefined study period rather than probability sampling from the entire source population, no formal a priori sample size calculation based on population prevalence and a predefined margin of error was used to determine the final sample size. The achieved sample therefore reflects the number of eligible women who were recruited and completed the study procedures during the recruitment period. A total of 112 pregnant women were initially enrolled. During follow-up, three participants were excluded due to complications occurring in the third trimester of pregnancy that required hospitalization and resulted in pre-term delivery. Consequently, the final study sample consisted of 109 pregnant women.

Participants were divided into two subgroups according to gestational age at enrolment. Subgroup I consisted of 52 pregnant women enrolled at approximately 12 weeks of gestation and followed at 12, 24, and 36 weeks of pregnancy. Subgroup II consisted of 57 pregnant women enrolled at approximately 24 weeks of gestation and followed at 24 and 36 weeks of pregnancy. The inclusion criteria were maternal age 18-40 years, gestational age of 12-24 weeks at enrolment, singleton pregnancy, permanent residence in Sarajevo Canton, and voluntary informed consent. Exclusion criteria included high-risk or multiple pregnancy, previously diagnosed diabetes, cardiovascular disease and/or other relevant comorbidities, as well as delivery before the 36th week of gestation. The participant selection and follow-up process is presented in Scheme 1.

The research instrument used was a modified, standardized survey questionnaire, the Prime Diet Quality Score (PDQS) (20). The PDQS is a questionnaire used to assess the dietary habits of pregnant women. Previously, the PDQS was used to examine the impact of maternal diet quality and diversity on birth outcomes (21), to demonstrate the link between poor diet and cardiovascular disease (22), as well as associations with gestational diabetes (20) and coronary heart disease (22). It was developed by the Harvard T.H. Chan School of Public Health in Boston, Massachusetts, USA. The questionnaire assesses the frequency of consumption of 21 food groups: 14 groups that are scored positively and seven groups that are scored negatively. The possible score range is 0-42. A higher score indicates greater dietary diversity or quality. Written consent from the authors was obtained for the use of the questionnaire in this study, and the instrument was validated. In our study, the PDQS questionnaire was modified to include personal and sociodemographic data, as well as the pregnant women's medical history.

The study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of the University of Sarajevo – Faculty of Health Studies, the Senate of the University of Sarajevo, and the Joint Ethics Committee of five public healthcare institutions in Sarajevo Canton. All participants



SCHEME 1. The participant selection and follow-up process.

were informed about the study's aim, purpose, methodology, procedures, follow-up process, and measurement time points, as well as their rights as participants. All participants voluntarily agreed to participate before study procedures were initiated, with the option to withdraw at any time, gave written informed consent, and completed the questionnaire themselves. All collected data were treated as confidential in a manner that precluded the identification of individual participants and were used exclusively for these scientific research purposes. Throughout the study, principles regarding privacy protection, data confidentiality, and voluntary participation were upheld. Particular attention was paid to protecting the rights and well-being of the pregnant women, as they constitute a vulnerable population.

Data were collected at the three participating antenatal care locations by the researcher. The researcher approached pregnant women attending routine antenatal care consecutively and screened them for eligibility according to the predefined inclusion and exclusion criteria. At each scheduled assessment, participants completed the study questionnaire. The questionnaire was primarily self-administered in paper format. The researcher reviewed each completed survey on-site immediately to avoid incomplete or inadequately filled-out forms. Because some participants were unable to complete the relatively lengthy questionnaire during the clinic visit, an electronic version created using Google Forms and containing essentially the same questionnaire items was also made available. Participants were instructed to complete the questionnaire at their convenience, but no later than 48 h.

For the electronic questionnaire, the introductory section stated that completion and submission of the form constituted consent to participate in the study and consent to the processing of the collected data. This represented the principal procedural difference from the paper-based questionnaire, for which written informed consent was obtained directly. Longitudinal follow-up was performed according to the participant's study subgroup. Women in Subgroup I were assessed at approximately 12, 24, and 36 weeks of gestation, whereas women in Subgroup II were assessed at approximately 24 and 36 weeks. Over the course of this study, the researcher collected 270 questionnaires as a result of repeated measurements obtained from 109 participants. Repeated assessments were linked using a unique participant identifier, allowing measurements from the same woman to be tracked across pregnancy. Participants who did not contribute data at every scheduled gestational time point were retained in the available-case dataset where appropriate. Repeated assessments from the same participant were not treated as independent observations in longitudinal analyses.

Following data collection, the study database was created in Microsoft Excel (Microsoft Office 365). Statistical analyses were performed using the Statistical Package for the Social Sciences version 28.0 (IBM Corp., Armonk, NY, USA) and RStudio 2026.04. Categorical variables are presented as absolute frequencies and percentages, n (%). Continuous variables were examined for distributional characteristics and are presented as mean ± standard deviation (SD) when approximately normally distributed, and as median with interquartile range (IQR) (25^{th}-75^{th} percentile) when the distribution was non-normal.

Differences in categorical sociodemographic and obstetric characteristics between Subgroup I and Subgroup II were assessed using Pearson's Chi-square test. Fisher's exact test was used when expected cell frequencies were small. For variables with more than two categories, a single overall *p*-value was reported for the comparison of the distribution between the two study subgroups. Because the study had a longitudinal design and repeated observations were obtained from the same participants, measurements from different gestational time points were not treated as statistically independent. Repeated assessments were linked using a unique participant identifier. Changes in the frequency of consumption of individual food groups across pregnancy were analyzed using cumulative ordinal logistic regression. Food-consumption frequency was treated as an ordinal outcome with four categories (0 = did not consume, 1 = once, 2 = twice, and 3 = three or more times during the previous 24 h), while gestational trimester was entered as a categorical predictor. To account for the correlation between repeated observations originating from the same participant, cluster-robust standard errors were calculated at the participant level. The overall effect of trimester for each food group was evaluated using the Wald Chi-square statistic, and the corresponding two-sided p-value was reported. For the overall descriptive assessment of dietary quality, all available PDQS assessments were pooled using the Mean, SD, median, IQR, minimum, and maximum values were calculated for the healthy-food component, unhealthy-food component, and total PDQS. These pooled estimates were used only to describe the overall distribution of PDQS scores across pregnancy and were not interpreted as independent participant-level observations. The internal consistency of the adapted dietary assessment instrument was explored using Cronbach's alpha. The suitability of the item structure for exploratory factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Associations between ordinal or non-normally distributed variables were assessed using Spearman's rank correlation coefficient, where applicable. For continuous outcomes compared across repeated gestational assessments, statistical procedures accounting for the within-participant repeated-measures structure were applied. Parametric or non-parametric methods were selected according to the distributional characteristics of the data and the assumptions of the respective statistical tests.

All statistical tests were two-sided, and a $p < 0.05$ was considered statistically significant. Results are presented in tabular and graphical form, as appropriate.

RESULTS

Based on the predefined inclusion criteria, a total of 109 pregnant women were included in the study. The sociodemographic and obstetric characteristics of the participants are presented in Table 1. The largest proportion of participants was aged 30-34 years (33.9%), followed by those aged 25-29 years (32.1%). Most participants were employed, either actively working (34.9%) or on pregnancy-related sick leave (36.7%), while 28.4% were unemployed. Nearly all participants were married (97.2%), and 93.6% reported that they did not smoke during pregnancy. Among the seven participants who reported smoking during pregnancy,

TABLE 1. Sociodemographic and obstetric characteristics of the study participants

Characteristic	Total sample (n=109)	Subgroup I (n=52)	Subgroup II (n=57)	*p*-value
Age group, n (%)				χ^2=18.46,
<20 years	2 (1.8)	0 (0.0)	2 (3.5)	***p*=0.001**
20-24 years	16 (14.7)	10 (19.2)	6 (10.5)	
25-29 years	35 (32.1)	9 (17.3)	26 (45.6)	
30-34 years	37 (33.9)	26 (50.0)	11 (19.3)	
35-39 years	19 (17.4)	7 (13.5)	12 (21.1)	
Employment status, n (%)				χ^2=1.88,
Employed and actively working	38 (34.9)	21 (40.4)	17 (29.8)	*p*=0.391
Employed, pregnancy-related sick leave	40 (36.7)	19 (36.5)	21 (36.8)	
Unemployed	31 (28.4)	12 (23.1)	19 (33.3)	
Education, n (%)				χ^2=1.41,
Secondary education	49 (45.0)	24 (46.2)	25 (43.9)	*p*=0.495
First-cycle higher education	36 (33.0)	19 (36.5)	17 (29.8)	
Master's degree	24 (22.0)	9 (17.3)	15 (26.3)	
Relationship status, n (%)				Fisher's exact=1.00
Married	106 (97.2)	51 (98.1)	55 (96.5)	
Common-law union	3 (2.8)	1 (1.9)	2 (3.5)	
Current smoking during pregnancy, n (%)	7 (6.4)	2 (3.8)	5 (8.8)	Fisher's exact=0.441
Receiving child benefit/social assistance, n (%)	9 (8.3)	5 (9.6)	4 (7.0)	Fisher's exact=0.734
Residence/housing status, n (%)				χ^2=0.89,
Own house/apartment, alone	58 (53.2)	26 (50.0)	32 (56.1)	*p*=0.641
Own house/apartment, with others	33 (30.3)	18 (34.6)	15 (26.3)	
Rented house/apartment	18 (16.5)	8 (15.4)	10 (17.5)	
Obstetric characteristics				
Parity, n (%)				Fisher's exact=0.439
Primiparous	42 (38.5)	18 (34.6)	24 (42.1)	
Multiparous	67 (61.5)	34 (65.4)	33 (57.9)	
Previous delivery mode, n (%)				χ^2=0.18,
Vaginal delivery	46 (68.7)	24 (70.6)	22 (66.7)	*p*=0.912
Elective cesarean section	9 (13.4)	4 (11.8)	5 (15.2)	
Emergency cesarean section	12 (17.9)	6 (17.6)	6 (18.2)	

Bold values indicate the highest discriminative performance among the evaluated parameters

the number of cigarettes smoked ranged from 6 to 15/day. Secondary education was the most frequently reported level of education (45.0%), followed by first-cycle higher education (33.0%) and a master's degree (22.0%).

Regarding obstetric characteristics, 42 participants (38.5%) were primiparous, and 67 (61.5%) were multiparous. Among multiparous women, previous vaginal delivery was the most common mode of delivery (68.7%), followed by emergency cesarean section (17.9%) and elective cesarean section (13.4%).

The internal consistency analysis of the instrument used to assess the frequency of consumption of different food groups, measured using Cronbach's alpha coefficient, was 0.678. Removing the item on dark orange fruit would raise the result from 0.678 to 0.690. Nevertheless, most items maintain a certain level of association with the overall result, and the inclusion of different food groups also has practical value in terms of the comprehensiveness of the instrument. This means that although individual items have a weak statistical contribution, they may still be important for the content validity of the questionnaire. The KMO measure of sampling adequacy was 0.629. Bartlett's test of sphericity showed χ^2 = 1229.204 with 253 degrees of freedom, $p < 0.001$.

The results presented in Table 2 show changes in the frequency of consumption of several food groups across pregnancy. A statistically significant change was observed for green leafy vegetables (Wald χ^2 = 10.75, p = 0.005). In the first trimester, 53.8% of participants reported consuming green leafy vegetables once during the previous 24 h, whereas in the third trimester 63.3% reported no consumption. In contrast, no statistically significant changes across trimesters were observed for cabbage-family vegetables (p = 0.486), dark orange vegetables (p = 0.168), potatoes (p = 0.149), or other vegetables (p = 0.247).

Fruit consumption showed a particularly marked change for citrus fruits (Wald χ^2 = 26.54, $p < 0.001$). The proportion of participants reporting no citrus fruit consumption increased from 26.9% in the first trimester to 67.9% in the third trimester. Consumption of dark orange fruits did not change significantly across pregnancy (p = 0.759). Changes in the consumption of other fruits approached, but did not reach, statistical significance (p = 0.070).

No statistically significant trimester-related differences were observed for legumes (p = 0.057), nuts and seeds (p = 0.169), poultry (p = 0.509), fish (p = 0.627), red meat (p = 0.853), or eggs and egg dishes (p = 0.623). However, consumption of processed meat products differed significantly across

TABLE 2. Frequency of food consumption in the last 24 h by trimester – total sample

Food groups	Trimester I (n=52)				Trimester II (n=109)				Trimester III (n=109)				Wald	*p*-value
	Did not eat n (%)	Once n (%)	Twice n (%)	3+n (%)	Did not eat n (%)	Once n (%)	Twice n (%)	3+n (%)	Did not eat n (%)	Once n (%)	Twice n (%)	3+n (%)		
Green leafy vegetables	19 (36.5)	28 (53.8)	5 (9.6)	-	38 (34.9)	57 (52.3)	14 (12.8)	-	69 (63.3)	35 (32.1)	4 (3.7)	1 (0.9)	10.75	**0.005**
Cabbage-family vegetables	33 (63.5)	17 (32.7)	2 (3.8)	-	84 (77.5)	21 (19.2)	4 (3.3)	-	78 (71.6)	28 (25.7)	3 (2.8)	-	1.44	0.486
Dark orange vegetables	28 (53.8)	24 (46.2)	-	-	47 (43.1)	52 (47.7)	10 (9.2)	-	63 (57.8)	32 (29.4)	14 (12.8)	-	3.57	0.168
Potatoes	17 (32.7)	28 (53.8)	7 (13.5)	-	33 (30.3)	49 (45)	27 (24.8)	-	31 (28.4)	46 (42.2)	26 (23.9)	6 (5.5)	3.81	0.149
Tomato, pepper, onion, cucumber, and other vegetables	17 (32.7)	26 (50)	7 (13.5)	2 (3.8)	28 (25.8)	58 (52.8)	21 (19.3)	2 (2.1)	34 (31.2)	65 (59.2)	10 (9.6)	-	2.79	0.247
Citrus fruit	14 (26.9)	19 (36.5)	17 (32.7)	2 (3.8)	56 (51.4)	35 (32.1)	13 (11.9)	5 (4.6)	74 (67.9)	33 (30.3)	2 (1.8)	-	26.54	**<0.001**
Dark orange fruit (melon, apricot, mango)	40 (77.3)	10 (18)	-	2 (4.5)	92 (84.4)	14 (12.8)	3 (2.8)	-	92 (84.4)	15 (13.8)	1 (0.9)	1 (0.9)	0.55	0.759
Other fruit (apples, pears, plums, etc.)	10 (19.2)	26 (50)	14 (26.9)	2 (3.8)	12 (11)	64 (58.7)	25 (22.9)	8 (7.3)	33 (30.3)	50 (45.9)	26 (23.9)	-	5.32	0.070
Legumes	40 (76.9)	10 (19.2)	2 (3.8)	-	76 (69.7)	25 (22.9)	8 (7.3)	-	66 (60.6)	41 (37.6)	2 (1.8)	-	5.73	0.057
Nuts and seeds	38 (73.1)	9 (17.3)	5 (9.6)	-	45 (41.3)	51 (46.8)	11 (10.1)	2 (1.8)	60 (55)	45 (41.3)	4 (3.7)	-	3.56	0.169
Poultry meat	19 (36.5)	28 (53.8)	5 (9.6)	-	28 (25.7)	70 (64.2)	11 (10.1)	-	39 (35.8)	58 (53.2)	12 (11)	-	1.35	0.509
Freshwater or saltwater fish	40 (76.9)	12 (23.1)	-	-	94 (86.2)	14 (12.8)	1 (0.9)	-	90 (82.6)	15 (13.8)	4 (3.7)	-	0.93	0.627
Red meat	31 (59.6)	19 (36.5)	2 (3.8)	-	68 (62.4)	41 (37.6)	-	-	75 (68.8)	29 (26.6)	5 (4.6)	-	0.32	0.853
Processed meat products	24 (46.2)	21 (40.4)	7 (13.5)	-	70 (64.2)	35 (32.1)	4 (3.7)	-	51 (46.8)	46 (42.2)	12 (11)	-	9.96	**0.007**
Eggs and egg dishes	19 (36.5)	28 (53.8)	5 (9.6)	-	25 (22.9)	79 (72.5)	4 (3.7)	1 (0.9)	37 (33.9)	58 (53.2)	13 (11.9)	1 (0.9)	0.95	0.623
Skim-milk dairy products	30 (57.7)	17 (32.7)	5 (9.6)	-	53 (48.6)	43 (39.4)	10 (9.2)	3 (2.8)	88 (80.7)	19 (17.4)	1 (0.9)	1 (0.9)	20.92	**<0.001**
Full-fat dairy products	14 (26.9)	26 (50)	12 (23.1)	-	55 (50.5)	41 (37.6)	8 (7.3)	5 (4.6)	77 (70.6)	26 (23.9)	5 (4.6)	1 (0.9)	12.26	**0.002**
Whole grains, whole-grain bread, and similar	24 (46.2)	19 (36.5)	9 (17.3)	-	57 (52.3)	36 (33)	14 (12.8)	2 (1.8)	85 (78)	21 (19.3)	2 (1.8)	1 (0.9)	10.13	**0.006**
White bread, croissants, doughnuts, and other white-flour products	2 (3.8)	28 (53.8)	17 (32.7)	5 (9.6)	22 (20.2)	49 (45)	33 (30.3)	5 (4.6)	31 (28.4)	32 (29.4)	37 (33.9)	9 (8.3)	2.15	0.342
Sugar-sweetened soft drinks	28 (53.8)	17 (32.7)	5 (9.6)	2 (3.8)	53 (48.6)	40 (36.7)	14 (12.8)	2 (1.8)	28 (25.7)	51 (46.8)	24 (22)	6 (5.5)	12.4	**0.002**
Sweets and desserts	14 (26.9)	31 (59.6)	5 (9.6)	2 (3.8)	28 (25.7)	44 (40.4)	26 (23.9)	11 (10.1)	31 (28.4)	49 (45)	20 (18.3)	9 (8.3)	1.84	0.398
Fried food (hamburgers, French fries, etc.)	35 (67.3)	17 (32.7)	-	-	94 (86.2)	14 (12.8)	1 (0.9)	-	64 (58.7)	39 (35.8)	6 (5.5)	-	10.59	**0.005**
Oil (sunflower, olive, etc.)	17 (32.7)	21 (40.4)	9 (17.3)	5 (9.6)	44 (40.4)	38 (34.9)	23 (21.1)	4 (3.7)	101 (92.7)	6 (5.5)	2 (1.8)	-	38.69	**<0.001**

Bold values indicate the highest discriminative performance among the evaluated parameters

trimesters (Wald χ^2 = 9.96, p = 0.007), with the proportion reporting no consumption increasing from 46.2% in the first trimester to 64.2% in the second trimester, before decreasing to 46.8% in the third trimester.

Significant changes were also observed for dairy products and whole grains. The frequency of low-fat dairy consumption changed significantly across pregnancy (Wald χ^2 = 20.92, p < 0.001), with 80.7% of participants reporting no consumption in the third trimester. Full-fat dairy consumption also changed significantly (Wald χ^2 = 12.26, p = 0.002), with the proportion reporting no consumption increasing from 26.9% in the first trimester to 70.6% in the third trimester. Similarly, whole-grain consumption declined significantly across pregnancy (Wald χ^2 = 10.13, p = 0.006), with 78.0% of participants reporting no consumption in the third trimester.

Among the less healthy food groups, consumption of sugar-sweetened beverages changed significantly across trimesters (Wald χ^2 = 12.40, p = 0.002). The proportion reporting no consumption decreased from 53.8% in the first trimester to 25.7% in the third trimester, while the proportion consuming these beverages once increased from 32.7% to 46.8%. No significant change was observed for white bread and other refined-grain products (p = 0.342) or sweets and desserts (p = 0.398). Fried food consumption outside the home changed significantly across pregnancy (Wald χ^2 = 10.59, p = 0.005), while the most pronounced change was observed for vegetable oil use (Wald χ^2 = 38.69, p < 0.001), with 92.7% of participants reporting no use in the third trimester.

Table 3 presents the descriptive statistics of PDQS scores across all gestational assessments. The mean healthy-food score was 17.6 ± 1.7, with a median of 17.0 (IQR: 16.0-18.0) and an observed range of 16.0-24.0. Compared with its theoretical range of 0-32, the observed values were concentrated within a relatively narrow interval.

The mean unhealthy-food score was 8.9 ± 2.8, with a median of 9.0 (IQR: 7.0-11.0) and an observed range of 3.0-14.0. This component showed greater variability than the healthy-food score. The mean total PDQS was 26.5 ± 3.0, with a median of 27.0 (IQR: 24.0-29.0) and an observed range of 19.0-34.0, compared with a theoretical range of 0-46.

Overall, the descriptive results demonstrate variability in dietary quality across the available gestational assessments, particularly in the unhealthy-food component. These findings provide an overall descriptive summary of PDQS scores across pregnancy, while trimester-specific changes are examined separately in the longitudinal analyses.

Changes in the PDQS score during pregnancy, separately for Subgroup I and II, as well as combined for the entire sample, are shown in Table 4. In Subgroup I, the average healthy-food score gradually decreased from 18.14 in the first, through 17.73 in the second, to 16.71 in the third trimester, and the change was statistically significant (F = 8.56; p < 0.001). However, the unhealthy-food score remained relatively stable throughout the entire period (8.91 → 9.36 → 9.62; F = 0.804; p = 0.449), without significant fluctuations. In Subgroup II, the trends were different. It was recorded that the average healthy-food score decreased from 18.16 in the second to 17.31 in the third trimester, which is statistically significant (F = 9.54; p = 0.003). An even more pronounced trend was observed for unhealthy foods – the average score dropped from 9.16 in the second to 7.35 in the third trimester (F = 17.102; p < 0.001), indicating increased consumption of unhealthy foods in the final phase of pregnancy.

Consequently, the overall PDQS score decreased significantly, from 27.33 in the second to 24.67 in the third trimester (F = 29.37; p < 0.001), suggesting a decline in dietary quality among participants in this subgroup. The overall PDQS score in Subgroup I showed only slight changes (27.05 → 27.09 → 26.33), which did not reach statistical significance (F = 0.986; p = 0.375). This indicates that in Subgroup I, dietary quality among pregnant women remained relatively stable, with minimal deterioration. When the data are analyzed collectively, it is observed that the healthy-food score decreased significantly during pregnancy (18.14 → 17.95 → 17.04; F = 11.33; p < 0.001). The unhealthy-food score showed a tendency toward increased consumption (8.91 → 9.26 → 8.41), but the differences were not statistically significant (F = 2.645; p = 0.073). The overall PDQS score, however, decreased significantly across measurements (27.05 → 27.21 → 25.44; F = 11.32; p < 0.001).

Figure 1 shows the distribution of the overall PDQS 24-H score across the three trimesters of pregnancy according to subgroup. In the first trimester, values relate only to Subgroup I, where the median overall PDQS was 27.0, with an IQR of 26.0-29.0. The range of values was from 22.0 to 34.0, showing a certain degree of variability but also a relatively stable dietary quality. In the second trimester, a difference between subgroups is observed.

Subgroup II had a lower median overall PDQS (27.3; range 21.0-33.0), while in Subgroup I the median was 27.6, with a somewhat higher upper quartile (30.3 vs. 28.0 in the comparison group). Both subgroups show a wide range of values, but Subgroup I included a greater number of participants with higher scores, suggesting more favorable dietary quality. In the third trimester, more pronounced differences emerge. Subgroup II shows a decline in the overall PDQS score, with a median of 24.7 and an IQR of 23.0-27.0, and a minimum value of 21.0. This indicates a deterioration in dietary quality toward the end of pregnancy. On the other hand, Subgroup I maintains a higher median of 26.3, with a range of values from 19.0 to 31.0, showing that pregnant women in this subgroup maintained relatively better dietary quality.

TABLE 3. Descriptive statistics of PDQS scores across all gestational assessments

Prime diet quality scores	Number of observations	Mean	SD	Median	IQ range	Min-Max	Theoretical range
PDQS healthy foods	270	17.6	1.7	17.0	16.0-18.0	16.0-24.0	0-32
PDQS unhealthy foods	270	8.9	2.8	9.0	7.0-11.0	3.0-14.0	0-14
PDQS 24H	270	26.5	3.0	27.0	24.0-29.0	19.0-34.0	0-46

PDQS: Prime diet quality score, SD: Standard deviation, IQ range: Interquartile range

TABLE 4. Dietary quality of participants by trimester of pregnancy, by subgroup

PDQS	Trimester I		Trimester II		Trimester III		t/F	*p*
	Mean	SD	Mean	SD	Mean	SD		
Subgroup I								
Healthy foods	18.14	2.16	17.73	2.05	16.71	0.77	8.56	**<0.001**
Unhealthy foods	8.91	2.58	9.36	2.9	9.62	3.14	0.804	0.449
Overall PDQS	27.05	2.43	27.09	3.64	26.33	2.96	0.986	0.375
Subgroup II								
Healthy foods			18.16	1.69	17.31	1.22	9.54	**0.003**
Unhealthy foods			9.16	2.25	7.35	2.42	17.102	**<0.001**
Overall PDQS			27.33	2.72	24.67	2.52	29.37	**<0.001**
Total								
Healthy foods	18.14	2.16	17.95	1.87	17.04	1.08	11.33	**<0.001**
Unhealthy foods	8.91	2.58	9.26	2.57	8.41	2.99	2.645	0.073
Overall PDQS	27.05	2.43	27.21	3.18	25.44	2.85	11.32	**<0.001**

PDQS: Prime diet quality score, SD: Standard deviation, t/F - Bold values indicate the highest discriminative performance among the evaluated parameters

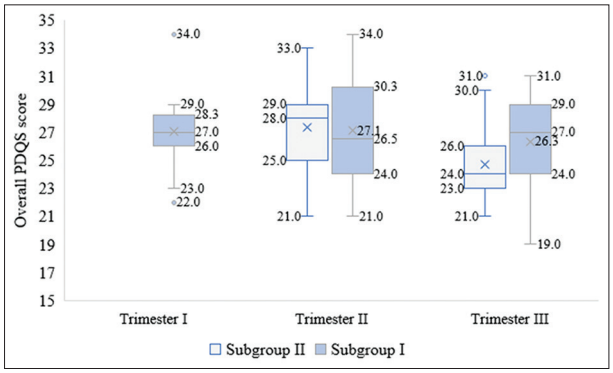


FIGURE 1. Distribution of the PDQS 24-H score across trimesters of pregnancy by subgroup. PDQS: Prime diet quality score.

Overall, the figure clearly shows a downward trend in dietary quality in Subgroup II during pregnancy (F = 29.37, $p < 0.001$), while Subgroup I shows a more stable pattern with a smaller decline in score in the third trimester (F = 0.986, $p = 0.375$). This confirms the results of the statistical analyses, which showed that continuous monitoring and follow-up may have a protective effect on maintaining dietary quality during pregnancy.

The results presented in Table 5 relate to changes in the dietary quality of pregnant women (PDQS) in Subgroup I and Subgroup II across all trimesters of pregnancy. During the first trimester, the assessment was conducted only in Subgroup I, where the average PDQS value for healthy foods was 18.14 ± 2.16, while for unhealthy foods it was 8.91 ± 2.58, resulting in an overall PDQS score of 27.05 ± 2.43. These results indicate that participants already showed moderately good dietary quality in the early stage of pregnancy, with a somewhat higher intake of healthy compared to unhealthy food groups.

In the second trimester, the average healthy-food score in Subgroup II was 18.16 ± 1.69, and in Subgroup I 17.73 ± 2.05, with no statistically significant difference (t = 1.215; $p = 0.227$). Similarly, differences in unhealthy-food intake between subgroups were not significant (t = –0.404; $p = 0.687$), nor was the overall PDQS score (t = 0.384; $p = 0.702$). These results suggest that in the second trimester of pregnancy, there was no major divergence in dietary habits between pregnant women in the two subgroups studied, and a slight stability of healthier patterns was observed in both groups.

However, in the third trimester, statistically significant differences were achieved in almost all PDQS components. Participants in Subgroup II had higher values for healthy dietary habits (17.31 ± 1.22) compared to Subgroup I (16.71 ± 0.77) (t = 2.998; $p = 0.003$), while participants in Subgroup I had significantly higher values for unhealthy dietary habits (9.62 ± 3.14 vs. 7.35 ± 2.42; t = –4.239; $p < 0.001$).

The overall PDQS score in the third trimester was also significantly higher in Subgroup I (26.33 ± 2.96) compared to Subgroup II (24.67 ± 2.52) (t = –3.165; $p = 0.002$). This result points to an interesting pattern – although pregnant women in Subgroup I achieved a higher overall PDQS score, which may indicate generally better dietary quality, the component-level analysis reveals that they simultaneously consumed unhealthy foods more often. This may indicate an increased overall energy intake in the later stages of pregnancy, probably in response to growing physiological needs, but with weaker control over food choices. In Subgroup II, on the other hand, the diet was more stable, with smaller fluctuations in the intake of unhealthy foods, although with a somewhat lower overall PDQS score.

DISCUSSION

The present study examined longitudinal changes in dietary quality and food-consumption patterns across pregnancy using an adapted PDQS-24HR approach. The PDQS was developed from the modified PrimeScreen questionnaire (23) and has been used to examine associations between dietary quality and cardiovascular disease (22), gestational diabetes (20), coronary heart disease (22), and maternal dietary quality in relation to birth outcomes (21). Given the importance of nutrition during pregnancy for maternal health, fetal growth, and gestational weight gain (24-27), the PDQS provided a practical tool for assessing changes in dietary quality across pregnancy.

The overall PDQS in the present study was 26.5 ± 3.0. This value was broadly comparable with that reported by Martin

TABLE 5. Dietary quality of pregnant women by trimester of pregnancy

Trimester	Variable	Subgroup I		Subgroup II		t	*p*
		Mean	SD	Mean	SD		
I	PDQS healthy	18.14	2.16	-	-	-	-
	PDQS unhealthy	8.91	2.58	-	-	-	-
	PDQS total	27.05	2.43	-	-	-	-
II	PDQS healthy	17.73	2.05	18.16	1.69	1.215	0.227
	PDQS unhealthy	9.36	2.9	9.16	2.25	−0.404	0.687
	PDQS total	27.09	3.64	27.33	2.72	0.384	0.702
III	PDQS healthy	17.31	1.22	16.71	0.77	2.998	**0.003**
	PDQS unhealthy	7.35	2.42	9.62	3.14	−4.239	**<0.001**
	PDQS total	24.67	2.52	26.33	2.96	−3.165	**0.002**

PDQS: Prime Diet Quality Score, SD: Standard deviation, t: Student's t-test. Bold values indicate the highest discriminative performance among the evaluated parameters

et al. (23.58 ± 2.54) (28), although it differed from the substantially higher value reported by Al-Bayyari et al. (29). Direct comparisons between studies should, however, be interpreted cautiously because differences in study populations, dietary patterns, questionnaire adaptations, and scoring procedures may influence total PDQS values. The longitudinal findings indicate that dietary quality changed as pregnancy progressed. The healthy-food score declined across gestation, while the overall PDQS was lower in the third trimester than at earlier assessments. These findings suggest that dietary patterns during pregnancy are dynamic and may change in response to physiological, behavioral, social, or environmental factors. Nutrition education and counseling have been identified as important approaches for improving dietary intake and supporting appropriate gestational weight gain and maternal and fetal outcomes (25,26).

Differences were also observed between the two study subgroups. In Subgroup I, which was followed from approximately 12 weeks of gestation, the overall PDQS remained relatively stable, although the healthy-food component declined over time. In Subgroup II, enrolled at approximately 24 weeks, a more pronounced decline in overall PDQS was observed between the second and third trimesters. Because the groups were not randomized, these differences cannot be interpreted as evidence that earlier or longer professional follow-up had a causal protective effect. Nevertheless, the findings support further investigation of whether continuous dietary counseling and monitoring throughout pregnancy could contribute to maintaining healthier dietary patterns (25). Green leafy vegetable consumption changed significantly across pregnancy. In the first trimester, more than half of the participants consumed green leafy vegetables once during the previous 24 h, whereas by the third trimester 63.3% reported no consumption ($p = 0.005$). This finding is broadly consistent with the results reported by Al-Bayyari et al. (29), while Martin et al. reported substantially higher intake of green leafy vegetables in their study population (28). Green leafy vegetables are important dietary sources of folate and other micronutrients relevant to pregnancy (30-36). However, because micronutrient intake and biochemical status were not directly measured in the present study, the observed reduction should be interpreted as a change in food-group consumption rather than evidence of a specific nutrient deficiency.

For cabbage-family vegetables, the proportion reporting no consumption increased from 63.5% in the first trimester to 71.6% in the third trimester. This pattern was similar to that reported by Al-Bayyari et al. (29), but the longitudinal difference in the present study was not statistically significant ($p = 0.486$). The result should therefore be interpreted as a descriptive pattern rather than a confirmed trimester-related change. Dark orange vegetables and fruits were consumed infrequently throughout pregnancy. These foods are relevant dietary sources of beta-carotene and other micronutrients involved in fetal growth and maternal health (30). Martin et al. reported substantially more favorable intake of these food groups (28). Differences between studies may reflect cultural dietary patterns, food availability, affordability, seasonality, and regional preferences.

Fruit consumption also varied across pregnancy. Citrus fruit showed one of the clearest longitudinal declines, with the proportion reporting no intake increasing markedly by the third trimester ($p < 0.001$). Other fruits, including apples, pears, and plums, remained more frequently consumed, although their intake also tended to decrease later in pregnancy. Similar concerns regarding suboptimal fruit and vegetable intake during pregnancy have been reported elsewhere (28,37). Possible explanations include changes in appetite, gastrointestinal symptoms, food preferences, seasonality, and food availability, although these factors were not directly evaluated in the present study.

Legumes, nuts and seeds showed more favorable descriptive patterns as pregnancy progressed. The proportion of women reporting no legume intake decreased from the first to the third trimester, although the overall longitudinal difference narrowly failed to reach statistical significance ($p = 0.057$). Changes in nuts and seeds were also not statistically significant ($p = 0.169$). These foods remain relevant in pregnancy because they provide plant protein, fibre, and unsaturated fats, but the present results should be interpreted as descriptive rather than confirmed longitudinal changes. Among animal-source foods, poultry was the most consistently consumed meat source across pregnancy. Fish consumption, in contrast, was very low, with more than 80% of participants reporting no intake at several assessments. Similar low fish intake has been reported in other studies (28,38). Because fish is an important dietary source of long-chain omega-3 fatty acids, this pattern may indicate limited intake of omega-3-rich foods, although actual fatty-acid intake was not

measured. Red meat consumption did not change significantly, whereas processed meat products showed a significant trimester-related pattern ($p = 0.007$). This distinction is important because red and processed meats may have different nutritional and health implications (39). Dairy consumption declined substantially in later pregnancy. Low-fat dairy products showed a significant decrease ($p < 0.001$), with 80.7% of participants reporting no consumption in the third trimester. Full-fat dairy products also declined significantly ($p = 0.002$). These findings contrast with the relatively high milk and dairy-product intake reported by Al-Bayyari et al. (29). Although dairy products are important dietary sources of calcium and protein, the present study did not directly quantify nutrient intake, and therefore conclusions regarding calcium adequacy cannot be made from these findings alone. Whole-grain consumption decreased significantly as pregnancy progressed ($p = 0.006$), with 78.0% of participants reporting no intake in the third trimester. In contrast, white bread and other refined-grain products remained commonly consumed throughout pregnancy and did not show a significant longitudinal change. This pattern is consistent with concerns regarding frequent consumption of refined carbohydrates and low intake of whole-grain alternatives (40,41). Similar dietary patterns have also been described by Al-Bayyari et al. (29).

Sugar-sweetened beverage consumption increased significantly across pregnancy ($p = 0.002$). The proportion of women reporting no consumption decreased substantially by the third trimester, while consumption at least once during the previous 24 h became more common. Sweets and desserts remained frequently consumed but did not show a significant longitudinal change. Fried foods consumed outside the home varied significantly across pregnancy ($p = 0.005$). These dietary components are relevant because frequent consumption of refined carbohydrates, sweetened beverages, processed foods, and fried foods has been associated with obesity, Type 2 diabetes, cardiovascular disease, and other chronic conditions (42). Vegetable-oil use showed the most pronounced statistical change across trimesters ($p < 0.001$), with a very high proportion of women reporting no use during the previous 24 h in the third trimester. This finding should be interpreted cautiously. The PDQS-24HR reflects intake during a single day, and vegetable-oil use may vary substantially according to meal preparation, eating outside the home, and whether participants recognized oil contained in prepared dishes. Repeated 24-h dietary assessments or more detailed dietary records could help clarify whether this result reflects a true dietary shift or short-term variation.

Taken together, the results show that dietary changes during pregnancy were selective rather than uniform. The clearest unfavorable longitudinal patterns included reduced consumption of green leafy vegetables, citrus fruits, dairy products, and whole grains, together with increased consumption of sugar-sweetened beverages. At the same time, several other dietary components remained relatively stable. These findings emphasize the importance of assessing dietary quality repeatedly throughout pregnancy rather than relying solely on nutritional counseling at the first antenatal visit. From a clinical and public-health perspective, the results support the need for structured and continuous dietary counseling during pregnancy. Previous research has shown that nutrition education and counseling can improve dietary practices and may contribute to more appropriate gestational weight gain and better pregnancy outcomes (25). The broader findings of the present study also suggest that healthcare professionals are regarded as an important and trusted source of information by pregnant women, consistent with previous research indicating that verbal communication from healthcare workers remains a key source of nutrition information during pregnancy (43). This reinforces the potential role of antenatal healthcare providers in delivering repeated, evidence-based dietary advice adapted to the local context. Local cultural and social factors may also influence dietary behavior during pregnancy. Traditional beliefs regarding increased food intake and the fulfillment of food cravings may affect dietary choices, while access to information through social media and online sources may further shape behavior. Previous research has highlighted the importance of reliable governmental, institutional, and professional sources of information on nutrition during pregnancy (43,44). These findings support the development of locally adapted, evidence-based dietary guidance for pregnant women in Bosnia and Herzegovina.

Several limitations should be considered. Dietary intake was assessed using a 24-h food-group questionnaire and may therefore be affected by day-to-day variation and recall error. The adapted PDQS provides a practical measure of dietary quality but does not directly quantify energy intake, macronutrients, or micronutrients. Consecutive rather than probability sampling was used, and participants were recruited from three antenatal care locations in Sarajevo Canton, which may limit generalizability, but it still presents largest part of population. In addition, because the two subgroups differed in the timing of enrolment and were not randomly allocated, between-group differences cannot be interpreted causally.

Despite these limitations, the longitudinal design represents an important strength because it enabled repeated assessment of dietary patterns across pregnancy. The findings indicate that dietary quality and specific food choices can change substantially during gestation and support continued nutritional assessment and counseling throughout routine antenatal care.

CONCLUSION

The results demonstrate significant changes in dietary patterns across pregnancy, particularly in the later trimesters, characterized by reduced consumption of several favorable food groups, including green leafy vegetables, citrus fruits, dairy products, and whole grains, alongside increased consumption of sugar-sweetened beverages and persistent intake of refined-grain products. These findings indicate that dietary quality may deteriorate as pregnancy progresses and support the importance of repeated nutritional assessment and counseling throughout antenatal care. Although participants followed from earlier pregnancy showed somewhat more stable dietary patterns, the observational design does not allow a causal effect of continuous follow-up to be established. Further prospective and intervention studies

are needed to determine whether structured nutritional counseling can help maintain dietary quality throughout pregnancy.

ACKNOWLEDGMENTS

The authors want to thank all the pregnant women who contributed to and participated in this study, as well as the authors of the questionnaire used in the study for granting permission.

DECLARATION OF INTERESTS

The authors declare no conflicts of interest.

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