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Association between mediterranean diet during pregnancy and gestational weight gain: a prospective cohort study

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Excessive gestational weight gain (GWG) elevated risks of gestational diabetes mellitus (GDM), pre-eclampsia, preterm birth, macrosomia, and infant mortality. This study investigated the relationship between the Mediterranean diet score (MDS) and GWG in Iranian pregnant women. We prospectively included 243 Iranian pregnant women aged 18–44 in Tehran. We assessed dietary intake through a validated Food Frequency Questionnaire (FFQ) in the third trimester. Physical activity was measured by the Pregnancy Physical Activity Questionnaire (PPAQ). Cox proportional hazard models were employed to calculate hazard ratios (HRs) and 95% confidence intervals (CIs) for inappropriate, inadequate, and excessive GWG by tertiles of MDS. During an average follow-up period of 3.86 weeks, 60, 99, and 159 cases of inadequate, excessive, and inappropriate GWG were recorded, respectively. We did not find any significant association between MDS and inadequate [HR, 0.69 (95% confidence interval: 0.35 to 1.37); *P*-trend = 0.303)], excessive [HR, 1.51 (0.91 to 2.49); *P*-trend = 0.120)], and inappropriate [HR, 1.18 (0.79 to 1.76); *P*-trend = 0.435)] GWG in the fully-adjusted model. Our findings indicated that MDS was not significantly associated with the risk of inappropriate, inadequate, and excessive GWG. Additional cohort studies with larger sample sizes and varied populations are needed to confirm these results.

Keywords Maternal diet, Mediterranean diet score, Gestational weight gain, Cohort, Iran, Pregnant women

Abbreviations

aMED	Alternate mediterranean diet
ANOVA	Analysis of variance
ANCOVA	Analysis of covariance
BMI	Body mass index
CHDI-P	Chinese healthy diet index for pregnancy
CI	Confidence interval
DASH	Dietary approaches to stop hypertension
FFQ	Food frequency questionnaire
GDM	Gestational diabetes mellitus
GWG	Gestational weight gain
HEI-2010	Healthy eating index-2010
HIV/AIDS	Human immunodeficiency virus/acquired immunodeficiency syndrome
HR	Hazard ratio
IOM	Institute of medicine
IPAQ	International physical activity questionnaire
LGA	Large for gestational age
LMD	Lebanese mediterranean diet
LMICs	Low- and middle-income countries

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MDS	Mediterranean diet score
MET	Metabolic equivalent of task
PA	Physical activity
PPAQ	Pregnancy physical activity questionnaire
PUFA	Polyunsaturated fatty acids
SD	Standard deviation
SES	Socioeconomic status
SFA	Saturated fatty acids
SGA	Small for gestational age
SMD	Standardized mean difference

Gestational weight gain (GWG), defined as the total amount of weight gain during pregnancy, is an essential indicator of health in pregnancy[1]. Recently, an individual participant data meta-analysis reported prevalence of severe and moderately inadequate, adequate, and excessive was 55.4%, 22.0%, and 22.6% in low- and middle-income countries (LMICs), respectively[2]. In Iran, the prevalence of insufficient and excessive GWG was 35.38% and 33.42%, respectively[3]. GWG mirrors the accumulation of maternal fat, fluid retention, and the development of the fetus, placenta, and uterus[4]. Excessive GWG is associated with increased risks of large for gestational age (LGA) infants, gestational diabetes mellitus (GDM), pre-eclampsia, preterm birth, cesarean delivery, macrosomia, infant mortality, and childhood obesity[5,6]. Conversely, Insufficient GWG has been linked to a higher risk of low birth weight, small for gestational age (SGA) infants, and preterm birth[2]. It has been demonstrated that the greater utilization of healthcare services is linked to obesity during pregnancy[7]. Many factors, such as maternal pre-pregnancy body mass index (BMI), diet, physical activity, smoking status, and socio-demographic factors, can contribute to GWG during pregnancy[8].

Diet is an adjustable factor that has been demonstrated to affect GWG in both high-income and LMICs[9]. A recent meta-analysis indicated that a low glycemic diet reduced the risk of excessive weight gain[10]. The health benefits of a diet are not from single nutrients, but from the synergistic and cumulative effects of its many components working together[11]. Since people consume a variety of foods rather than single nutrients, dietary patterns offer a more precise insight into their eating patterns[12]. Numerous studies investigated the association between dietary patterns and GWG. For example, Jayedi et al.[1] found higher adherence to a plant-based diet reduced 50% risk of inadequate GWG, whereas no significant association between healthy plant-based diet, unhealthy plant-based diet and inadequate GWG was found. Also, there was no association between plant-based diet, healthy plant-based diet, and unhealthy plant-based diet and the risk of excessive GWG. In another cohort study conducted by Yisihak et al.[13], vegetarianism was not associated with inadequate and excessive GWG. Radwan et al. found high adherence to the Lebanese Mediterranean Diet (LMD) reduced the odds of excessive GWG to 60%[14].

The Mediterranean-style diet has been identified as a healthy and balanced dietary pattern[15]. It is marked as a high intake of fruits, vegetables, olive oil, legumes, fish and nuts; moderate consumption of dairy products; and low intake of meat and processed meat products[16]. A meta-analysis indicated healthy diet during pregnancy was not associated with inadequate as well as excessive GWG[17]. However, a cohort study revealed a significant inverse association between the mediterranean diet and excessive and insufficient GWG[14].

GWG is a crucial indicator of maternal nutritional status during pregnancy and has been associated with various adverse perinatal outcomes[2]. Achieving optimal weight gain during pregnancy is essential for the mother's and infant's health[18]. Given the above-mentioned reasons, importance of GWG, and lack of evidence about mediterranean diet and GWG in Iran, we aim to evaluate the adherence to mediterranean diet, incident of GWG, and association between the mediterranean diet and GWG in a prospective cohort study of pregnant Iranian women.

Methods
Study design
This study is a prospective cohort investigation conducted among Iranian pregnant women from October 2022 to May 2023. Patients were recruited from outpatient healthcare centers or Yas Hospital, affiliated with the Tehran University of Medical Sciences through a simple random sampling technique. Primarily, 300 individuals participated in this cohort. We included pregnant women in the third trimester of pregnancy (24 to 40 weeks), aged ≥ 18, and having a singleton pregnancy. We excluded women who had hepatitis, tumors (malignancies), severe infections, HIV/AIDS, and other autoimmune diseases. Also, we excluded participants who had used corticosteroids, immunosuppressive drugs, and neurologic medications, subjects who had implausible energy intake (< 800 or >4200 kcal/day) (n = 10)[19] and history of GDM or diabetes (n = 16). In next step, 274 pregnant women met the inclusion criteria which 31 pregnant women had not information for infant gender. Eventually, 243 pregnant women included in final analysis (Fig. 1). The study protocol was endorsed and granted by the Tehran University of Medical Sciences Research Ethics Committee (IR.TUMS.MEDICINE.REC.1400.1406). All participants provided written informed consent. This study followed the ethical guidelines outlined in the Declaration of Helsinki.

Assessment of dietary intake
The food intake of participants at baseline (third semester) was evaluated by a validated and reliable semiquantitative food frequency questionnaire (FFQ) with 168 items[20,21]. The participants provided information on how often they consumed each food item during the pregnancy, specifying their intake on a daily, weekly, monthly, or yearly scale. Daily intake of each food item was determined based on the given portion size and consumption frequency, then converted to grams per day using household measures[22]. Nutrient content was

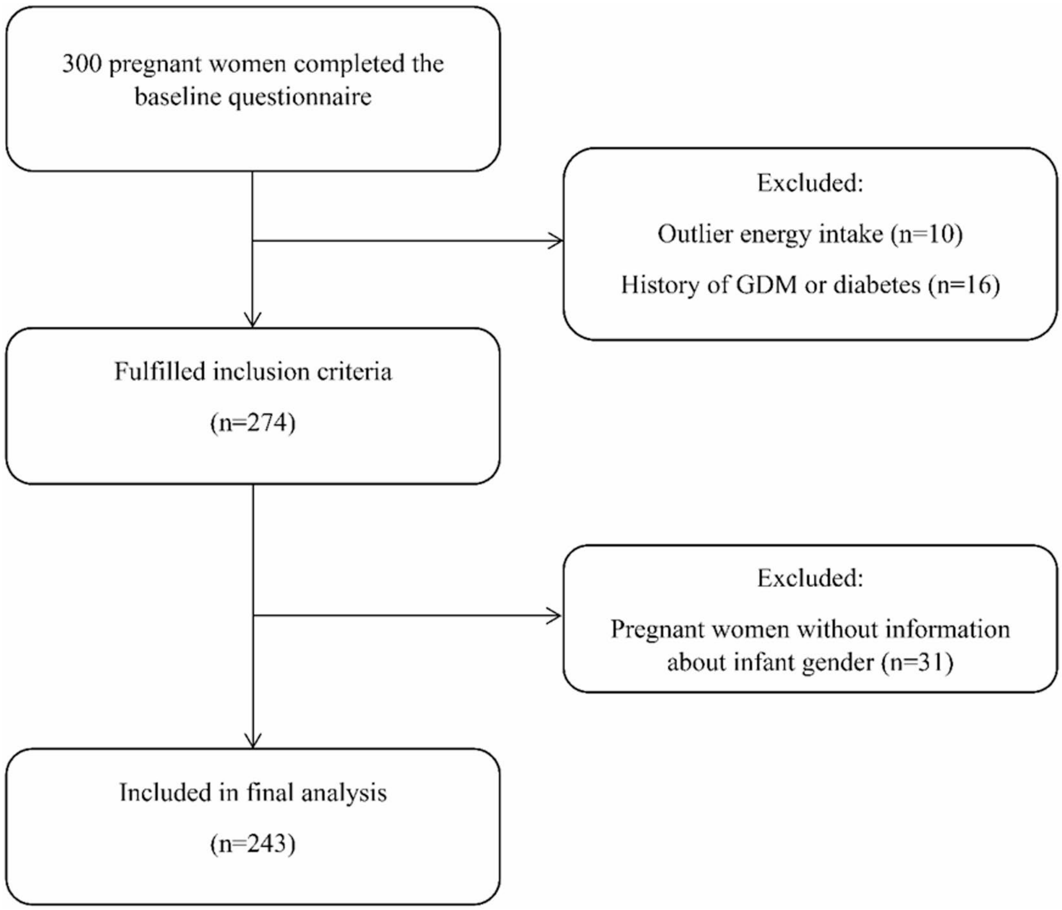

Fig. 1. Flowchart of recruitment of pregnant women in the study.

determined using the Nutritionist IV software (First Databank, San Bruno, CA), which had been adapted for Iranian food items.

Calculation of Mediterranean-diet score

We computed the Mediterranean diet score (MDS) according to a method proposed by Trichopoulou et al.[23,24]. We calculated the median intake of food groups that contributed to a traditional Mediterranean diet. It consists of nine items: (i) whole grains, (ii) vegetables, (iii) fruits, (iv) nuts, (v) legumes and seeds, (vi) fish, (vii) mono-unsaturated fatty acid to saturated fatty acid ratio, (viii) meat (red meat, processed meat, and poultry) and (ix) dairy products. We assign a point if women consumed the first seven items at or above the median and intake below the median was allocated a value of 0. Vice versa, we assign a point if women consumed detrimental items (meat and dairy products) below the median and intake equal to or above the median was assigned 0. We exclude alcohol consumption in the construction of MDS due to the harmful effects of alcohol on pregnant women and religious reasons. We didn't include whole grains in the Mediterranean score because of the lack of consumption of whole grains in the traditional Iranian diet[25]. So, the total score is computed based on 8 components (0 to 8).

Outcome assessment

Pre-pregnancy weight was obtained from available records. If records were not accessible, we used self-reported pre-pregnancy weight. In the next step, if self-reported information is not available, we utilized weight documented during the first trimester of pregnancy from existing records. Height was measured by non-elastic tape stuck to the wall while participants wore no shoes. Pre-pregnancy BMI is calculated as divided weight (in kilograms) by the square of height (in meters).

Gestational weight gain was calculated by subtracting the pre-pregnancy weight from the weight recorded at the time of delivery. Based on the guidelines established by the Institute of Medicine (IOM)[26], GWG was categorized into three groups (inadequate, adequate, and excessive) depending on the pre-pregnancy BMI. Weight gain below the specified thresholds was categorized as inadequate GWG, while weight gain above these thresholds was classified as excessive GWG; (1) Underweight (BMI < 18.5 kg/m^2): 12.8–18 kg; (2) Normal weight (18.5–24.9 kg/m^2): 11.5–16 kg; (3) Overweight (25–29.9 kg/m^2): 7–11.5 kg; and (4) Obese (BMI ≥ 30 kg/m^2): 5–9 kg.

Assessment of other variables

Demographic traits like age, education, occupation, multi-vitamin intake, smoking status, parity, and family history of diabetes were obtained via a structured questionnaire at the start of the study. The socioeconomic status (SES) of women was evaluated by considering household income, number of households, the education of both parents, and their respective occupations. To assess the physical activity (PA) levels of pregnant women in their third trimester, we employed the Pregnancy Physical Activity Questionnaire (PPAQ), a validated instrument created by Chasan-Taber et al.[27]. The reliability and validity of this questionnaire have been verified in the Iranian community[28]. The intensity of PA is measured using the Metabolic Equivalent of Task (MET), and the overall PA score is determined as MET-hours per week. Participants were subsequently categorized into three groups according to their MET-hours per week scores, which correspond to low, moderate, and high levels of PA.

Statistical analyses

We calculated MDS and then categorized individuals across tertiles of MDS. Data showed mean ± standard deviation (SD) for continuous variables and frequency as well as percentage for categorical variables. For the calculation of difference across tertiles of MDS, we used one-way analysis of variance and Chi-square test for continuous and categorical variables, respectively. Mean differences in dietary intake were evaluated with analysis of covariance (ANCOVA) which was adjusted with age for energy intake and age and energy for other dietary intakes. We utilized Cox proportional hazard models to assess the association between MDS and GWG in the context of different models that finally presented as hazard ratios (HRs) and 95% confidence intervals (CIs)[29]. The first model adjusted for age and calorie intake. In the second model, we adjusted for age, energy, education (under diploma and diploma, upper diploma), occupation (housekeeper, employed), physical activity (continuous), SES (low, moderate, high), smoking (never, quit smoker, smoker), parity (primiparous/multiparous), multi-vitamin uses during pregnancy (yes/no). The third model further adjusted for infant gender (boy/girl), GDM (yes/no), pre-pregnancy BMI (underweight and normal, obese, overweight), and family history of diabetes (yes/no). SPSS version 26 (IBM Corp, Armonk, NY, USA) was used for these statistical analyses. For all analyses, *P* values were two-tailed, and a *P* value of < 0.05 was considered significant.

Results

Totally, 243 participants were included in our study with a retention rate of 88.6%. The mean participant's age was 30.67 ± 6.22 years with a mean follow-up of 3.86 weeks. The average of GWG and PA was 12.83 ± 5.69 kg and 133.45 ± 65.20 MET hours/week, respectively. Demographic status is depicted in Table 1. Women in the highest tertiles of MDS were more likely to have GDM. The characteristics of mothers did not significantly differ across the tertiles of the MDS.

The dietary intake of pregnant women is illustrated in Table 2. People with higher adherence to MDS consumed more PUFA, fiber, vitamins A, E, C, B6, folate, magnesium, legumes, fruits, vegetables, nuts, and fish. In contrast, women with lower adherence to MDS eat more protein, saturated fat, calcium, and dairy. No significant differences were observed in other micro- or macronutrients and food group intakes across the MDS tertiles.

Table 3 presents crude and multivariable-adjusted HRs and 95% CIs of inadequate, excessive, and inappropriate GWG across tertiles of MDS. Finally, we recorded 60, 99, and 159 women with inadequate, excessive, and inappropriate GWG, respectively. We did not find an association between MDS and risk of inadequate [HR, 0.94 (95% CI: 0.50 to 1.75)], excessive [HR, 1.42 (95% CI: 0.88 to 2.27)], and inappropriate [HR, 1.22 (95% CI: 0.84 to 1.77)] GWG in crude model. Also, results were remained non-significant about association between MDS and risk of inadequate [HR, 0.69 (95% CI: 0.35 to 1.37); *P*-trend = 0.303)], excessive [HR, 1.51 (95% CI: 0.91, 2.49); *P*-trend = 0.120)], and inappropriate [HR, 1.18 (95% CI: 0.79, 1.76); *P*-trend = 0.435)] GWG after adjustment for maternal age, maternal energy intake, mother education, occupation, PA, smoking, parity, multivitamin use, SES, infant gender, GDM, pre-pregnancy BMI, family history of diabetes.

Discussion

This prospective cohort study aimed to investigate the association between MDS during pregnancy and GWG in Iranian pregnant women. Our results suggest that MDS was not associated with inadequate, excessive, or inappropriate GWG in crude and full-adjusted models. It is important to mention that this first study investigated the association between MDS and GWG in Iran.

Our study indicated no association between MDS and inadequate GWG. In contrast with our study, Radwan et al.[14] conducted a cohort study on 243 United Arab Emirates pregnant women and showed high adherence to the alternate Mediterranean Diet (aMED) score reduced the odds of insufficient GWG to 69% while no significant association between high adherence to LMD and insufficient GWG was observed. The structures of aMED and LMD used in Radwan's study were different from our score. We did not include whole grains in our Mediterranean Diet Score (MDS), and olive oil was not originally included in the MDS. Moreover, we used a long FFQ (168-items) but Radwan's study utilized a short FFQ (86-items). Another difference between our study and Radwan et al.'s study was the number of adjustments. We adjusted for a wide range of confounders, whereas Radwan et al. adjusted for age, energy intake, and the number of children. In line with our result, Liu et al.[30] prospectively indicated no association between aMED, Dietary Approaches to Stop Hypertension (DASH), and Healthy Eating Index 2010 (HEI-2010) with inadequate GWG in a multi-racial and ethnic cohort of 2914 pregnant women. Another retrospective study[31] conducted among 503 Spanish pregnant women reported no association between Mediterranean dietary pattern and GWG. Yang et al.[32] performed a prospective investigation among Chinese pregnant women, adopting Chinese GWG guidelines. A total of 1416 participants

Tertiles of Mediterranean Diet Score				
	T1 (*n* = 88)	T2 (*n* = 70)	T3 (*n* = 85)	*P*-value*
Score range	0–3	4	5–8	
Age (year)	29.80 ± 6.24	30.75 ± 6.59	31.50 ± 5.83	0.198
Gestational weight gain (kg)	12.71 ± 5.69	12.75 ± 5.48	13.04 ± 5.92	0.921
Physical activity (MET hours/week)	142.14 ± 69.55	134.44 ± 65.64	123.64 ± 59.34	0.174
Educational level				0.099
≤ Diploma	66 (39.8)	49 (29.5)	51 (30.7)	
>Diploma	22 (28.6)	21 (27.3)	34 (44.2)	
Occupation				0.146
Housewife	80 (37.9)	62 (29.4)	69 (32.7)	
Employed	8 (25.0)	8 (25.0)	16 (50.0)	
Socioeconomic status				0.706
Low	21 (32.3)	20 (30.8)	24 (36.9)	
Moderate	39 (39.4)	30 (30.3)	30 (30.3)	
High	28 (35.4)	20 (25.3)	31 (39.2)	
Parity				0.561
Primiparous	38 (35.8)	34 (32.1)	34 (32.1)	
Multiparous	50 (36.5)	36 (26.3)	51 (37.2)	
Pre-pregnancy BMI status				0.683
Under & Normal weight	41 (36.3)	32 (28.3)	40 (35.4)	
Overweight	37 (40.2)	25 (27.2)	30 (32.6)	
Obese	10 (26.3)	13 (34.2)	15 (39.5)	
Smoking status				0.161
Never	81 (34.8)	68 (29.2)	84 (36.1)	
Former	6 (75.0)	1 (12.5)	1 (12.5)	
Current	1 (50.0)	1 (50.0)	0 (0.0)	
Preterm birth				0.274
Yes	8 (27.6)	7 (24.1)	14 (48.3)	
No	80 (37.4)	63 (29.4)	71 (33.2)	
GDM				**0.036**
Yes	13 (27.7)	10 (21.3)	24 (51.1)	
No	75 (38.3)	60 (30.6)	61 (31.1)	
Family history of diabetes				0.768
Yes	25 (32.9)	23 (30.3)	28 (36.8)	
No	63 (37.7)	47 (28.1)	57 (34.1)	
Multivitamin use				0.322
Yes	75 (38.5)	55 (28.2)	65 (33.3)	
No	13 (27.1)	15 (31.3)	20 (41.7)	
Infant sex				0.632
Boy	43 (38.4)	29 (25.9)	40 (35.7)	
Girl	45 (34.4)	41 (31.3)	45 (34.4)	

Table 1. General characteristics of women across tertiles of mediterranean diet Score. Data are presented as mean ± standard deviation or n (%). BMI: body mass index; GDM: gestational diabetes mellitus. *Obtained from the ANOVA for continuous variables and Chi-square test for categorical variables.

were recruited in early pregnancy, and 971 and 997 participants were respectively followed up in middle and late pregnancy. Food intake was collected by 24-hour dietary recalls for three consecutive days. Eventually, they did not observe any association between the Chinese Healthy Diet Index for Pregnancy (CHDI-P) in early, middle, and late pregnancy with inadequate GWG. In another study, Yang et al.[33] conducted a prospective cohort study among 1190 pregnant women in Tanzania whose food intake was derived from FFQ. This study reported inadequate GWG not related to the Prime Diet Quality Score (PDQS). In contrast with our results, Yong et al.[34] conducted a prospective cohort study in 480 Malaysian women that dietary consumption was collected by a one-day, 24-hour dietary recall at each trimester. Finally, Yong et al. revealed that women with higher total HEI scores during the second trimester had a significantly lower risk of inadequate GWG (OR = 0.98, 95% CI = 0.96–0.98) after adjusting for confounders but this significant association was not observed in the first and third trimester. In this study, dietary information was collected by a 24-hour recall while in our study gathered through FFQ.

Variable	Mediterranean Diet Score			*p*-value[2]
	Tertile 1 (*n* = 88)	Tertile 2 (*n* = 70)	Tertile 3 (*n* = 85)	
Energy (kcal/d)[1]	2362.64 ± 80.84	2400.32 ± 90.32	2261.57 ± 82.23	0.490
Nutrients:				
Carbohydrate (g/d)	344.44 ± 4.83	350.04 ± 5.40	356.04 ± 4.92	0.248
Total fat (g/d)	75.83 ± 2.11	78.00 ± 2.36	74.81 ± 2.15	0.600
Total protein (g/d)	80.57 ± 1.41	71.91 ± 1.57	76.86 ± 1.43	**< 0.001**
Saturated fat (g/d)	26.14 ± 0.93	24.82 ± 1.05	21.43 ± 0.95	**0.002**
PUFA (g/d)	16.93 ± 0.75	19.40 ± 0.84	20.17 ± 0.77	**0.008**
MUFA (g/d)	24.37 ± 0.87	25.19 ± 0.97	24.14 ± 0.88	0.707
Dietary fiber (g/d)	17.77 ± 0.52	20.33 ± 0.58	24.96 ± 0.53	**< 0.001**
Vitamin A (mcg/d)	5199.32 ± 352.96	5628.37 ± 394.66	6788.85 ± 359.57	**0.006**
Vitamin E (mg/d)	13.38 ± 0.90	16.18 ± 1.01	16.21 ± 0.92	**0.048**
Vitamin C (mg/d)	120.62 ± 7.53	145.56 ± 8.43	182.60 ± 7.68	**< 0.001**
Vitamin D (mcg/d)	2.04 ± 0.20	1.55 ± 0.23	1.87 ± 0.21	0.269
Vitamin B6 (mg/d)	1.32 ± 0.04	1.54 ± 0.05	1.69 ± 0.05	**< 0.001**
Vitamin B12 (mcg/d)	3.90 ± 0.31	3.57 ± 0.35	3.84 ± 0.32	0.771
Folate (mcg/d)	258.70 ± 9.63	278.21 ± 10.77	331.54 ± 9.81	**< 0.001**
Magnesium (mg/d)	251.62 ± 6.50	248.69 ± 7.27	287.87 ± 6.62	**< 0.001**
Calcium (mg/d)	1112.52 ± 35.36	920.67 ± 39.54	989.95 ± 36.02	**0.001**
Food groups:				
Legumes (g/d)	27.97 ± 3.48	35.23 ± 3.89	53.94 ± 3.55	**< 0.001**
Dairy (g/d)	690.60 ± 36.33	504.28 ± 40.62	512.20 ± 37.01	**< 0.001**
Fruits (g/d)	350.00 ± 25.94	472.65 ± 29.01	586.30 ± 26.43	**< 0.001**
Vegetables (g/d)	285.80 ± 17.17	297.15 ± 19.20	373.39 ± 17.49	**0.001**
Nuts (g/d)	13.61 ± 1.83	16.74 ± 2.05	25.75 ± 1.86	**< 0.001**
Fish (g/d)	4.15 ± 0.88	6.22 ± 0.99	7.35 ± 0.90	**0.041**
Red and processed meat (g/d)	59.91 ± 3.94	53.36 ± 4.40	47.12 ± 4.01	0.079

Table 2. Dietary intake of the women across tertiles of mediterranean diet Score. PUFA: poly unsaturated fatty acid; MUFA: mono unsaturated fatty acid. [1]All values are means ± standard error (SE); energy adjusted for age and macronutrients intake and food groups were adjusted for age and energy. [2]Obtained from ANCOVA.

Jayedi et al. analyzed prospective cohort data in 657 Iranian women and found that those in the highest quartile of the Plant-based diet score compared to the lowest quartile had a 50% lower risk of inadequate GWG. In Jayedi's study, PA was examined by an International Physical Activity Questionnaire (IPAQ), and diet intake was measured in the first trimester while in our cohort PA was evaluated through PPAQ and diet was measured only in the third trimester. Additionally, we measured pre-pregnancy weight only once whereas Jayedi et al. measured weight during the first trimester four times.

Analysis of our data revealed MDS was not related to inappropriate GWG. In align our result, Yang et al. prospectively showed PDQS, a healthy dietary index, was not associated with inappropriate GWG in 1190 Tanzanian pregnant women[33].

In the current study, we did not find an association between MDS and excessive GWG. In parallel with our result, Liu et al. [30] investigated the association between aMED and excessive GWG in 2914 Californian pregnant women, prospectively. The above-mentioned study evaluated dietary intake by FFQ and concluded no significant association between aMED and the risk of excessive GWG. In contrast with the present study, Radwan et al. showed that aMED and LMD significantly reduced the risk of excessive GWG to 59% and 60%, respectively. The structure of aMED and LMD in Radwan's study is different from our MDS structure which did not cover a few components like dairy products in aMED and meat in LMD. A cross-sectional study reported a change in MD during pregnancy not related to the risk of extremely low and excessively high weight gain[35]. A meta-analysis of randomized controlled trials performed on 3 studies with 657 and 692 pregnant women in mediterranean and control groups indicated mediterranean diet led to lower GWG (SMD = -0.15; 95% CI = -0.26 to -0.05; p = 0.004)[36]. The health conditions of the included participants in this meta-analysis were heterogeneous. For example, one study was performed on pregnant women who high risk of having a child who will develop asthma or allergic disease[37] and one study was conducted on pregnant women with metabolic risk factors[38] and another study was performed on normoglycemic pregnant women[39].

As of now, the precise mechanism underlying the association between MDS and GWG remains poorly understood. One possible explanation for the Mediterranean diet's protective role against weight gain could be its focus on a plant-based diet, higher fiber intake, and the low glycemic index of foods such as pulses, which promote satiety[40]. Consuming foods with a lower glycemic index leads to reduced insulin secretion, an anabolic hormone, which may play a role in minimizing weight gain[40]. A Mediterranean diet consists of a high intake of

	Mediterranean Diet Score			P for trend*
	T_1	T_2	T_3	
Inadequate GWG				
n	88	70	85	
Score range	0–3	4	5–8	
Case	22	20	18	
Crude	1.00	0.94 (0.51, 1.73)	0.94 (0.50, 1.75)	0.842
Model 1	1.00	0.93 (0.50, 1.72)	0.96 (0.51, 1.80)	0.900
Model 2	1.00	0.88 (0.47, 1.64)	0.90 (0.47, 1.72)	0.741
Model 3	1.00	0.92 (0.48, 1.73)	0.69 (0.35, 1.37)	0.303
Excessive GWG				
n	88	70	85	
Score range	0–3	4	5–8	
Case	32	28	39	
Crude	1.00	0.91 (0.54, 1.51)	1.42 (0.88, 2.27)	0.146
Model 1	1.00	0.89 (0.53, 1.49)	1.44 (0.90, 2.32)	0.132
Model 2	1.00	0.88 (0.52, 1.48)	1.42 (0.86, 2.33)	0.163
Model 3	1.00	0.79 (0.46, 1.33)	1.51 (0.91, 2.49)	0.120
Inappropriate GWG				
n	88	70	85	
Score range	0–3	4	5–8	
Case	54	48	57	
Crude	1.00	0.92 (0.62, 1.36)	1.22 (0.84, 1.77)	0.306
Model 1	1.00	0.91 (0.61, 1.34)	1.24 (0.85, 1.81)	0.267
Model 2	1.00	0.88 (0.59, 1.31)	1.19 (0.80, 1.76)	0.381
Model 3	1.00	0.87 (0.58, 1.30)	1.18 (0.79, 1.76)	0.435

Table 3. Hazard ratio (95% CI) of inadequate, excessive and inappropriate gestational weight gain by tertiles of the mediterranean diet score ($n=243$). GWG: gestational weight gain; T: tertile. Model 1: Adjustment for maternal age and maternal energy intake. Model 2: Further adjustment for education, occupation, physical activity, smoking, parity, multivitamin use and socioeconomic status. Model 3: Additional adjustment for infant gender, GDM, pre-pregnancy BMI, family history of diabetes. *Obtained by Cox proportional hazard regression model.

low energy-density foods, such as water-rich fruits and vegetables, which induce satiety and consequently reduce overall energy intake[40].

The strength of our study lies in its prospective design and high retention rate. This study utilized a validated and reliable FFQ to assess dietary intake and adjust for a wide range of variables to elucidate the association between MDS and GWG. Nonetheless, certain limitations must be taken into account when interpreting our findings. First, our sample size included a limited number of pregnant women. Second, we should consider reporting bias due to dietary intake assessed with FFQ. Third, we evaluated dietary intake only during the third trimester and did not collect dietary intake in earlier periods of pregnancy. Finally, this study was conducted among pregnant women in Tehran province, Iran. It is essential to interpret the findings carefully before applying them to the broader population of pregnant women nationwide. Our study employed a version of the MDS that did not account for whole grain intake. Our results, therefore, should be interpreted with caution.

Conclusion

In the current study, we found no significant association between the MDS and inadequate, inappropriate, or excessive GWG. This cohort study represents the first investigation into the relationship between MDS during pregnancy and GWG residing in Tehran province, Iran; therefore, the results should be interpreted with caution when applying them to the broader population of pregnant women. The results of previous studies were inconsistent with our results; thus, we urgently need to conduct prospective cohorts with high sample sizes in diverse regions.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Author contributions

LA, MMB and RT designed the study. RT, MMN, MK and NO carried out interviews, extracted data from the medical records and imported the data for analysis. MMB and RT performed the statistical analyses. MMB drafted the manuscript. LA and RT read and commented on the manuscript. LA supervised the study. The final manuscript was approved by all the authors.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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