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Evaluation of the Relationship of Maternal Feeding Style with Fetal Sex

Maternal Beslenme Tarzının Fetal Cinsiyetle İlişkisinin Değerlendirilmesi

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Öz

Çalışmanın ana amacı gebelik öncesi diyet tarzı ile fetal cinsiyet arasındaki ilişkiyi belirlemektir. Gebelik öncesi ve sırasında Akdeniz diyetine bağlılık düzeyi ve fetal cinsiyet değerlendirildi. Fetal cinsiyetin gebelik sırasında maternal vücut kitle indeksi değişimine etkisi de değerlendirildi. Tanımlayıcı anket çalışmasına Etlik Şehir Hastanesi'nde doğum yapan 412 hasta dahil edilmiştir. Çalışma kapsamında, güç analizi ile örneklem sayısı hesaplanmıştır. 2 gruplu çalışmada G Power (Version 3.1.9.6) ile yapılan güç analizi sonucunda güvenirlik %95, etki düzeyi 0,50 ve güç %90 alınmıştır. Bu kapsamda en düşük örneklem sayısı her bir grup için 86 olmak üzere toplamda 172 olarak hesaplanmıştır. Ancak sonuçların güvenilirliği için erkek çocuklardan 192 ve kız çocuklardan 220 örneklem alınmıştır. Akdeniz diyet ölçeği anketi ilk trimester takibi sırasında ve doğum sırasında doldurulmuştur. Hastaların gebelik öncesi ve doğum sırasındaki kilo, boy ve vücut kitle indeksleri karşılaştırıldı. Çalışmaya dahil edilen hastalar doğumdan sonra bebeğin cinsiyetine göre iki gruba ayrıldı. Gebelik öncesi Akdeniz diyeti uyum puanı ortalaması erkek bebek annelerinde 6.98±2.21, kız bebek annelerinde 4.89±2.08'dir ve iki grup arasında anlamlı fark vardır. Gebelik süresince BKİ'deki ortalama değişim erkek bebeklerin annelerinde 2.83±1.70 ve kız bebeklerin annelerinde 3.60±1.84'tür ve bu fark istatistiksel olarak anlamlıdır. Gebelik öncesinde Akdeniz diyetine bağlı kalan hastaların gebelik süresince de bu diyete sadık kaldıkları gözlemlenmiştir. Akdeniz diyeti ile beslenenlerin anlamlı olarak daha fazla erkek bebeğe sahip olduğu sonucuna varılmıştır. Akdeniz diyetine uyum sonucunda, gebelik öncesi ve gebelikte bu diyete uyan hastaların vücut kitle indeksinin anlamlı olarak daha düşük olduğu, gebelikte kilo alımına bağlı olarak vücut kitle indeksindeki değişimin anlamlı olarak daha az arttığı sonucuna varıldı.

Anahtar Kelimeler: Akdeniz Diyeti, Fetal Cinsiyet, Gebelikte Beslenme

Abstract

The main aim of the study was to determine the relationship between pre-pregnancy dietary style and fetal sex. The level of adherence to the Mediterranean diet and fetal gender were assessed before and during pregnancy. The effect of fetal gender on maternal body mass index change during pregnancy was also evaluated. Descriptive survey study included 412 patients gave birth in Etlik City Hospital. The Mediterranean diet scale questionnaire was completed during first trimester follow-up and at time of delivery. Weight, height and body mass index of the patients before pregnancy and at delivery were compared. The included patients were divided into two groups according to sex of baby after delivery. Mean pre-pregnancy Mediterranean diet compliance score was 6.98±2.21 in mothers of male infants and 4.89±2.08 in mothers of female infants, and there was significant difference between the two groups. Mean change in BMI during pregnancy was 2.83±1.70 in mothers of male infants and 3.60±1.84 in mothers of female infants and this difference was statistically significant. It was observed that patients adhered to Mediterranean diet before pregnancy remained loyal to this diet during pregnancy. It was concluded that those fed with Mediterranean diet had significantly more male babies. Result of compliance with Mediterranean diet, it was concluded that body mass index of patients who adhered to this diet before and during pregnancy was significantly lower and change in body mass index increased significantly less due to weight gain during pregnancy.

Keywords: Mediterranean Diet, Fetal Sex, Nutrition in Pregnancy

Introduction

Pregnancy is a complex process that requires physiological adaptation of the mother and changes in nutritional needs and regular intake of macro and micronutrients to ensure fetal growth and development. Pregnancy is a 40-week period of life with different nutritional requirements for mother and child, and it is an important period of life for both (1). Diet and other lifestyle factors such as smoking and alcohol consumption before and during pregnancy and lactation have been shown to affect child health (2). In addition, an unbalanced diet during pregnancy has been associated with serious pregnancy complications (3). The baby's physiology and metabolism can be permanently altered and shaped by the intrauterine environment (4). One of the most important reasons for these changes is undoubtedly maternal diet . Several studies have investigated the association between the intake of various nutrients, foods or food groups during pregnancy and maternal and fetal diseases (5).

There are also hypotheses that assess the relationship between environmental factors and maternal physiological status and fetal sex. One of

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the most well-known of these is The Trivers - Willard hypothesis. The Trivers – Willard hypothesis (TWH) predicts that, when one sex exhibits more variation in reproductive value, then mothers in good condition should 'prefer' offspring of that sex, while mothers in poor condition should 'prefer' offspring of the other sex (6).

There are other studies evaluating the relationship between diet and maternal body type on fetal sex. A large group of African women, most of whom were malnourished as determined by their height and weight, for example, produced more daughters than sons (7). A study examining birth rates of women from rural Ethiopia also demonstrated that a positive correlation existed between women who were in better nutritional state, as determined by body mass and muscle indices, and percent of male births (8). Analysis of over 10 000 children born in Modena, Italy, revealed that thinner mothers were less likely to give birth to sons (9). In humans, males appear to have higher in utero caloric demands than females (10). Vulnerability of male offspring to in utero malnutrition and other environmental stressors might, therefore, have arisen through natural selection, by maximizing the mother's reproductive success, so that she tends to give birth to the more energy-demanding male offspring during auspicious environmental cycles (11).

The Mediterranean diet, with its low intake of meat products and high-fat foods, is a balanced, nutritious diet that is considered a standard for diet quality because of its components such as vegetables, cheese, olive oil, fish, shellfish and little meat (12).

Mediterranean diet is accepted as a healthy nutrition program all over the world. The positive effects of the Mediterranean diet are known especially in the prevention of many disease groups such as cardiovascular diseases, diabetes, obesity and cancer. Mediterranean diet, which is applied before and during pregnancy, is a suitable and sufficient nutrition option for expectant mothers. It is distinguished by its high methyl donor content for one-carbon metabolism, which is engaged in growth and programming activities, notably during the periconceptional period (13).

During pregnancy, the mother has an excessive desire for some foods, while there is a desire to avoid some foods due to hypersensitivity and disgust. Although the cause of this situation is not known exactly, it is estimated that there are changing physiological and hormonal conditions during pregnancy. It is known that traditional behaviors and practices are frequently used in some cultures during this period. One of the conditions thought to be effective on the sex of the baby is the mother's diet. One of the traditional beliefs of Turkish society is that a woman who eats sour food will have a girl child and a woman who eats sweet food will have a boy child (14).

The primary aim of this study is to determine the relationship between pre-pregnancy dietary intake and infant gender. The extent to which the patients included in the study adhered to the Mediterranean diet style before and during pregnancy will also be evaluated, considering the fetal gender. In addition, the effect of fetal sex on maternal body mass index change during pregnancy will be investigated.

Material and Method

The aim of this prospective descriptive questionnaire study was to investigate the effect of a Mediterranean diet on the prediction of fetal sex. The study was conducted in the Department of Obstetrics and Gynecology and included patients presenting to the outpatient clinic between 1 October 2023 and 1 July 2024. Patients were excluded if they were under 18 years of age, had pre-existing systemic diseases, multiple pregnancies, history of malignancy before pregnancy, active smoking, alcohol consumption or illicit drug use, HIV, HCV or HBV infection or any pre-existing chronic disease.

A total of 412 pregnant patients who applied to the pregnancy outpatient clinic in the 1st trimester were included in the study. Within the scope of the study, the sample size was calculated by power analysis. In the 2-group study, because of the power analysis performed with G Power (Version 3.1.9.6), reliability was 95%, effect level was 0.50 and power was 90%. In this context, the minimum sample size was calculated as 86 for each group, totaling 172. However, for the reliability of the results, 192 samples were taken from boys, and 220 samples were taken from girls. Informed consent was obtained from the participants that they wanted to be included in the study. Patients were asked to fill out questionnaire adapted to Turkish version of the Mediterranean Dietary Adherence Scale (MEDAS) (figure 1) considering their nutritional attitudes in the last 1 month before conception. Height, weight and body mass index of the patients were recorded in their files. When the patients were admitted to the hospital for delivery, they were asked to consider their dietary habits during pregnancy and questionnaire adapted to Turkish version of the Mediterranean Dietary Adherence Scale (MEDAS) was filled out again.

Height, weight and body index of the patients were re-evaluated and recorded in their files. The Mediterranean diet adherence scale is a test consisting of 14 questions and a score of 1 or 0 for each question. A total score of 7 and above indicates that the individual has acceptable compliance with the Mediterranean diet, and a score of 9 and above indicates that the individual has strict compliance with the Mediterranean diet (15).

1.	**Yemeklerde temel yağ olarak zeytinyağı kullanıyor musunuz?**	**Haftada en az 2 kez salata, sebze, et veya balık yemeklerinde kullanıyorsa 1 puan**
2.	Günde ne kadar zeytinyağı tüketiyorsunuz? (Kızartmalarda, salatalarda, ev dışında yenilen yemeklerde kullanılanlarda vb.) (1 yemek kaşığı=13.5 g*)	Günde 48 g'dan fazla tüketiyorsa 1 puan
3.	Günde kaç porsiyon sebze tüketiyorsunuz? (1 porsiyon= 200 g)	Günde 2 porsiyon ve fazlası tüketiyorsa 1 puan
4.	Günde kaç porsiyon meyve (taze sıkılmış meyve suları dahil) tüketiyorsunuz? (Toplam meyve porsiyonu= Total meyve g/80) (Taze meyve suyu porsiyonu= Her 100 ml** için 1 porsiyon)	Günde 3 porsiyon ve üzerinde tüketiyorsa 1 puan
5.	Günde kaç porsiyon kırmızı et tüketiyorsunuz?	Günde 100 g altında tüketiyorsa 1 puan
6.	Günde kaç porsiyon tereyağı veya margarin tüketiyorsunuz? (1 yemek kaşığı=12 g)	Günde 1 porsiyonun altında tüketiyorsa 1 puan
7.	Günde ne kadar şekerli ya da tatlandırılmış içecekler tüketirsiniz? (1 porsiyon=100 ml)	Günde 1 porsiyonun altında tüketiyorsa 1 puan
8.	Şarap içer misiniz? Haftada ne kadar tüketiyorsunuz? (1 kadeh= 125 ml)	Haftada 7 kadeh ve fazlası ise 1 puan
9.	Haftada kaç porsiyon bakliyat tüketiyorsunuz? (1 porsiyon= 150 g)	Haftada 3 porsiyon ve fazlası ise 1 puan
10.	Haftada kaç porsiyon balık / deniz ürünü tüketiyorsunuz? (1 porsiyon = 100-150 g balık veya 4-5 adet veya 200 g kabuklu deniz ürünleri)	Haftada 3 porsiyon ve fazlası ise 1 puan
11.	Haftada kaç kez işlenmiş tatlı ya da hamur işi (ev yapımı olmayan) tüketiyorsunuz?	Haftada 3 den az ise 1 puan
12.	Haftada kaç defa fındık (yer fıstığı dahil) tüketiyorsunuz? (1 porsiyon = 30 g)	Haftada 3 porsiyon ve fazlası ise 1 puan
13.	Sığır eti, domuz eti, hamburger veya sosis yerine tavuk, hindi veya tavşan eti yemeyi mi tercih edersiniz?	Beyaz et tüketimi, kırmızı et tüketiminden gramaj olarak fazla ise 1 puan
14.	Haftada kaç kere haşlanmış sebze, makarna, pilav veya diğer yemeklerinize domates, sarımsak, soğan veya pırasa soslu zeytinyağı kullanırsınız?	Haftada 2 defa ve daha fazla ise 1 puan ver

Figure 1. Questionnaire adapted to Turkish version of the Mediterranean Dietary Adherence Scale (MEDAS)

Mediterranean diet compliance scores of the patients were also divided into 3 groups for both sexes. Those with a Mediterranean diet nutritional score of 0-6 were defined as level 1, 7-8 as level 2, and 9 and above as level 3.

The patients included in the study were divided into two groups according to the sex of the baby after delivery. The completed questionnaires and body mass indexes that changed during pregnancy were evaluated according to the sex of the baby. The analyses were performed with SPSS 26.0 programmed and 95% confidence level was used. In the analyses, mean and standard deviation values for measurements, frequency and percentage values for categorical variables were given. Since the skewness and kurtosis values obtained from the measurements were between +1 and -1, normality was ensured and the analysis in terms of gender was analyzed with the Independent groups t test. The relationship between gender and MEDAS level before pregnancy was analyzed by Chi-square test. Since the skewness and kurtosis values obtained from the measurements are between +1 and -1, normality is ensured and parametric test techniques will be used in the analyses (Table 1).

Table 1. Normality Test

	Skewness	**Kurtosis**
Pre-pregnancy MEDAS level	0,356	-0,173
Pre-pregnancy BMI	0,526	0,407
During Pregnancy Medas level	0,380	-0,481
During Pregnancy BMI	0,199	0,815
In pregnancy BMI Change	0,372	-0,586

Results

The mean pre-pregnancy Mediterranean diet compatibility score was 6.98±2.21 in mothers of male infants and 4.89±2.08 in mothers of female infants, and there was a significant difference between the two groups (p<.001). The mean Mediterranean diet compliance level before pregnancy was 1.52±0.71 in mothers of male infants and 1.13±0.38 in mothers of female infants, and this difference was statistically significant (p<.001). The mean Mediterranean diet compliance score during pregnancy was found to be 6.81±1.78 and 5.09±2.15 in mothers of male and female infants, respectively, and this difference was statistically significant (p<.001). Mediterranean diet compliance level during pregnancy was found to be 1.46±0.61 in mothers of male infants and 1.20±0.48 in mothers of female infants and there was a significant difference between them (p=0.020). The mean pre-pregnancy BMI was found to be 24.19±4.17 in mothers of male infants and 26.20±4.14 in mothers of female infants, with a statistically significant difference (p=0.013). The mean BMI at the end of pregnancy was 27.02±3.98 and 29.96±3.56 in mothers of male and female infants, respectively, and the difference between them was statistically significant (p<.001). The mean change in BMI during pregnancy was 2.83±1.70 in mothers of male infants and 3.60±1.84 in mothers of female infants, and this difference was statistically significant (p=0.032) (Table 2).

Table 2. Comparison of the values of patients grouped according to sex (MEDAS: Mediterranean Diet Adherence Scale)

	Group	Mean±ss	P Value
Pre-pregnancy MEDAS	Boy(n=192) Girl (n=220)	6.98±2.21 4.89±2.08	0.000
Pre-pregnancy MEDAS level	Boy (n=192) Girl (n=220)	1.52±0.71 1.13±0.38	0.000
During Pregnancy MEDAS	Boy (n=192) Girl(n=220)	6.81±1.78 5.09±2.15	0.000
During Pregnancy MEDAS level	Boy(n=192) Girl(n=220)	1.46±0.61 1.20±0.48	0.020
Pre-pregnancy BMI	Boy (n=192) Girl(n=220)	24.19±4.17 26.20±4.14	0.013
End of Pregnancy BMI	Boy(n=192) Girl(n=220)	27.02±3.98 29.96±3.56	0.000
In pregancy BMI Change	Boy(n=192) Girl(n=220)	2.83±1.70 3.60±1.84	0.032

When classified according to MEDAS level in mothers of male infants, there were 116 patients in incompatible, 52 patients in moderately compatible, and 24 patients in tightly compliant group. In mothers of baby girls, there were 196, 20 and 4 patients, respectively (Table 3).

Table 3. Gender distribution in patients grouped according to pre-pregnancy MEDAS level (MEDAS: Mediterranean Diet Adherence Scale)

Sex	Pre-pregnancy MEDAS level	n (%)	p
Boy	Group 1(incompatible)	116 (%60,4)	
	Group 2 (moderately compliant)	52 (%27,1)	
	Group 3 (tightly matched)	24 (%12,5)	0,000
Girl	Group 1(incompatible)	196 (%89,1)	
	Group 2 (moderately compliant)	20 (%9,1)	
	Group 3 (tightly matched)	4 (%1,8)	

Discussion

Healthy nutrition during pregnancy is important for fetal development and maternal health. Many expectant mothers recognize that the right diet during pregnancy is important for the health of their baby. There are also different cultural beliefs that diet and a strong preference for certain foods are related to the sex of the baby. Expectant mothers are concerned about the health of their baby as well as the sex of the baby. Maternal diet is one of the important parameters thought to be associated with fetal sex.

Mothers that experience different individual or environmental conditions may produce different proportions of male to female offspring (16). Mammals usually produce approximately equal numbers of sons and daughters, but there are exceptions to this general rule, as has been observed in ruminant ungulate species, where the sex-allocation hypothesis of Trivers and Willard has provided a rational evolutionary underpinning to adaptive changes in sex ratio (17). In a laboratory study on mice, it was shown that maternal age and maternal diet, rather than maternal body condition, play a guiding role in controlling sex ratio (17). They concluded that a diet high in saturated fat but low in carbohydrate resulted in the birth of significantly more male offspring than female offspring in mature laboratory mice, while female offspring were more dominant when calories were provided in the form of carbohydrate rather than fat (17).

The Mediterranean diet is a term based on the traditional diet in countries bordering the Mediterranean Sea. Interest in the Mediterranean diet began in the 1950s. This interest arose from the realization that heart disease was less common in people living in Mediterranean countries than in wealthier Western countries. In addition, the Mediterranean diet has become one of the most preferred dietary styles during pregnancy. Many studies have been undertaken to investigate the effect of Mediterranean diet on maternal health and offspring health. For instance, the Mediterranean diet is associated with a higher chance of clinical pregnancy and live birth after IVF, and a lower incidence of infertility (18,19). There are studies showing the effective power of the Mediterranean diet in preventing gestational diabetes mellitus, pre-eclampsia, metabolic syndrome and syndromic infant birth during pregnancy. In our country, this diet style, which was previously preferred especially in the Mediterranean and Aegean regions, has started to be adopted in all regions today.

In previous studies, the importance of Mediterranean diet during pregnancy has been emphasized, but the relationship with fetal sex has not been mentioned. In our study, we aimed to evaluate the relationship between the Mediterranean dietary pattern preferred in the preconceptional period and fetal sex. The effect of adherence to the Mediterranean diet during pregnancy on body mass index has also been investigated. The pre-pregnancy Mediterranean diet adherence score was significantly higher in mothers who gave birth to male infants. The pre-pregnancy Mediterranean diet adherence level was significantly higher in mothers who gave birth to a male baby. However, when both scores and compliance levels were evaluated, it was observed that both groups of mothers did not have an

acceptable level of compliance with the Mediterranean diet. Both the score and the level of adherence to the Mediterranean diet during pregnancy were significantly higher in mothers who gave birth to male infants. It is noteworthy that the pre-pregnancy diet score of mothers of male infants was higher than the pre-pregnancy score. On the other hand, the Mediterranean diet score during pregnancy was found to be higher than the pre-pregnancy diet score in mothers of female infants. This contrast between the groups suggests that the compliance with the Mediterranean diet decreased with pregnancy in mothers of male infants, whereas mothers of female infants adopted a healthier eating style and turned to the Mediterranean diet. Body mass index was found to be significantly lower in mothers of male infants than in mothers of female infants before and at the end of pregnancy. At the same time, the increase in body mass index during pregnancy was found to be higher in mothers of female infants.

This study provides valuable information on the effects of a Mediterranean diet in predicting changes in body mass index and fetal sex. However, it is important to recognize some limitations of the study. Sample size, errors in completing the Turkish adapted questionnaire of the Mediterranean dietary adherence scale and patient selection may lead to inherent bias. One of the limitations of the study is that the influence of paternal factors on fetal sex was ignored. This limitation narrows the results of the study and does not sufficiently examine the potential effects of paternal genetic and environmental factors.

Despite these limitations, the fact that the association of Mediterranean diet with fetal sex was not evaluated makes our study original. In the light of these findings, it is thought that larger and more prospective studies and investigations should be carried out to confirm the relationships defined and to elucidate the underlying mechanisms.

Conclusion

In the Trivers - Willard hypothesis, the prediction that expectant mothers with good fitness and environmental factors have a high potential to give birth to a male baby of the opposite sex can be associated with the conclusion that adherence to the Mediterranean diet will also lead to a male baby by providing good fitness and physiology in the mother.

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Conflict of interest statement

Our study has not conflict of interest

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