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The Determinants of Academic Achievement in Medical Students: a Cross-Sectional Designed Multifactorial Approach

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Abstract

Objective: Medical students have a heavy academic burden, hence, various factors can directly and easily affect their academic performance. In this study, we aimed to investigate the effects of hemoglobin levels, body composition, nutritional status and physical activity on academic achievement in medical students.

Methods: 121 students (69 males, 52 females) participated in the study. Body compositions were recorded; data concerning nutritional habits, food consumption frequency and physical activity was obtained using a survey. The hemoglobin and hematocrit values measured in the physiology practice were recorded and the scores obtained from the committee exam were considered as academic achievement criteria.

Results: Female students were found to be more successful than males (p=0.012). Smokers (p=0.007) and sugary-beverage consumers (p=0.022) were also more unsuccessful. Males who did not consume coffee daily were more successful than those who did (p=0.015). Additionally, males with moderate physical activity levels were more successful than those who had low physical activity levels (p=0.04). Furthermore, there was a moderate positive correlation between academic achievement and sedentary behavior (p<0.05, r=0.265).

Discussion: Based on our findings, we determined that smoking, coffee and sugary-beverage consumption may negatively affect academic success in medical students. Studying theoretical lessons daily for a sufficient period and getting moderate physical activity in leisure time can be recommended as tools for medical students to increase academic achievement.

Keywords: Academic achievement, body composition, physical activity, nutrition, medical education

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Tıp Öğrencilerinde Akademik Başarının Belirleyicileri: Kesitsel Tasarlanmış Multifaktöriyel Bir Yaklaşım

Öz

Giriş: Tıp öğrencilerinin akademik yükünün fazla olması nedeniyle, çeşitli faktörler akademik başarılarını doğrudan ve kolayca etkileyebilmektedir. Bu çalışmada, tıp öğrencilerinde hemoglobin düzeyi, vücut kompozisyonu, beslenme durumu ve fiziksel aktivitenin akademik başarıya etkisini araştırmayı amaçladık.

Yöntemler: Çalışmaya 121 öğrenci (69 erkek, 52 kız) katılmıştır. Öğrencilerin vücut kompozisyonları kaydedilmiştir. Beslenme alışkanlıkları, besin tüketim sıklığı ve fiziksel aktivite verileri anket yöntemi ile elde edilmiştir. Fizyoloji uygulaması sırasında ölçülen hemoglobin ve hematokrit değerleri kayıt altına alınmış ve akademik başarı kriteri olarak öğrencilerin kurul sınavından aldıkları puanlar kullanılmıştır.

Bulgular: Kız öğrenciler erkeklere göre daha başarılı bulunmuştur (p=0,012). Sigara içenler (p=0,007) ve şekerli içecek tüketenler (p=0,022) daha başarısız iken günlük kahve tüketmeyen erkekler tüketenlere göre daha başarılı olarak saptanmıştır (p=0,015). Ayrıca orta düzeyde fiziksel aktiviteye sahip erkekler, düşük fiziksel aktivite düzeyine sahip olanlardan daha başarılı sınav performansı sergilemiştir (p=0,04). Ek olarak, akademik başarı ile sedanter davranış arasında orta düzeyde pozitif bir ilişki bulunmuştur (p<0,05, r=0,265).

Tartışma: Bulgularımıza göre tıp öğrencilerinde sigara, kahve ve şekerli içecek tüketimi akademik başarıyı olumsuz etkilemektedir. Tıp öğrencilerinin akademik başarılarını artırmak için her gün teorik derslere yeterince zaman ayırmaları ve boş zamanlarında orta derecede fiziksel aktivite yapmaları önerilebilir.

Anahtar kelimeler: Akademik başarı, vücut kompozisyonu, fiziksel aktivite, beslenme, tıp eğitimi.

INTRODUCTION

Academic achievement in medical education is very important not only for medical students but also for society in general. Since incorrect interventions or treatments due to a lack of knowledge of physicians can result in the cost of human life, a graduate of medical school must have sufficient medical knowledge to implement the right decisions in vital situations.

To date, many factors have been associated with academic achievement. However, these factors have generally been addressed individually, or the research concentrated on children and adolescents. Thus, extensive studies addressing many factors simultaneously may provide deeper insight into various factors affecting academic performance[1].

The academic burden of medical students is higher than other undergraduates. Therefore, physical, psychological and social factors may easily affect their academic achievement. In the literature, many factors affecting the academic success of students have been examined. To the best of our knowledge, no research focusing on the academic success of medical students on many modifiable physiological factors within a single study have yet been conducted. Instead of studying social and psychological factors, our objective was to clarify the relationship between academic achievement and various physiological parameters which are "modifiable". In addition, we aimed to offer suggestions and appropriate guidance to medical faculty students in order to enable them to increase their academic performance. In this study, the effects of hemoglobin level, body composition, physical activity and nutritional habits on academic success were investigated in medical students.

METHODS

Participants

This study was conducted on students in the 2nd year of the Balıkesir University School of Medicine in the 2018-2019 academic year. The 2nd year students were chosen for two reasons: they have generally overcome the adaptation

period to the physical and social environment in the first year and have the highest theoretical burden in the medical faculty. Consequently, the psychogenic factors have been eliminated as much as possible. Since there are certain situations which can cause changes in physiological parameters that have the potential to affect students' academic achievement, students with chronic diseases (diabetes, hypertension, hypothyroidism, etc.), those who used medications continuously (hormones, antidiabetics, anti-hypertensives, antidepressants, sleeping pills, iron supplement etc.) or followed a special diet (low calorie diet, ketogenic diet, etc.) or who were younger than 18 and older than 25 were excluded. For example, chronic diseases such as diabetes, hypothyroidism, and the continued use of drugs (hormones, antidepressants, etc.) can affect the metabolism and yield have a direct effect on body composition, physical activity and nutritional habits. Based on these exclusion criteria, 12 students in total were not included. A total of 121 second-year students, (69 males and 52 females) aged 19-25 were included in the study. Post hoc, two-tailed power analysis was calculated as 87% with 0.05 type-1 error probability. Participation was entirely voluntary and students' written consents were obtained. The study protocol was approved by the Clinical Research Ethics Committee of Balıkesir University Faculty of Medicine (Decision date: 30.01.2019, Number: 2019/24).

Measurements

This study was implemented between November 2018 and January 2019 and lasted for a total of 3 months. Hemoglobin values were determined in November, questionnaire data (nutritional habits and physical activity status) was collected and body composition measurements were completed in December-January. Hemoglobin measurements and questionnaire applications were conducted by the Balıkesir University Physiology Department, while body composition measurements were obtained in the Balıkesir University Hospital Diet Polyclinic.

Hemoglobin and Hematocrit

The students' hemoglobin and hematocrit measurements were performed using a hemoglobinometer device (Mission Hb, ACON Laboratories, Inc. San Diego, USA) and obtained during the hemoglobin practice of physiology in November of the 2018-2019 academic year. This device works with 1 drop of blood taken from the fingertip via a lancet, without the need for blood to be stored, and provides results within 5-10 seconds.

Academic Achievement

Academic achievement was evaluated based on the scores of the 2nd Committee exam in January of the 2018-2019 academic year. It is known that the life span of an erythrocyte is 120 days. Thus, the 2nd Board exam was preferred as it was the closest exam to the date of student practice of hemoglobin measurement. Hence, we aimed to obtain more reliable results by keeping the time between the exam dates and the hemoglobin measurements at minimum.

Body Composition and Body Mass Index (BMI)

Students' height and weight were recorded by the same researcher with a weighing stadiometer device (Nanbaskul Scale DR-MOD.85, Istanbul, Turkey) before lunch and without shoes. BMI was calculated as the weight (kg) divided by the square of height (m) and separated into two categories as BMI<25 and BMI≥25[2]. In addition, body compositions were determined with an analyzer (MC-780MA body composition analyzer, Tanita Cooperation, Tokyo, Japan) which performs based on the bioelectrical impedance method. Body fat ratio values of 8-15% in men and 15-22% in women were considered as normal ranges[3].

The Determination of Physical Activity Level and Nutritional Status

A questionnaire was developed to determine the physical activity levels and nutritional status of the last three months[4,5]. The four-part questionnaire included questions concerning general information, physical activity, eating habits and frequency of food consumption, respectively.

General Information: This section contained questions about age, gender, smoking and alcohol use, chronic disease, medication, vitamin supplement and following a diet.

Physical activity: The Turkish version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF), of which the validity and reliability study had previously been performed, was applied to determine the physical activity status[6]. The test-retest reliability coefficient of the Turkish IPAQ short form was $r = 0.69$, $p<0.001$. There are 7 questions in total in the IPAQ short form and it allows the calculation of metabolic equivalent (MET) by determining the students' weekly physical activity frequency, duration and intensity levels. As a result, the weekly physical activity amounts were determined quantitatively in addition to being evaluated in 3 categories as low, medium and high. The MET limit values used for categorization are as follows: (1) <600 MET-min/wk sedentary, (2) 600-3000 MET-min/wk moderate, (3) >3000 MET-min/wk high physical activity level.

Eating habits: In this section, we questioned the habits for daily main meals, water, tea, coffee, beverage consumption and adding sugar to drinks.

Food consumption frequency: In this section of the questionnaire, the frequencies of dairy products, meat products, vegetable, fruit, grains, oil and sugar consumptions were determined. In addition to the content of these groups, the recommended daily amount of portions for individuals aged 18-49 for each food group were determined according to the Turkey Nutrition Guideline[4]. The foods under each group title were indicated along with portion amounts (in g or mL) and their equivalents (spoon, bowl, palm, cup etc.). The food consumption frequency was evaluated in 9 categories: "each meal", "each day", "5-6 times a week", "3-4 times a week", "1-2 times a week", "once in 15 days", "once a month", "rarely" and "never". In addition, the participants were asked to add cross marks to indicate the number of portions they consumed to the appropriate consumption frequency box. During data evaluation, a coefficient value corresponding to each food consumption frequency was determined. As we aimed to evaluate the food consumption scores of the last 3 months, the coefficient values were 270 (90 days x3) for "each meal", 90 for "each day", 72 (13 weeks x5.5) for "5-6 times a week", 46 (13 weeks x3.5) for "3-4 times a week", 20 (13 weeks x1.5) for " 1-2 times a week", 6 (90 days/15=6) for "once in 15 days", 3 (90 days/30=3) for "once a month ", 1 for "rarely" and 0 for "never". These coefficients were multiplied by the number of portions that the participants marked on the food consumption frequency. Consequently, the nutritional score was obtained for each food group. In addition, according to the daily recommended portion quantity of each food group, a 3-month sufficient consumption score was calculated separately for males and females. As result of the comparison with these limit scores, scores obtained from the participants were categorized as sufficient and insufficient consumption. Since there was no recommended limit of daily consumption for these groups, fat and sugar consumption was not categorized.

Statistical Analysis

All analyses of data were conducted via SPSS v.21.0 software. The independent t-test was conducted to examine the differences in academic achievement between two groups. For the data consisting of three groups, the

difference between groups was evaluated with one-way ANOVA and post-hoc Bonferroni. The relationship between continuous data and academic achievement was investigated using the Pearson correlation analysis. p<0.05 was considered statistically significant.

RESULTS

Hemoglobin results

The hemoglobin and hematocrit values for both females and males are provided in Table1.

When anemia criteria determined as 12 gr/dl for females and 13 gr/dl for males were applied[7], 7 females were evaluated as being anemic while no males met the anemia criteria. The hemoglobin and hematocrit values of male students were observed to be significantly higher than female students (p<0.0001). No significant correlation was detected between hemoglobin and hematocrit values and academic achievement (Table 4).

Physical Activity Results

The physical activity and sedentary behavior details of males and females are provided in Table1.

Table I: Descriptive results for continuous variables

Characteristic	Range			Mean☐SD		
	Male	Female	Total	Male	Female	Total
Age (years)	19-25	19-25	19-25	20,7±1,57	20,1±1,03	20,44±1,39
Weight (kg)	57,3-99,7	44,3-87,4	44,3-97,9	75,27±10,84	61,25±9,25	69,39±12,3
Height (cm)	162-189	154-177	154-189	175,66±5,92	164,03±5,87	170,78±8,23
BMI (kg/m²)	18,93-36,18	16,88-30,97	16,88-36,18	24,36±3,17	22,79±3,37	23,7±3,33
Skeletal muscle mass (kg)	44,5-73,4	34,7-50,6	34,7-73,4	57,5±6,24	41,9±3,57	50,95±9,36
Skeletal muscle ratio (%)	68,3-86,8	57,3-80,7	57,3-86,8	76,93±4,46	69,17±5,96	73,67±6,4
Body fat mass (kg)	5-27,5	7,7-34,6	5-34,6	14,69±5,35	17,06±6,57	15,69±5,97
Body fat ratio (%)	8,6-28,1	15,1-39,6	8,6-39,6	19,02±4,72	27,14±6,27	22,43±6,73
MET-min/week	248-5466	198-4026	198-5466	2029,98±1521,52	1525,08±960,66	1820,08±1334,85
Sedentary behavior (min/day)	60-1080	180-900	60-1080	468,27±214,62	545,68±182,19	500,45±204,32
Hemoglobin (g/dl)	13,1-17,6	9,3-16,5	9,3-17,6	15,25±0,97	13,2±1,3	14,37±1,51
Hematocrit (%)	39-52	27-49	27-52	44,67±3,03	38,81±3,81	42,14±4,46
Committee exam score	41-94	38-92	38-94	67,23±12,66	72,83±10,93	69,64±12,22
Dairy products consumption score	20-626	66-544	20-626	171,87±112,81	200,78±120,51	183,63±116,22
Meat products consumption score	32-618	69-326	32-618	198,09±104,85	174,59±65,97	188,54±91,37
Vegetable consumption score	4-630	5-324	4-630	122,46±95,19	142±70,89	130,41±86,25
Fruit consumption score	4-544	14-1160	4-1160	119,83±102,79	177,19±189,45	143,15±146,22
Grain consumption score	125-939	119-643	119-939	382,83±173,46	347,73±148,39	368,56±163,79
Fat consumption score	4-586	4-452	4-586	198,8±146,21	171,54±109,63	187,71±132,58
Sugar consumption score	1-362	7-270	1-362	127,43±81,08	100,16±62,46	116,34±74,92

(BMI: Body mass index, MET: Metabolic equivalent)

There was no significant difference between the weekly MET/min values of males and females (p=0.059). In addition, no significant correlation was found between weekly MET/min values and academic success (p=0.536) (Table 4).

The categorical results of physical activity levels
are provided in Tables 2 and 3.

Table II: Statistical results for categorized variables (* p <0.05)

Characteristics	Category	(%)	n	Grade average±SD	t value (t test) / F value (ANOVA)	p value
Gender	male	57	69	67,23±12,660	-2,550	0,012*
	female	43	52	72,83±10,931		
Physical activity	low	20	18	66,11±11,842	1,542	0,22
	moderate	63	56	71,71±11,646		
	high	17	15	68,93±14,099		
BMI (kg/m²)	25>	74	60	70,08±12,407	0,725	0,471
	25≤	26	21	67,81±12,291		
Body fat ratio (%)	normal	21	17	65,00±14,722	-1,709	0,091
	high	79	64	70,69±11,465		
Smoking	yes	29	26	64,88±11,504	-2,756	0,007*
	no	71	65	72,49±12,047		
Alcohol	yes	40	36	67,83±12,225	-1,569	0,12
	no	60	55	71,95±12,227		
Vitamin	yes	21	19	68,84±13,035	-0,585	0,56
	no	79	72	70,71±12,196		
Main meal	1 or 2	35	32	67,66±10,703	-1,529	0,13
	3	65	59	71,76±12,979		
Adding sugar to drink	no	66	60	72,43±11,040	2,332	0,022*
	yes	34	31	66,23±13,776		
Daily water	< 1500ml	47	43	67,95±12,660	-1,752	0,083
	≥1500 ml	53	48	72,44±11,745		
Daily tea	none	11	10	76,5±10,648	1,791	0,173
	1-2 cup	47	43	70,63±12,507		
	3 or more cup	42	38	68,34±12,244		
Daily coffee	no	35	32	71,78±12,007	0,832	0,407
	yes	65	59	69,53±12,524		
Daily beverage	no	81	74	71,12±12,711	1,302	0,196
	yes	19	17	66,82±10,070		
Dairy products	enough	19	17	72,94±13,222	0,973	0,333
	not enough	81	74	69,72±12,124		
Meat products	enough	71	65	70,91±12,219	0,795	0,474
	not enough	29	26	68,85±12,708		
Vegetable	enough	6	5	74,80±10,378	0,843	0,401
	not enough	94	85	69,99±12,488		
Fruit	enough	26	24	70,71±10,255	0,193	0,858
	not enough	74	67	70,18±13,055		
Grain	enough	36	33	71,64±13,007	0,768	0,445
	not enough	64	58	69,57±11,971		

(BMI: Body mass index)

Table III: Gender-separated results for categorized variables (* p <0.05)

Characteristics	Category	Male					Female				
		(%)	n	grade average±SD	t value (t test) / F value (ANOVA)	p value	(%)	n	grade average±SD	t value (t test) / F value (ANOVA)	p value
Physical activity	low	25	13	61,92±9,535	3,454	0,04*	14	5	77,00±10,863	1,256	0,298
	moderate	52	27	72,22±11,882			78	29	71,24±11,612		
	high	23	12	66,17±14,528			8	3	80,00±1,000		
BMI (kg/m²)	25>	70	33	67,88±14,333	0,743	0,461	79	27	72,78±9,099	0,066	0,949
	25≤	30	14	65,57±6,914			21	7	72,29±19,102		
Body fat ratio	normal	23	11	59,55±13,909	-2,428	0,019*	18	6	75,00±11,009	0,541	0,592
	high	77	36	69,53±11,305			82	28	72,18±11,703		
Smoking	yes	31	17	62,35±12,604	-2,575	0,013*	24	9	69,67±7,517	-0,937	0,355
	no	69	37	71,57±12,036			76	28	73,71±12,171		
Alcohol	yes	41	22	65,77±11,856	-1,384	0,172	38	14	71,07±12,524	-0,694	0,492
	no	59	32	70,66±13,300			62	23	73,74±10,580		
Vitamin	yes	19	10	68,70±13,905	0,009	0,993	24	9	69,00±12,835	-1,147	0,259
	no	81	44	68,66±12,764			76	28	73,93±10,680		
Main meal	1 or 2	31	17	64,47±11,641	-1,653	0,104	41	15	71,27±8,514	-0,647	0,522
	3 or more	69	37	70,59±13,061			59	22	73,73±12,900		
Adding sugar to drink	no	57	31	71,16±12,396	1,685	0,098	78	29	73,79±9,405	1,097	0,28
	yes	43	23	65,30±12,938			22	8	68,88±16,626		
Daily water	< 1500ml	46	25	65,80±11,916	-1,542	0,129	49	18	70,94±13,388	-0,937	0,355
	≥1500 ml	54	29	71,14±13,303			51	19	74,42±8,834		
Daily tea	None	11	6	77,33±9,730	1,760	0,182	11	4	75,25±13,376	0,260	0,773
	1-2 cup	33	18	69,00±14,125			67	25	71,80±11,358		
	3 or more	56	30	66,73±12,199			22	8	74,38±11,096		
Daily coffee	no	48	26	73,00±12,576	2,505	0,015*	16	6	66,50±7,868	-1,507	0,141
	yes	52	28	64,64±11,942			84	31	73,94±11,512		
Daily beverage	no	80	43	69,40±13,322	0,822	0,415	84	31	73,52±11,596	0,965	0,341
	yes	20	11	65,82±10,861			16	6	68,67±9,070		
Dairy products	enough	17	9	72,33±15,851	0,937	0,353	22	8	73,63±10,555	0,251	0,803
	not enough	83	45	67,93±12,239			78	29	72,48±11,612		
Meat products	enough	74	40	69,80±13,812	1,098	0,277	68	25	72,68±9,100	-0,038	0,97
	not enough	26	14	65,43±9,230			32	12	72,83±15,302		
Vegetable	enough	2	1	71,00	Not calculated		11	4	75,75±11,730	0,573	0,57
	not enough	98	53	68,62±12,965			89	32	72,25±11,495		
Fruit	enough	17	9	66,22±10,533	-0,622	0,537	41	15	73,40±9,417	0,295	0,77
	not enough	83	45	69,16±13,309			59	22	72,27±12,555		
Grain	enough	26	14	66,14±14,852	-0,852	0,398	51	19	75,68±10,034	1,681	0,102
	not enough	74	40	69,55±12,151			49	18	69,61±11,907		

(BMI: Body mass index)

The committee exam scores of males with moderate physical activity levels were found to be significantly higher than males with low physical activity levels (p=0.043) (Figure 1).
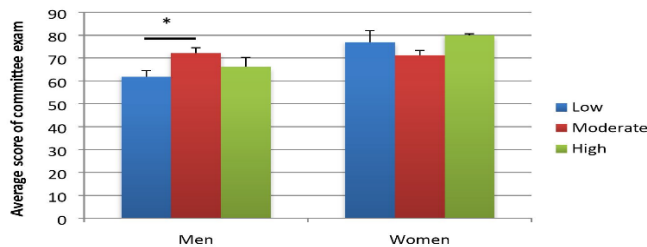

Figure 1: The effects of physical activity levels on academic achievement. * p<0.05

A moderate positive correlation was determined between sedentary behavior and exam scores (p=0.012 r=0.265) (Figure 2).
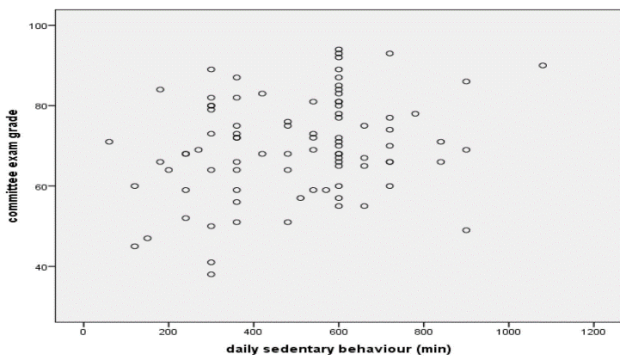

Figure 2: Correlation between sedentary behavior and academic achievement.

Body Composition Results

The results of students' height, weight, body mass index, muscle and fat ratios are provided in Table 1. The categorized results of BMI and body fat ratio are shown in Tables 2 and 3.

There was no statistically significant difference between the exam scores of the students with BMI<25 and the students with BMI≥25 (Table-2, Figure 3). No significant difference was detected in the exam scores of the student groups with normal and high fat ratio (p=0.091) (Figure-3).
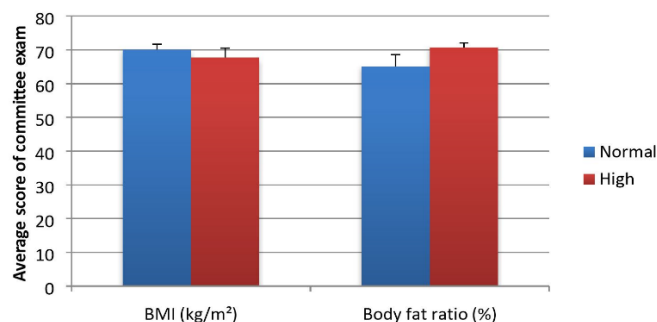
Figure 3: The effects of BMI (kg/m2) and body fat ratio (%) on academic achievement. BMI: Body mass index.

The exam scores were not correlated with BMI and body fat ratios (Table 4).

Table IV: Results of correlation analyses between continuous variables and academic achievement (* p <0.05)

Parameter	Male		Female		Total	
	Correlation coefficient (r)	p value	Correlation coefficient (r)	p value	Correlation coefficient (r)	p value
MET-min/week	0,078	0,582	0,174	0,303	0,067	0,536
Sedentary behavior (min/day)	0,364*	0,008*	0,003	0,985	0,265*	0,012*
Skeletal muscle ratio (%)	-0,123	0,409	0,273	0,118	-0,085	0,448
Body fat ratio (%)	0,124	0,406	-0,274	0,117	0,085	0,448
BMI (kg/m²)	0,068	0,652	-0,093	0,601	-0,05	0,655
Hemoglobin (g/dl)	0,172	0,179	-0,03	0,838	-0,086	0,369
Hematocrit(%)	0,193	0,129	-0,032	0,827	-0,07	0,467
Dairy products consumption score	0,2	0,147	0,147	0,386	0,195	0,065
Meat products consumption score	-0,04	0,773	0,073	0,667	-0,03	0,78
Vegetable consumption score	-0,05	0,974	0,088	0,604	0,042	0,695
Fruit consumption score	0,075	0,589	-0,131	0,438	0,002	0,987
Grain consumption score	-0,07	0,589	0,254	0,129	0,022	0,838
Fat consumption score	0,203	0,141	-0,063	0,712	0,102	0,336
Sugar consumption score	0,081	0,559	-0,048	0,776	0,01	0,925

(MET: Metabolic equivalent, BMI: Body mass index)

Results of Eating Habits

The data on students' smoking, alcohol usage, vitamin, water, tea, coffee, beverage and main meal consumptions, as well as adding sugar to their drinks are presented in Tables 2 and 3.

Non-smokers were more successful than smokers (p=0.007). When compared to those adding sugar to their drinks, the ones who did not add sugar to their drinks (p=0.022) were observed to be more successful. Additionally, male students who did not consume coffee were also found to be more successful than those consuming coffee (p=0.015) (Figure 4).
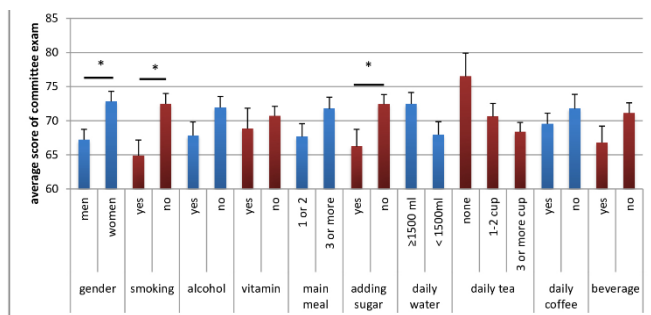
Figure 4: The effects of eating habits on academic achievement. * p<0.05

Results of food consumption frequency

There was no significant difference between the exam scores of sufficient and insufficient consumers (Figure 5). Additionally, no significant correlation was observed in the consumption scores of food groups and exam scores (Table 4).
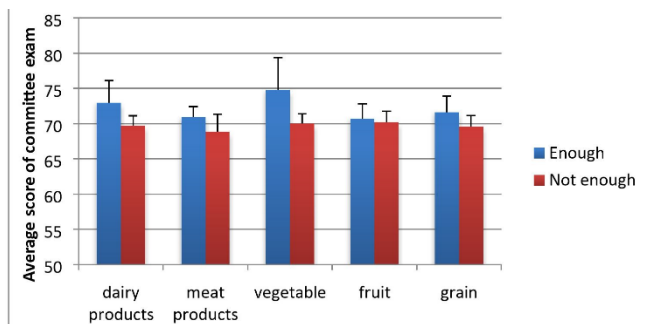
Figure 5: The effects of food consumption frequencies on academic achievement.

DİSCUSSİON

In this study, we evaluated hemoglobin levels, body compositions, nutritional habits, food consumption frequencies and physical activity levels among medical students, and investigated the effects of these factors on academic achievement. Our findings indicate that female students, non-smokers, those who do not consume sugary-beverages, male students with moderate physical activity levels coffee-nonconsuming males were found to be more successful than their counterparts. Interestingly, sedentary behavior was associated with an increase in exam scores. On the other hand, hemoglobin levels, food consumption frequencies and body composition did not affect the academic achievement of medical students.

Although smoking rates are decreasing in Turkey as well as in many other countries, they are known to still be high among medical students[8]. In addition to the well-known deleterious effects of smoking on public health, it also adversely affects cognitive functions. Moreover, these effects have also been demonstrated in young adults[9]. In this study, we observed that students who smoked were not as successful as non-smokers. Although there is not enough data on the effects of cigarette smoking on academic achievement in university students in the literature, our result is not surprising as smoking has a negative impact on cognitive functions.

Our results demonstrated that female students were more successful than male students; gender is known to be one of the factors affecting academic success in medical schools. In the literature, despite several varying results in studies examining the effect of gender on success in medical education, it is reported that female students generally perform better[10]. The reasons for these differences in academic acheivement is thought to be due to the

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differences both in the education systems applied in medical schools and in the learning styles of males and females. In addition, a study stated that since women tend to be more anxious in terms of doability, they study harder and more meticulously to deal with this uncertainty. This helps to explain the success of female students in medical education[11].

In our study, we observed that the consumption of sugary beverages negatively affected academic achievement in medical students. Medical students usually restrict both their social lives and sleep times in order to allocate suffient study time. Thus, they tend to consume caffeinated beverages such as tea and coffee. For students who have the habit of adding sugar to their drinks, this results in an unconsciously excessive intake of simple sugar. Sugary beverage consumption yields negative effects on cognitive functions by affecting various inflammatory mechanisms and neurotrophic factors in the brain; this has been demonstrated in both experimental studies and among various age groups[12,13].

Physical activity has a positive effect on cognitive functions and academic success by increasing brain perfusion, glucose and lipid metabolism, neurotrophic factor levels and gray matter volume of the hippocampus and frontal cortex[14]. However, there are studies in the literature stating that the improvement in cognitive skills in response to increasing exercise levels does not indicate linearity and draws an inverted-U like curve[15,16]. In our study, male students with moderate physical activity levels were found to be more successful than males with low physical activity levels. Our results support the tenet that similar to cognitive functions, physical activity also has a dose-dependent effect on academic achievement.

It is known that caffeine increases alertness and cognitive performance. Although caffeine reduces headaches with its vasoconstrictor effect, in chronic use, it has been shown to trigger headaches and cause psychiatric symptoms such as anxiety and depression; this in turn negatively affects academic success[17,18]. In our study, male students who consumed coffee every day were found to be more unsuccessful than those who did not. The gender-dependent differences in consumption rates or total caffeine intake doses and duration of other various caffeinated products such as tea, chocolate, and energy drinks may explain the different results we observed according to gender.

In this study, we found that sedentary behavior increased the academic achievement of medical students. Sedentary behavior refers to the situation of sitting or lying down while awake in which energy expenditure is very low. Many activities such as reading, studying, resting, watching TV, and computer use are included in sedentary behavior. A study reported that a long duration of screen viewing negatively affected cognitive skills and academic success[19]. However, due to the academic load, medical students are likely to study for most of the duration of time they spend in a sedentary manner. It is known that spending a long time studying and reading is associated with an increase in academic achievement[20].

Hemoglobin, which is associated with cognitive skills in terms of its content and function, has been reported to cause a 1.73 point decrease in IQ scores in case of 1 gr/dl decrease in its levels[21]. Thus, hemoglobin is a fundamental factor that can influence cognitive functions via IQ scores. However, our study population was students older than 18 who were medical students with a higer level of intelligence. In addition, low hemoglobin levels can cause stress, headaches, fatigue and hypoxia, and can consequently adversely affect physical endurance, immune responses, temperature regulation and energy metabolism. This in turn can reduce cognitive performance[22,23]. In the

literature, various studies usually comparing anemic and non-anemic student groups have reported hemoglobin level has a positive or null effect on academic achievement[24]. In our study, the hemoglobin levels of the vast majority of the students were within the normal range and we did not detect a relationship between academic achievement and hemoglobin levels. This result may be due to our focusing on an isolated student group such as medical students, or due to the fact that the impact of fluctuations observed in the normal hemoglobin concentrations on academic success are negligible.

Dietary nutrients can affect cognitive functions through many different mechanisms. The consumption of whole grains, dairy products and foods with high antioxidant content such as vegetables and fruits have been shown to yield beneficial effects on cognition and academic achievement[25,26]. In contrast, the "Western diet" rich in saturated fat and refined carbohydrates, has a negative effect on learning-memory[27]. In our study, there was no correlation between the consumption scores of the food groups and academic achievement in medical students. As a consequence of moving to other cities to study at university, students usually start to live apart from their families and their ongoing eating habits change dramatically. Therefore, it may be possible to observe cognitive changes depending on the consumption of food groups by planning more time-extended studies.

Today, the consumption of calorie-rich and nutrient-poor foods is rapidly increasing among children and youth. Thus, individuals who are uncertain about meeting their micronutrient needs by diet tend to use multivitamin-mineral supplements. A study reported that only the students whose diets had a low micro-nutrient content benefited from the micronutrient supplements[28]. Another study indicated these supplements were found to be ineffective on school performance[29]. Consistently, in our study, the use of vitamin supplements did not affect academic achievement. However, our study has some limitations in that the participants were not questioned if there was a micronutrient deficiency and neither were the contents of the vitamin preparations mentioned.

In our study, we did not detect a relationship between BMI and academic achievement in medical students. However, BMI is a limited method on its own. The determination of body fat ratio in addition to the calculation of BMI yields more reliable results. In the present study, no correlation was found between body fat and academic achievement, whereas male students with a high body fat ratio were more successful than the males in the normal range. In Turkey, the vast majority of students leave their homes to attend university and usually stay in student dormitories during the first years. Thus, they expereince difficulty in consuming sufficient and balanced nutrition. In this study, we observed that compared to female students, males insufficiently consume all food groups except meat products. This result supports the possibility of males being more affected by malnutrition during the university life adaptation phase. The possible explanation of our results may be that compared to malnutrition, excessive energy intake results in better consequences in terms of cognitive skills such as perception, learning and study performance. In accordance with our results, another study reported the increase in adiposity was associated with good nutritional status which was emphasized to be the main determinant of cognitive functions especially in low income countries[30]. In our study, according to the WHO classification of BMI, students with a high fat ratio belonged to the overweight category with the exceptance of 2 males who were considered obese. Since the participants' fat ratio distribution was within a restricted range, we were unable to find a correlation

between body fat ratio and academic achievement in medical students.

CONCLUSİON

In summary, while being male, smoking, coffee consumption and adding sugar to their drinks were detected to be some factors decreasing academic achievement, a moderate level of physical activity enhanced academic performance in medical students. However, the consumption frequencies of food groups, hemoglobin levels and BMI have been found to be ineffective on academic success. In addition, a possible explanation of the positive relationship between sedentary behavior and academic achievement might be due to the fact the time spent in a sedentary manner often corresponds to the time medical students allocate to studying. It should also be emphasized that these factors affect academic success of medical students in a gender-dependent manner. In this study, we generally evaluated "changeable" factors with the potential to affect academic achievement and based on these, we aimed to provide some recommendations to medical students. It is clear that, in additon to these factors, psychological, social and environmental factors also play important roles on academic success. Although a large number of factors were addressed in this study, further studies equipped with biopsychosocial factors are needed to elucidate all the determinants of academic achievement during medical school.

Our study has some limitations. Firstly, academic achievement was evaluated based on a single exam and this may not fully reflect overall success. Secondly, this study was implemented only among medical school students. Therefore, the results of this study cannot be generalized to encompass all undergraduate students. Thirdly, as it has a cross-sectional design, this study cannot reveal the cause-effect relationship. Fourthly, since the data on nutritional status and physical activity was collected by the survey method, bias probability cannot be excluded. The strength of this study is that it was implemented on a homogeneous student population including both genders.

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