



## The Effect of Consumption of Probiotics, Prebiotics and Physical Activity Level on the Quality of Sleep and Academic Achievement Among the University Students

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### ABSTRACT

Even though literature research focuses on the contribution of probiotics and prebiotics to body health, current studies show that they also have effects on mental health. In this study, it was aimed to examine the effects of consumption of probiotics and prebiotics and physical activity levels of university students on sleep and academic achievement. In the study, a survey which consists of socio-demographic information, National Health and Nutrition Examination Survey (NHANES), International Physical Activity Questionnaire (IPAQ) short form and Pittsburgh Sleep Quality Index (PSQI) short form were conducted on 241 university students studying in Konya. While there was an increase in academic achievement in male students as prebiotic consumption decreases ( $p=.013$ ), an exact opposite situation ( $p=.041$ ) was observed in female students based on research results. In both groups which consists of high and low achievement students, it was observed that there was an increase in the sleep quality of the individuals with a below average prebiotic consumption as the physical activity levels increased. In conclusion, effective methods should be developed by taking gender into account in order to improve the sleep habits and academic achievement of

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university students, and students should be encouraged to acquire the right habits.

**Keywords:** Probiotic, Prebiotic, Sleep, Academic Achievement

## Üniversite Öğrencilerinde Probiyotik-Prebiyotik Tüketimi ve Fiziksel Aktivite Düzeyinin Uyku Kalitesi ile Akademik Başarı Üzerine Etkisi

### ÖZ

Alan yazın araştırmaları probiyotik ve prebiyotiklerin beden sağlığına katkısına odaklansa da güncel çalışmalar zihinsel sağlık üzerine de etkilerinin olduğunu göstermektedir. Bu çalışmada üniversite öğrencilerinin probiyotik ve prebiyotik tüketimi ve fiziksel aktivite seviyelerinin, uyku ile akademik başarı üzerine etkisinin incelenmesi amaçlanmıştır. Çalışmada Konya’da okuyan 241 üniversite öğrencisine; sosyo-demografik bilgiler, Ulusal Sağlık ve Beslenme İnceleme Anketi (NHANES), Uluslararası Fiziksel Aktivite Anketi (IPAQ) kısa formu ve Pittsburgh Uyku Kalitesi İndeksi (PUKİ) içeren bir anket uygulanmıştır. Araştırma sonuçlarına göre erkek öğrencilerde akademik başarı artarken prebiyotik tüketimi azalmakta ( $p=.013$ ), kız öğrencilerde ise tam tersi bir durum ( $p=.041$ ) görülmektedir. Akademik başarısı düşük ve yüksek olan gruplarda, prebiyotik tüketimi ortalamanın altında olan bireylerin, fiziksel aktivite düzeyleri arttıkça uyku kalitelerinin de arttığı görülmüştür. Sonuç olarak üniversite öğrencilerinin uyku alışkanlıklarının ve akademik başarılarının iyileştirilmesi için cinsiyet de göz önüne alınarak etkili yöntemler geliştirilmeli ve öğrenciler, doğru alışkanlıklar kazanmaları için teşvik edilmelidir.

**Anahtar Kelimeler:** Probiyotik, Prebiyotik, Uyku, Akademik Başarı

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## INTRODUCTION

The term probiotic means “for life” (Net et al., 2014). Probiotics are microorganisms that are beneficial to the health of the host when taken in adequate amounts. Probiotics have positive health effects such as treating diarrhea, improving digestion, and reducing intestinal infections (Lee et al., 2021).

Prebiotics, on the other hand, act as nutrient for probiotics and other beneficial microorganisms in the intestines and nourish the intestines. It is known that the end products of prebiotics are short-chain fatty acids. Short-chain fatty acids get released into the blood and affect other tissues and organs as well (Davani-Davari et al., 2019). There is also evidence that prebiotics boost immunity, reduce blood lipid levels and improve mental health (Gibson et al., 2017).

Sleep is the process of temporary, partial and periodic loss of the organism’s communication with the environment in a reversible manner with stimuli of varying intensity. This process is the period of resting the body, repairing and renewing cells, promoting learning by regulating memory functions and preparing for a new day. Healthy sleep is an indispensable element of life (Emirza et al., 2012).

Sleep quality is affected by the individual’s age, gender, genetic background, physical activity during the day, presence of menopausal or pregnancy conditions, regular use of any medication, presence of a sleep partner, working hours, alcohol use and income status (Souza Lopes et al., 2012). Gender is an important factor to be considered when assessing sleep quality. Although the reason has not been fully explained, women state that they have more sleep problems despite sleeping more than men in total (Laposky et al., 2008). Furthermore, as the age of an individual increases, the time spent on sleep during the day decreases (Laposky et al., 2008).

It is known that if the physical activity of the individual is high during the day, the fatigue increases and the transition to sleep becomes easier with this situation (Laposky et al., 2008). However, there is also a general opinion that university students sleep insufficiently (Orzech et al., 2011).

Studies conducted by Mayda et al. on sleep quality in medical school students showed that more than half of the students did not have good sleep quality (Mayda et al., 2006). This view was also supported in another study conducted by Saygılı et al (Saygılı et al., 2011).

Another factor that affects sleep is the intestinal flora. Depletion of the intestinal microbiota can result in decreased sleep, suggesting that the intestinal flora is a source of sleep-inducing signals (Szentirmai et al., 2019). Changing the intestinal microbiota is now possible through dietary and non-dietary means (Orzech et al., 2011).

The relationship between sleep and intestinal microbiota is bidirectional. While the impairment of the microbiota causes sleep disorders, the disruption of sleep negatively affects the intestinal microbiome (Sen et al., 2021). In this bidirectional interaction process, it is stated that different mechanisms affect serotonin concentrations in the intestine (Sen et al., 2021). In a study conducted by Ogawa et al. on mice, they reported that the amount of serotonin decreased due to the change in the microbiota in the intestine of the mice with administration of antibiotics and caused a change in the NREM model (Ogawa et al., 2020).

In this study, it was aimed to determine the relationship between consumption of probiotics, prebiotics, physical activity level and sleep level, academic achievement.

## **METHOD**

### **Participants**

University students studying in Konya were included in this study. Individuals who used antibiotics within 2 weeks, followed an elimination diet, had lactose or gluten intolerance, had a vegan and vegetarian diet, and used probiotic supplements were not included in the study. A total of 361 students between the ages of 18-30 participated in the study, 120 students were not included in the study as they had exclusion criteria.

### **Measurement Tools**

The survey form includes information about socio-demographic information, probiotic-prebiotic food consumption status, Pittsburgh Sleep Quality Index, International Physical Activity Scale and general academic achievement score.

#### ***International Physical Activity Questionnaire (IPAQ) Short Form***

To measure the physical activity in the last 7 days, the adapted version of the IPAQ short form, which Özgür et al. conducted a validity and reliability study, was used (Öztürk, 2005). In the questionnaire, intense physical activity, moderate physical activity, walking and daily sitting duration of participants in the last week were questioned.

#### ***Pittsburgh Sleep Quality Index (PSQI)***

The questionnaire consists of a total of 24 questions. 19 of the questions were answered by the individual himself, and 5 of them were answered by the spouse or a friend of the individual. The Sleep Quality Index which determines the sleep quality of an individual consists of sleep duration, sleep latency, and factors that determine the frequency and severity of special sleep-related problems that affect the sleep quality. High PSQI scores indicate poor sleep quality.

#### ***National Health and Nutrition Examination Survey (NHANES)***

NHANES is a questionnaire used to collect information about the frequency of food consumption in the last 12 months. In this survey, it is questioned how often foods are consumed, but portion amounts are not questioned. Consumption frequency can be questioned by using 5 or 11 different consumption frequency options; however, in this study, the survey has 5 options; 2-3 times a day, once a day, 3-4 times a week, 2-3 times a month or less and I do not consume.

### **Procedure**

Approval for the study was obtained from the Necmettin Erbakan University, Meram Faculty of Medicine, Ethics Committee of Non-Pharmaceutical and Medical Device Excluded Research (Decision No.:2022/3649). As a result of the preliminary research conducted during the design and duration of the research, it was preferred to collect data with the online survey method (Google Forms), which is one of the primary data collection methods.

## Data Analysis

Descriptive statistics are indicated for all values. Categorical variables were represented by frequency and percentage. Numerical variables were shown as mean and standard deviation or median (25th percentile-75th percentile). In the analysis of numerical variables, 2-way or 3-way analysis of variance was used depending on the situation. Analyses were made with the Jamovi 2.3.13 software.  $p < .05$  was considered significant.

## RESULTS

91 male (38%) and 150 female (62%) students participated in the study. Demographic characteristics of the participating individuals are given in Table 1.

**Table 1.** Demographic Characteristics of Participants (N=241)

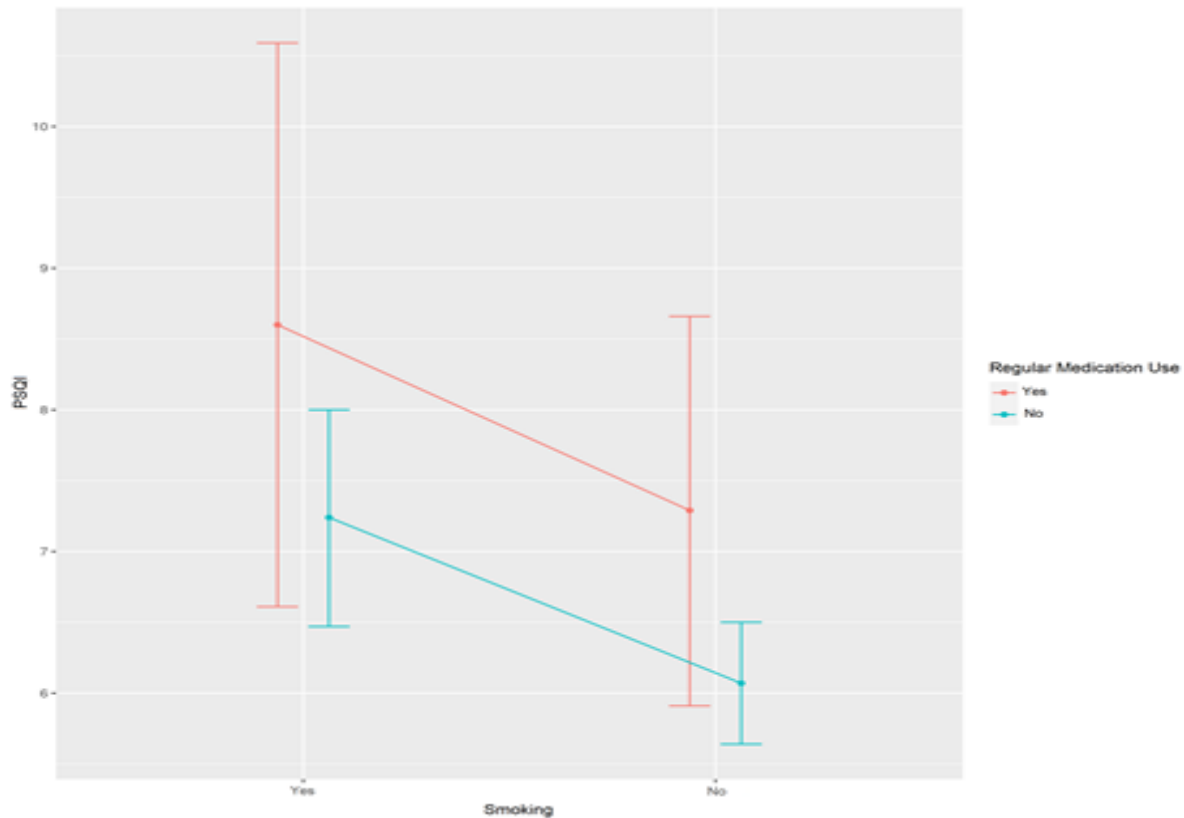
<b>Age (Mean)</b>	21.66 ± 2.19
<b>Gender</b>	
Female	150 (%62)
Male	91 (%38)
<b>Smoking Status</b>	
Non-Smoker	167 (%69)
Smoker	74 (%31)
<b>Use of Medication</b>	
Does Not Use Medication Regularly	205 (%85)
Uses Medication Regularly	36 (%15)

When consumption of prebiotics is analyzed in line with academic achievement and gender; it was found that as academic achievement increases, prebiotic consumption decreases in men, on the contrary, in women, as academic achievement increases, prebiotic consumption also increases (academic achievement-gender interaction effect  $p = .013$ , Table 2.). The relationship between prebiotic consumption, academic achievement and gender is given in Table 2.

**Table 2.** Prebiotic Consumption, Academic Achievement and Gender Relationship

<b>Gender</b>	<b>Academic Achievement (1.5-2.5)</b>	<b>Academic Achievement (2.5-3.5)</b>	<b>Academic Achievement (3.5-4.0)</b>
<b>Male</b>	2.92±1.7	2.59±2.24	1.49±0.77
<b>Female</b>	2.14±1.99	3.31±2.7	3.97±3.87*

When sleep quality and smoking and regular drug use were examined, it was found that PSQI was higher in regular medication users compared to non-users ( $p = 0.014$ ) and PSQI was higher in smokers than non-smokers ( $p = .018$ ) (figure 1). PSQI data on regular medication use and smoking are pointed out in Figure 1.



**Figure 1.** PSQI Relationship with Regular Medication and Cigarette Use

The relationship between probiotic consumption, physical activity levels and PSQI was examined with different academic achievement groups. Academic achievement-MET-probiotic interaction effect was found to be significant ( $p=.045$ ). In the analysis carried out to examine this interaction, it was determined that in the group with academic success between 1.5 and 2.5, sleep quality decreases as physical activity increases (as the MET score increases) in individuals whose probiotic consumption was one standard deviation below the mean, on contrary it has been determined that as physical activity increases, sleep quality also increases in the group which had one standard deviation above the mean.

In the group whose academic success is between 2.5-3.5, sleep quality decreases as physical activity increases in those whose probiotic consumption is 1 standard deviation below the mean. However, in the group whose probiotic consumption is 1 standard deviation above the mean, sleep quality increases as physical activity increases.

In the group with an academic success of 3.5-4, sleep quality decreases as physical activity increases in individuals whose probiotic consumption is 1 standard deviation below the mean. While in individuals whose probiotic consumption is 1 standard deviation above the mean, sleep quality increases as physical activity increases. In brief, it has been determined that the relationship pattern between physical activity and sleep quality in individuals with an academic achievement of 2.5-3.5 is different from the other two academic achievement groups.

The relationship data between academic achievement, probiotic consumption, MET scores and PSQI values are shown in Table 3.

**Table 3.** Relationship Between Academic Achievement, Prebiotic Consumption, MET scores and PSQI

	<b>Academic Achievement (1.5-2.5)</b>	<b>Academic Achievement (2.5-3.5)</b>	<b>Academic Achievement (3.5-4.0)</b>
<b>PSQI</b>	6.56±2.96	6.57±2.83	6.97±3.07
<b>MET</b>	2202.00 (1201.50- 3887.25)	2466.00 (1519.50-4677.25)	1926.00 (1284.38-3193.88)
<b>Prebiotics</b>	1.82 (1.06-3.24)	2.58 (1.57-4.08)	3.28 (1.64-4.14)
<b>Probiotics</b>	.08 (.08-.46)	.16 (.08-.66)	.08 (.08-.68)

## DISCUSSION

Microorganisms living in the gastrointestinal tract have an important place in the development and functioning of the physiological process (Cerdo et al., 2017). Recent studies have focused specifically on the relationship between gut and brain (Lew et al., 2019). In human studies, gut microbiota interventions appear to improve cognitive performance. In a 12-week randomized controlled trial by Lew et al., it was observed that probiotic intake improved verbal learning, cognition, and memory (Horasan et al., 2021). Increasing cognitive performance has an importance especially in school-age individuals.

In the studies conducted by Horasan et al. to determine the probiotic knowledge levels and consumption status of university students, it was reported that female students consumed higher probiotic foods than male students (Derin & Erdem, 2018). Similarly, in a study conducted by Derin and Erdem, it was revealed that female university students consume more probiotic-containing foods than male university students (Derin & Erdem, 2018).

Although there is not enough study in the literature on prebiotics in this sense, it has been observed that the effect of prebiotic consumption on academic achievement is similarly related to gender in this study. While prebiotic consumption in men is inversely related to academic success, prebiotic consumption in women is directly related to academic success.

Sarı et al., in their study examining the factors affecting the sleep quality of university students staying in dormitories using PSQI, reported that the sleep quality of the group with medication use was worse than the group with no medication use (Sarı et al., 2015). Arslan et al., in their study with university students in 2020, again supported the result of our current study, and stated that the sleep quality of those who do not use medication is better (Arslan et al., 2020). The literature findings support our study.

Smoking is known to cause sleep disturbance (Purani et al., 2019). In the study of Şenol et al., sleep quality of adolescents who smoke was found to be significantly lower (Senol et al., 2012). In the study of Saygılı et al., in which they examined sleep and fatigue in university students, it was also reported that the sleep quality of smokers was poor and that of non-smokers was good (Saygılı et al., 2011). Furthermore, it was observed that there was a significant relationship between cigarette consumption and fatigue. Similarly, in our study, it was found that the sleep quality of smokers was low. These results show that smoking cessation interventions may be important for sleep quality and to prevent adverse conditions caused by sleep disorders.

According to our findings, it was noted that among the students who are considered to be academically unsuccessful with below the average prebiotics consumption, sleep quality decreases as physical activity increases. In contrast, it was determined that the sleep quality of individuals with a higher than the average consumption of prebiotics increases as their physical activity increases. It has been determined that this situation is also valid for students who are considered to be academically successful.

This is the first study to examine the effects of university students' probiotic and prebiotic consumption and physical activity levels on academic achievement and sleep. In the results of the study, it was seen that the relationship between consumption of prebiotics and academic achievement is related to gender. It was concluded that as the academic achievement increases in female students, prebiotic consumption also increases, but not in male students, on the contrary, it decreases. The effect of gender should not be ignored in future studies to be made on sleep, nutrition and academic achievement in university students.

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