ORIGINAL ARTICLE

AHI EVRAN MEDICAL JOURNAL
E-ISSN: 2619 - 9203

The Relationship Between Physical Activity and Cognition in Kırşehir Ahi Evran University Medical Faculty Students

Kırşehir Ahi Evran Üniversitesi Tıp Fakültesi Öğrencilerinde Fiziksel Aktivite ve Biliş Arasındaki İlişki

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ÖZ

Amaç: Tıp Fakültesi eğitiminin zorluğu ve yoğunluğu nedeniyle tıp öğrencilerinde sedanter yaşam görülmektedir. Farklı metodolojik çalışmalarda görüldüğü gibi, fiziksel aktivite bilişsel işlevleri etkiler. Bu çalışmaların çok azı gençlikle ilgilidir. Bu nedenle tıp fakültesi öğrencilerinin fiziksel aktivite ve bilişsel parametrelerini ve birbirleri ile olan ilişkilerini kesitsel bir çalışmada analiz etmeyi amaçlandı.
Araçlar ve Yöntem: Çalışmaya bir tıp fakültesinin tüm sınıflarından 138 öğrenci dahil edildi. Tıp öğrencileri üç ölçeği tamamladı. Fiziksel aktivite IPAQ-SF ile belirlendi. Bilişsel değişkenler otonom öğrenme ve bilişsel esneklik ölçeği ile ölçüldü.
Bulgular: Sonuçlar, toplam, şiddetli ve orta düzeyde fiziksel aktivitenin kız ve erkek öğrenciler arasında önemli ölçüde farklılık gösterdiğini ortaya koydu. Benzer şekilde, öğrenmenin bağımsızlığı da doğumda atanan cinsiyetten etkilenmiştir. İlk üç sınıf öğrencilerinin bilişsel esneklik puanları son üç sınıf öğrencilerine göre daha yüksekti (p=0.001). Bilişsel esneklik tıpta yıllar içinde azaldı.
Sonuç: Korelasyon analizine göre fiziksel aktiviteler ile bilişsel işlevler arasında anlamlı bir ilişki olmadığı sonucuna varılmıştır. Tıp eğitimi ve fiziksel aktivitelerde etkinliği çok fazla araştırmaya konu olmayan otonom öğrenme ve bilişsel esneklik gibi bilişsel işlev çalışmaları gelecekte daha fazla araştırılmalıdır.

Anahtar Kelimeler: bilişsel esneklik; egzersiz; otonom öğrenme

ABSTRACT

Purpose: Due to the difficulty and intensity of medical school education, medical students often lead a sedentary lifestyle. As seen in different methodological studies, physical activity affects cognitive functions. Few of these studies are related to youth. Therefore, we aimed to analyze medical students physical activity and cognitive parameters and their association between each other in cross sectional study.
Materials and Methods: 138 students from all classes of a medical faculty were included in the study. Medical students completed three scales. Physical activity was determined by the IPAQ-SF. Cognitive variables were measured by autonomous learning and cognitive flexibility scale.
Results: The results revealed that total, vigorous and moderate physical activity differed significantly between female and male students. Similarly independence of learning was influenced by sex assigned at birth. First three years students' cognitive flexibility scores were higher than last three year ones (p=0.001). Cognitive flexibility has decreased over the years in medicine.
Conclusion: According to the correlation analysis reported in the study, there was no conclusive link between physical activity and cognitive abilities. Cognitive function studies such as autonomous learning and cognitive flexibility, whose effectiveness has not been the subject of much research in medical education and physical activities should be investigated more in future.

Keywords: cognition; medical students; physical activity

Received: 28.05.2023; Accepted: 29.11.2023

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How to cite: Koçak S, Çalışkan H, Karakullukçu S, Pektaş F. The relationship between physical activity and cognition in kırşehir ahi evran university medical faculty students. Ahi Evran Med J. 2024;8(1):85-93. DOI: 10.46332/aemj.1303657

INTRODUCTION

Humans have led a life that includes compulsory physical activity alongside hunger and satiety cycles historically. Mankind encountered a less active life with the mechanization brought by the industrial revolution. Furthermore environmental conditions and lifestyle have changed dramatically with the technological revolution.[1] Physical inactivity is admitted a risk factor leading to the formation of chronic and psychological diseases in today's societies.[2] According to the WHO's 2004 report, Around 3.2 million individuals die each year from physical inactivity, the fourth most important risk factor for mortality.[3] In Turkey, sedentary lifestyle is gradually increasing. The rate of people over 19 years of age with a sedentary lifestyle is 39.9% according to the Turkey Nutrition and Health Research reports made in 2017.[4] While physical inactivity has increased in university students and medical students as there are closures worldwide during the pandemic, no different situation has been observed in Turkey.[5]

When cognitive flexibility is defined psychologically, it can be considered as the ability to change one's behavior and strategy in changing situations and conditions.[6] The neuropsychological definition of cognitive flexibility, on the other hand, can be counted as a concept in which executive functions such as problem solving skills, coping with stress for problem solving and decision making are carried out in higher brain regions such as lateral, medial prefrontal and anterior cingulate cortex, where cognitive processes are dynamically changed and activated.[7] Medical education is an integrated system consisting of many sub-branches. Medicine and sub-branches of medicine, such as physiology, are called ill-structured domains. In medical education, students can be successful by combining and interpreting the information they have learned from different branches. Therefore, a medical student should have a certain cognitive flexibility in order to be successful.[8]

Autonomous learning is the process of organizing, planning and taking action for learning activities by taking control and responsibility People who have gained autonomy in learning actually develop their cognitive flexibility by questioning their methods and applying the techniques to the situation in order to overcome optimal difficulties in education.[9] Face-to-face education was discontinued during the pandemic. Therefore, autonomous learning has become a more important skill in the COVID-19 era[10] Students have the opportunity to study more autonomously with the web-based learning policies developed in this process.[11] However, during the pandemic process, distance education had disadvantages as well as advantages in terms of autonomous learning. While students with strong self-learning skills were comfortable studying from home, education was insufficient for these low-skilled students. Thus, the value of autonomous learning to promote student development in medical education was once again understood.

Research on the relationship between physical activity and cognitive abilities has been conducted in clinical populations and healthy humans.[11] In many studies, cognitive functions have been evaluated using neuropsychological tools.[12,13] Few of these studies are related to youth groups.[14] Therefore, young medical students were selected in present study. Our research was aimed to question the relevance of physical activity and cognitive functions in medical students, and to analyse the relationship between physical activity and cognitive functions.

MATERIALS and METHODS

Design

This cross-sectional study, which analysed physical activity and cognitive abilities, was carried out in a medical school in Turkey. While International Physical Activity Questionnaire Short Form (IPAQ-SF) was used for physical activity, autonomous learning and cognitive flexibility scales were used for cognitive functions.

Participants

The study included all medical students in the academic year 2021-2022 at Kırşehir Ahi Evran University. The sample of study was 138 medical students comprised of 87 female (%63) and 51 male (%37). We wanted to include all classes in faculty, therefore there were no exclusionary requirements. Our study was reviewed and approved by the Non-Interventional Clinical Research Ethics Committee of Kırşehir Ahi Evran University Faculty of Medicine (dated 22.03.2022 and numbered 2022/06-58). Participants were included from all six classes. We used and analyzed all factors that would affect the results of the data in socio-demographic questions and scales.

G-Power 3.1 program was used to calculate the sample size. The total sample size was found to be 134 via considering the effect size as 0.3, alpha err prob as 0.05 and power as 0.95. Therefore, 138 students who volunteered to participate in the study were included.

Web-based surveys were distrubuted to the students in medical faculty via WhatsApp or e-mail for data collection using Google forms. Students were required to sign a consent form that detailed the study and stated that they were free to reject to participate. Then, students filled out demographic questionnaire as well as the other scales. Participants were given a WhatsApp and e-mail contact to use throughout the research in order to contact the study team with any questions or issues.

Ouestionnaires

Demographic Questionnaire: This questionnaire was developed for this study to gather demographic information and self-reported daily life information. The questionnaire includes factors that could affect their cognitive performance and/or physical activity like age, sex assigned at birth, classes, health and medical conditions, including the usage of mental medications and marital status. Body mass index (BMI) was calculated using height and weight values (weight in kilograms divided by height in meters squared).

International Physical Activity Questionnaire (Short Form): In our study, a The international physical activity questionnaire with Turkish validity and reliability was used.[15] The short form of questionnaire was used. The questionnaire's goal is to find out how much healthy adults and youth exercised throughout the previous seven days. The questionnaire consists of 7 questions. The questionnaire asks how much time was spent doing walking, moderate physical activity, and vigorous physical activity. Time spent sitting is considered as a separate question. Responses were translated to metabolic equivalent task minutes per week (MET-min/wk), using the IPAQ scoring method. For the analysis of IPAQ data, the following values were used: 3.3 METs for walking, 4.0 METs for moderate physical activity, and 8.0 METs for strenuous physical activity. According to the formula, the amount of physical activity was calculated using the collected data.

An average MET score was calculated for each type of activity. The formula was created by multiplying the activity's minutes, days, and METs. Physical activities were also divided into three categories: low, moderate, and high levels of physical activity. Low physical activity refers to a lack of or insufficient physical exercise to fall into categories 2 or 3. Moderate physical activity refers to moderate-intensity, or vigorous-intensity activities attaining a minimum of 600 MET-min/wk. High physical activity is defined as activities of moderate to vigorous intensity that total at least 3.000 MET-min per week. Calculation of the total score includes the sum of walking, moderate-intensity activity and vigorous activity over minutes and days.

Autonomous Learning Scale: The Autonomous scale adapted to Turkish by Arslan and Yurdakul was conducted in this study.[16] The scale measures independent learning and study habits on two separate subscales. Items are graded on a Likert scale of 1 to 5, with 1 being the most unlike me and 5 being the most like me. Two items were worded negatively to help participants avoid response bias. The range of possible scores on the scale is between 12 and 60. Higher scores indicate greater autonomy, independence, and a favorable attitude toward learning.

Cognitive Flexibility Scale: Celikkaleli conducted validity and reliability assessments on the Turkish version of Cognitive Flexibility scale.[17]There are a total of 12 items on the scale. It is a 6 point Likert scale. (1) I do not participate at all, (2) I do not participate, (3) I do not attend, (4) I participate a little, (5) I participate, and (6) I definitely participate are scale responses. The range of possible scores on the scale is between 12 and 72. Scores that are higher reflect better cognitive flexibility.

Statistical Analysis

Following the IPAQ's guidelines for measuring physical activity based on MET, we calculated the total METs equal to a week. The formula was:

Total Physical Activty: 3.3 MET for walking X minutes X days +4.0 MET for moderate activity X days X minutes + 8 MET for vigorous activity X minutes X days.

All statistical analyses were carried out using SPSS 22.0. In the descriptive statistics of the evaluation outcomes, numerical variables were expressed as mean and standard deviation, while categorical variables were expressed as number and percentage. In the analysis of the research data, descriptive data were expressed as number, percentage, mean, and standard deviation. The Mann Whitney U test was used to analyze numerical variable comparisons between two independent groups. When three or more independent groups were compared, Kruskal Wallis test was used. To compare qualitative data, chi-square analysis was performed. The correlation analysis (Spearman) was conducted to examine the extent of correlations among physical activity level, autonomous learning and cognitive flexibility. Statistical alpha significance level was accepted as p<0.05.

RESULTS

Sociodemographic Characteristics of Medical Students

The distribution of students across different educational years, as well as variances in demographics and body composition factors, are shown in Table 1. %63 of 138 students were female and %29.7 of 138 students' age were 21-22. %65.2 students' BMI was normal. Most of the students (%44.2) were first-year students. %37.7 students were living with family. In terms of health and medical issues, 12 of all students (%8.7) reported psychiatric disorder that could affect their cognitive performance. 8 of 138 students reported using psychiatric medication.

Assesment of Physical Activity

The distribution of the students in the study according to their physical activity levels is as follows: 43 students (%31.1) were low active, 60 students were moderate active (%43.4) and 35 students were highly active (%25.3). Figure 1 shows students by physical activity level.: The amount of physical activity for the individual was categorized as follows: Low: when MET-minutes per week are less than 600; Moderate: when the MET-minutes per week are between 600 and 1500; and High: when MET-minutes per week are greater than 1500.[18]

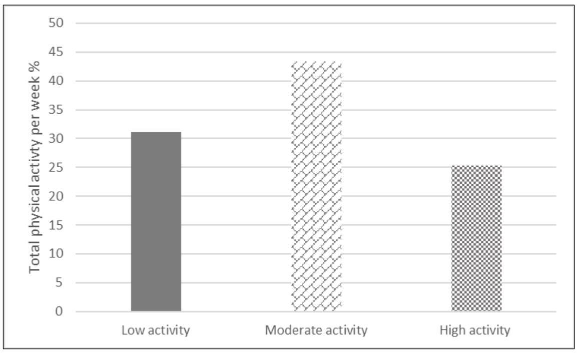

Figure 1. Total physical activity per week %.

Table 1. Sociodemographic Characteristics of Medical Students.

Sociodemographic Variable		
Age	**N**	**Percentage (%)**
17-18	17	12.3
19-20	49	35.5
21-22	41	29.7
23+	31	22.5
Gender		
Female	87	63
Male	51	37
Body Mass Index (BMI)		
Underweight	17	12.3
Normal	90	65.2
Overweight	23	16.7
Obese	8	5.8
Years		
Year 1	61	44.2
Year 2	26	18.8
Year 3	17	12.3
Year 4	10	7.2
Year 5	12	8.7
Year 6	12	8.7
Marital Status		
Single	102	73.9
Single (Partnered)	36	26.1
Monthly Allowance (Turkish lira)		
Less than 4000	98	71
4001-6000	8	5.8
6001-8000	8	5.8
8001-10000	14	10.1
10001+	10	7.2
Living situation		
Alone	16	11.6
With friends	25	18.1
With family	52	37.7
Student accomodation	45	32.6
History of a chronic disease		
Yes	12	8.7
No	126	91.3
History of a psychiatric disorder		
Yes	12	8.7
No	126	91.3
History of a psychiatric drug		
Yes	8	5.8
No	130	94.2
Smoking		
Smoking	29	21
Never smoked	93	67.4
Previously smoked	16	11.6
Alcohol Consumption		
Yes	29	21
Never	100	72.5
Withdrawn	9	6.5

*Mann-Whitney U test

Assessment of Physical Activity Parameters According to Sex Assigned at Birth and Years

Differences in physical activity were analyzed for sex assigned at birth. Total, vigorous and moderate physical activity differed significantly between female and male as Table 2 shows. Walking and sitting parameters did not change according to sex assigned at birth (p=0.519 and p=0.149 respectively). Male students' BMI was higher than female students' (p<0.001). Average BMI scores of students were normal according to the World Health Organization obesity classification.

Table 2. Physical activity parameters according to years and sex assigned at birth.

Variables	Total Group (n=138)	Female (n=87)	Male (n=51)	p*	1-3 Years (n=104)	4-6 Years (n=34)	p*
BMI	22.6±4.0	21.4±3.6	24.5±4.1	<0.001	22.4±4.0	23.2±4.2	0.222
Total Physical Activity (MET-min/wk)	1292.8±1335.6	1029.7±1002.7	1741.5±1683.0	0.003	1314.6±1394.3	1226.0±1153.9	0.676
Vigorous Physical Activity (MET-min/wk)	317.1±821.0	191.7±531.8	531.0±1134.3	0.003	313.1±883.8	329.4±600.1	0.013
Moderate Physical activity (MET-min/wk)	233.2±471.8	150.2±362.3	374.9±593.1	0.01	238.3±503.8	217.8±363.0	0.18
Walking (MET)	743.0±729.3	687.8±691.4	837.2±787.9	0.519	764.0±718.8	678.8±768.2	0.103
Sitting (hour/day)	4.7±5.2	4.2±5.0	5.5±5.4	0.149	5.0±5.4	3.7±4.4	0.228

*Mann-Whitney U test

The first three years are typically theoretical, with the following three years consisting of practical/clinical rotations in medicine. Pre-clinical years spend most of time in the classroom. No difference was seen although expecting students to be highly active during clinical rotations according to total, moderate physical activity levels, sitting and walking parameters. Vigorous physical activity levels were higher in 4-6 years (p=0.013). Table 2 indicates the reported level of students' physical activity.

Assessment of Autonomous Learning and Cognitive Flexibility According To Sex Assigned At Birth, Years, Living With Psychiatric Disorder, Terms and Marital Status

The 12-item Autonomous Learning Scale has two subscales that assess study habits and independence of learning. Sex assigned at birth did not influence autonomous learning and cognitive flexibility scores. Independence of learning was influenced by it. Male independent of learning scores were higher than female ones (p=0.045). Study habbits was not influenced by sex assigned at birth. Lectures and laboratory activities are mixed during the first three years of medical school. Medical students are preoccupied with a massive amount of knowledge that they study in 3 years. Busy syllabus in pre-clinical years can influence cognitive flexibility. First three years students' cognitive flexibility scores were higher than last three year ones (p=0.001). Medical education years effected cognitive flexibility scores. Cognitive flexibility has decreased over the years in medicine. Table 3 indicates autonomous learning and cognitive flexibility scores according to sex assigned at birth and years.

After analyzing autonomous learning scores for sex assigned at birth (p=0.096), 3- year terms (p=0.759) and years of medical students (p=0.824), there were no significant effects of these parameters on autonomous learning. Likewise, types of living situation did not effect autonomous learning (p=0.774). No relationship was found between history of a physchiatric disorder and autonomous learning (p=0.427).

Table 3. Autonomous Learning And Cognitive Flexibility according to Gender and Years.

Variables	Total (n=138)	Female (n=87)	Male (n=51)	p*	1-3 Years (n=104)	4-6 Years (n=34)	p*
Autonomous Learning	40.1±10.9	41.6±9.7	37.6±12.5	0.096	40.0±10.8	40.6±11.5	0.759
Independence of Learning	24.4±6.4	25.4±5.7	22.7±7.3	**0.045**	24.5±6.3	24.1±6.9	0.825
Study Habits	15.7±5.1	16.2±4.7	14.9±5.7	0.238	15.5±5.1	16.5±5.2	0.304
Cognitive Flexibility	47.5±10.5	48.4±10.6	46.0±10.1	0.112	49.1±10.4	42.8±9.5	**0.001**

*Mann-Whitney U test

Correlation Between Physical Activity, Autonomous Learning and Cognitive Flexibility

Data revealed the links between students' physical activity, autonomous learning and cognitive flexibility. The findings of the correlation study revealed a weak negative association between walking and autonomous learning. Similarly, there is a weak correlation between independence of learning and walking. Moreover, no correlation was found between cognitive flexibility and physical activity levels. BMI did not effect physical activity levels. Autonomous learning independence of learning and study habits were found to have positive strong relationship. There was no correlation between autonomous learning and cognitive flexibility. Total physical activity levels were positively related with vigorous and moderate physical activities and walking. Table 4 indicates correlation analysis of physical activity and cognitive functions.

Table 4. Correlation between Physical Activity, Autonomous Learning and Cognitive Flexibility.

Variables	BMI	Total Physical Activity	Vigorous Physical Activity	Moderate Physical Activity	Walking (MET)	Sitting (hour/day)	Autonomous learning	Independence of learning	Study habits
BMI	-	-	-	-	-	-	-	-	-
Total Physical Activity (MET)	r= 0.167 p= 0.050	-	-	-	-	-	-	-	-
Vigorous Physical Activity (MET)	r= 0.099 p= 0.250	**r= 0.546** **p= <0.001**	-	-	-	-	-	-	-
Moderate Physical Activity (MET)	r= 0.030 p= 0.723	**r= 0.455** **p= <0.001**	**r= 0.515** **p= <0.001**	-	-	-	-	-	-
Walking (MET)	r= 0.093 p= 0.276	**r= 0.676** **p= <0.001**	r= 0.003 p= 0.972	r= -0.092 p= 0.285	-	-	-	-	-
Sitting (hour/day)	r= -0.002 p= 0.986	**r= 0.234** **p= 0.006**	r= -0.077 p= 0.369	r= 0.028 p= 0.747	**r= 0.267** **p= 0.002**	-	-	-	-
Autonomous learning	r= 0.023 p= 0.787	r= 0.044 p= 0.611	r= -0.048 p= 0.573	**r= -0.191** **p= 0.025**	**r= 0.190** **p= 0.025**	r= 0.048 p= 0.574	-	-	-
Independence of learning	r= 0.048 p= 0.576	r= 0.061 p= 0.480	r= 0.061 p= 0.480	r= -0.149 p= 0.082	**r= 0.207** **p= 0.015**	r= 0.007 p= 0.937	**r= 0.915** **p= <0.001**	-	-
Study habits	r= 0.029 p= 0.736	r= 0.024 p= 0.779	r= -0.006 p= 0.944	**r= -0.178** **p= 0.037**	r= 0.144 p= 0.092	r= 0.037 p= 0.671	**r= 0.926** **p= <0.001**	**r= 0.725** **p= <0.001**	-
Cognitive Flexibility	r= -0.113 p= 0.188	r= 0.035 p= 0.688	r= -0.144 p= 0.093	r= -0.058 p= 0.501	r= 0.161 p= 0.059	r= 0.061 p= 0.476	r= 0.036 p= 0.672	r= 0.119 p= 0.164	r= -0.058 p= 0.500

* Spearman test.

DISCUSSION

The relationship between exercise and medical students' cognitive abilities was analysed in this study. However, research on physical activity's effect on medical students' cognition and mediating roles of demographic parameters are limited. Our results not only expand the relationship between physical activity and autonomous learning and cognitive flexibility over previous studies[19] but also provide indirect evidence by explaining some of the variables about them.

Out of all, 43 (%31.1) were inactive, 60 (%43.4) active and 35 (%25.3) more active than normal. Medical students in our sample tended to be active type. In a study conducted with Turkish medical students, the rate of active students was found to be %75.1,[20] while the rate of active students was found to be %50.3 in another study.[21] The percentage of active students in our study remains low compared to other studies.

When we evaluated the physical activity parameters according to sex assigned at birth, total physical activity, vigorous physical activity and moderate physical activity values were higher in male students. Female students were %69 less active than male ones (1029.7 and 1741.5 MET-min/wk.).Women participate in physical activity at lower rates than men. In this case, gender-specific psychosocial factors are effective like self-efficacy, social support, and motivation.[22] More studies are needed to address gender-specific psychological and social aspects of physical activity motivations in medical students.

There are studies in medicine on autonomous learning or cognitive flexibility.[23-25] To the best of our knowledge, there are no studies evaluating autonomous learning and cognitive flexibility in medical students. There may be significant individual variability in tasks related to cognitive flexibility and autonomous learning. Derrick et al. emphasized that demographic factors like gender and are crucial factors to take into account in autonomous learning.[26] When the autonomous learning and cognitive flexibility values were analyzed in our study, no statistically significant sex assigned at birth difference emerged.

One of the striking results of our research is that independence of learning scores of female students is higher than male students. Various predictors underlie the gender difference in independent learning. While only self-efficacy was a predictor for female students, these predictors were more in male students like study time, active learning strategies, performance goal and self-efficacy.[27] Although it was not measured by any scale in our study, it is thought that the self-efficacy of female students is higher.

Social and emotional changes occur in lives and young people develop mechanisms that require adaptation with the transition to a professional career in adolescence and young adulthood. Therefore, young people's cognitive flexibility may provide some advantages.[28] Some of past researches indicate that cognitive flexibility declines with age.[29,30] Some of them indicates that cognitive flexibility was not affected by age.[31] Although there is no significant difference in cognitive flexibility values between ages, a decrease is observed. This may be due to the small difference between age groups. When the pre-clinical and clinical periods were evaluated in our study, years 4-6 students were less flexible than years 1-3 students. The level of cognitive flexibility is also affected by the fact that people are experts in their subjects. The degree of specialization and cognitive flexibility are inversely correlated. As a person specializes, the ability to adapt to new situations and develop different approaches to similar problems, in short, decreases cognitive flexibility.[32] It can be predicted that the same situation may occur in the education phase. In the pre-clinical years, ideas for specialization may also be formed, and the orientation to internships in the subject of specialization may increase.

Considering other parameters affecting cognitive flexibility, psychiatric diseases come to the fore in the literature.[33] Recent studies revealed that there was a lack of cognitive flexibility in different psychiatric disorders like major depressive disorder,[34] obsessive-compulsive disorder[35] and schizophrenia.[36] Cognitive flexibility scores of students with psychiatric disorder were lower than those without, but this difference was not significant in our study. Similar results were also noted in autonomous learning in the present study. The number of students with psychiatric disorder was small. The small size of the group may affect the statistical result. Future studies about psychiatric disorders, cognitive flexibility and autonomous learning in young university students will increase further evaluations.

Emotional state is another parameter that affects cognitive flexibility. Indirect evidence suggests that emotional state influences cognitive flexibility.[37] Partnered students had lower cognitive flexibility scores than single students. The link between emotional states and cognitive processes may vary from person to person.

In our study, autonomous learning scores of students living alone and students living with other people were also compared. In this comparison, the lowest score was in the students living alone, and no statistically significant difference was found. Interaction of students with other people in their lives may affect their learning processes. Higher mental functions may have occurred as a result of students providing dynamic social interactions with their environment.[38]

There are few studies investigating the effect of physical activity on cognitive functions in university students, generally the studies were conducted with the elderly.[39] When the correlation analysis results are examined, we analyzed that there is no relationship between the physical activity levels of university students and their cognitive functions. Different exercise types don't affect cognition in a study conducted with adolescents. Reasons for this have been suggested as exercise intensity and timing of cognitive tests.[40] Another study supporting our results showed that both higher physical activity and lower sedantary behaviour have no effect on cognitive performance.[41] Uncorrelatedness between exercise and cognition has been hypothesized as an explanation that young age marks the brain's maximal development in regions associated to cognitive skills, making it impossible to acquire additional progress of these cognitive abilities.[42,43] Our results contradict a prior study conducted among university students, higher executive functions showed a correlation with physical activity.[19] Cognitive functions were better in active students and academic success was associated with cognitive decline in inactive students in another study conducted with medical and engineering students.[44] Magnon et al. emphasized that past sedantariness affects cognitive performance in university students.[45]

In present study it is unclear whether the inactivity of the physically inactive students is attributed to their lifestyle rather than their medical studies. No correlation was found between physical activity and cognition. In order to understand the inactivity of medical students, preventive interventions may be needed so that the student health problems related to inactivity can be overcome.

The present study was subjected to limitations. First, the data on physical activity and cognitive function was based on self-reports. The use of self-reports might have had an impact on the findings. Second, there may be pre-existing personal differences in cognitive and physical activity. Third, precise reasoning is difficult as we applied a cross-sectional study design.

In summary, The correlation study showed no evidence of a substantial association between physical activity and cognitive processes. Further research is needed to define the relationship between cognitive functions and physical activity in medical students.

Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

Acknowledgments

Presented at Europhysiology 2022, Copenhagen, Denmark (Poster number is B 03-29-L).

Ethics Committee Permission

Approval for this study was received from Kırşehir Ahi Evran University Non-Interventional Research Ethics Committee (dated 22.03.2022 and numbered 2022-6/58).

Authors' Contributions

Concept/Design: SK, FP, HÇ, SK. Data Collection and/or Processing: SK, FP, HÇ, SK. Data analysis and interpretation: SK, FP, HÇ, SK. Literature Search: SK, FP, HÇ, SK. Drafting manuscript: SDK. Critical revision of manuscript: HÇ, SK. Supervisor: SK, HÇ.

REFERENCES

1. Berkhout F, Hertin J. Impacts of information and communication technologies on environmental sustainability: Speculations and evidence. OECD: Brighton, UK, 2001.
2. González K, Fuentes J, Márquez JL. Physical inactivity, sedentary behavior and chronic diseases. Korean J Fam Med. 2017;38(3):111.
3. World Health Organization. The World health report: 2004: changing history, 2004.
4. Bakanlığı, TC Sağlık. Türkiye beslenme ve sağlık araştırması (TBSA) " Beslenme durumu ve alışkanlıklarının değerlendirilmesi sonuç raporu. 2019.
5. Bağcı TAB, Kanadıkırık A, Somyürek E, et al. Impact of COVID-19 on eating habits, sleeping behaviour and physical activity status of final-year medical students in Ankara, Turkey. Public Health Nutr. 2021;24(18): 6369-6376.
6. Ionescu T. Exploring the nature of cognitive flexibility. New Ideas Psychol. 2012;30(2):190-200.
7. Dajani DR, Uddin LQ. Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. Trends Neurosci. 2015;38(9):571-578.
8. Rhodes AE, Rozell TG. Cognitive flexibility and undergraduate physiology students: increasing advanced knowledge acquisition within an ill-structured domain. Adv Physiol Educ. 2017;41(3):375-382.
9. Tam M. Constructivism, instructional design, and technology: Implications for transforming distance learning. J Educ Techno Soc. 2000;3(2):50-60.

10. Ariebowo T. Autonomous learning during COVID-19 pandemic: Students' objectives and preferences. J. Foreign Lang. Teach. 2021;6(1):56-77.
11. Maru MG, Pikirang CC, Setiawan S, Oroh EZ, Pelenkahu N. The internet use for autonomous learning during COVID-19 pandemic and its hindrances. Int. J. Interact. Mob. Technol. 2021;15(18):65-79.
12. Ruet A, Brochet B. Cognitive assessment in patients with multiple sclerosis: From neuropsychological batteries to ecological tools. Ann. Phys. Rehabil. Med. 2020;63(2):154-158.
13. Chan AS, Shum D, Cheung RW. Recent development of cognitive and neuropsychological assessment in Asian countries. Psychol. Assess. 2003;15(3):257.
14. Ruiz-Hermosa A, Álvarez-Bueno C, Cavero-Redondo I, Martínez-Vizcaíno V, Redondo-Tébar A, Sánchez-López M. Active commuting to and from school, cognitive performance, and academic achievement in children and adolescents: A systematic review and meta-analysis of observational studies. Int. J. Environ. Res. Public Health. 2019;16(10):1839.
15. Saglam M, Arikan H, Savci S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. Percept. Mot. Skills. 2010;111(1):278-284.
16. Yurdakul C. An investigation of the relationship between autonomous learning and lifelong learning. Int. J. Educ. Res. 2017;2(1):15-20.
17. elikkaleli Ö. The Validity and Reliability of the Cognitive Flexibility Scale. Education & Science. 2014;176(3):339-346.
18. Schlickmann DW, Kock KS. Level of Physical Activity Knowledge of Medical Students in a Brazilian University. J Lifestyle Med. 2022;12(1):47-55.
19. Byrd-Bredbenner C, Quick V, Koenings M, Martin-Biggers J, Kattelmann KK. Relationships of cognitive load on eating and weight-related behaviors of young adults. Eat. Behav. 2016;21:89-94.
20. Dikmen AU, Altunsoy M, Koç AK, Eda K, Özkan S. Physical activity level of medical students: Is there a family effect? Arch. Med. Res. 2022;3(2):63-73.
21. Oğuzhan A, Girit Ç, Şennur K, Necdet S, Vardar SA. The relationship between chronotypes and physical activity in healthy young medical students. Turk. Med. Stud. J. 2018;5(2):24-27.
22. Edwards ES, Sackett SC. Psychosocial Variables Related to Why Women are Less Active than Men and Related Health Implications. Clin Med Insights Womens Health. 2016;9(1):47-56.
23. Meyerson SL, Odell DD, Zwischenberger JB, et al. The effect of gender on operative autonomy in general surgery residents. Surgery. 2019;166(5):738-743.
24. Coulson RL, Feltovich PJ, Spiro RJ. Cognitive Flexibility in Medicine: An Application to the Recognition and Understanding of Hypertension. Adv Health Sci Educ Theory Pract. 1997;2(2):141-161.
25. Houser MM, Worzella G, Burchsted S, Marquez C, Domack T, Acevedo Y. Wellness skills for medical learners and teachers: Perspective taking and cognitive flexibility. MedEdPORTAL. 2018;14:10674.
26. Derrick M, Rovai A, Ponton M, Confessore G, Carr P. An examination of the relationship of gender, marital status, and prior educational attainment and learner autonomy. Educ. Res. Rev. 2007;2(1):1-8.
27. Pirmohamed S, Boduszek D. Gender Differences in the Presence and Extent of Academic Motivational Attributes, Independent Study, and the Predictive Value on Achievement amongst University Students. Proceedings of International Academic Conferences.IISES.2015:2704648.
28. Crone EA, Dahl RE. Understanding adolescence as a period of social–affective engagement and goal flexibility. Nat. Rev. Neurosci. 2012;13(9):636-650.
29. Richard's MM, Krzemien D, Valentina V, et al. Cognitive flexibility in adulthood and advanced age: Evidence of internal and external validity. Applied Neuropsychology: Adult. 2021;28(4):464-478.
30. Wilson CG, Nusbaum AT, Whitney P, Hinson JM. Age-differences in cognitive flexibility when overcoming a preexisting bias through feedback. J Clin Exp Neuropsychol. 2018;40(6):586-594.
31. Fleming VB. Cognitive flexibility and spoken discourse in younger and older adults.Doctoral dissertation, University of Texas.2007.
32. Wu JS-T, Hauert C, Kremen C, Zhao J. A Framework on Polarization, Cognitive Inflexibility, and Rigid Cognitive Specialization. Front. Psychol. 2022;13:1386.
33. Snyder HR, Miyake A, Hankin BL. Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. Front. Psychol. 2015;6:328.
34. Stange JP, Alloy LB, Fresco DM. Inflexibility as a vulnerability to depression: A systematic qualitative review. Clinical Psychology: Science and Practice. 2017;24(3):245.
35. Gruner P, Pittenger C. Cognitive inflexibility in obsessive-compulsive disorder. Neurosci. 2017;345:243-255.
36. Koren D, Seidman LJ, Harrison RH, et al. Factor structure of the Wisconsin Card Sorting Test: dimensions of deficit in schizophrenia. Neurosci. 1998;12(2):289.
37. Vásquez-Rosati A, Montefusco-Siegmund R, López V, Cosmelli D. Emotional influences on cognitive flexibility depend on individual differences: A combined micro-phenomenological and psychophysiological study. Front. Psychol. 2019;10:1138.
38. Stubbé HE, Theunissen NC. Self-directed adult learning in a ubiquitous learning environment: A meta-review. Proceedings of the First Workshop on Technology Support for Self-Organized Learners.2008:5-28.
39. Erickson KI, Hillman C, Stillman CM, et al. Physical Activity, Cognition, and Brain Outcomes: A Review of the 2018 Physical Activity Guidelines. Med Sci Sports Exerc. 2019;51(6):1242-1251.
40. Van den Berg V, Saliasi E, De Groot RH, Jolles J, Chinapaw MJ, Singh AS. Physical activity in the school setting: Cognitive performance is not affected by three different types of acute exercise. Front. Psychol. 2016;7:723.
41. Golsteijn RH, Gijselaers HJ, Savelberg HH, Singh AS, de Groot RH. Differences in habitual physical activity behavior between students from different vocational education tracks and the association with cognitive performance. Int. J. Environ. Res. Public Health. 2021;18(6):3031.
42. Rezab S. Exercise and cognition in young adults. Psychological Sciences Undergraduate Publications, Presentations and Projects. 2015.
43. Salthouse TA, Davis HP. Organization of cognitive abilities and neuropsychological variables across the lifespan. Developmental Review. 2006;26(1):31-54.
44. Akram M, Ghous M, Tariq I, Khan H, Paracha M, Hussain B. The association between physical activity with cognitive and cardiovascular deconditioning in age related decline of college students. JPMA J Pakistan Med Assoc. 2018;68(12):1755-1758.
45. Magnon V, Vallet GT, Dutheil F, Auxiette C. Sedentary lifestyle matters as past sedentariness, not current sedentariness, predicts cognitive inhibition performance among college students: an exploratory study. Int. J. Environ. Res. Public Health. 2021;18(14):7649.