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HOW DO MEDICAL STUDENTS' CHRONOBIOLOGICAL TENDENCIES AND STUDY APPROACHES AFFECT ACADEMIC PERFORMANCE?

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Abstract. *Academic performance scores of medical students have been associated with many variables. Students' sociodemographic characteristics, study times and approaches may affect academic performance separately. Examining academic performance by considering all these variables together can improve medical education. The aim of this study is to determine whether there is a significant difference between the academic performance of medical faculty students in terms of study approaches, chronobiological patterns and socio-demographic features. In this cross-sectional study, data were collected from medical students. As data collection tools, Sociodemographic Data Form, The Revised Two Factor Study Process Questionnaire (R-SPQ2F) and Morning-Evening Questionnaire (MEQ) were used. A total of 163 sixth-year students (n=90) male and (n=73) female were included in the study. There was no significant difference between the gender of the students and their academic performance scores (p=0.880). Academic performance scores of morning type students were significantly higher than those of evening type students (p<0.05). There is a correlation of 0.521 in the same direction between the deep approach and the academic performance score, and this relationship is statistically significant (p<0.001). There is a negative correlation of 0.608 between the superficial approach and the academic performance score, and this relationship is statistically significant. While developing the program and curriculum in medical education, students' sociodemographic characteristics study approaches and chronobiological patterns should be taken into consideration.*

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1. INTRODUCTION

All living things have developed biological clocks by adapting their internal physiological processes to the environment in the most appropriate way. The circadian rhythm is the biological oscillations that occur in a daily cycle and can be characterized as the main biological clock that regulates these cycles of the organism (Julius et al., 2019; Roenneberg et al., 2008). It is stated that circadian rhythms that develop with the adaptive evolution of the organism are genetically transmitted (Kuhlman et al., 2018; Reinberg and Ashkenazi, 2003). Besides genetic factors, environmental factors affect each person's circadian rhythm and determine the individual's chronotype, which is manifested by morning or evening preference (Adan et al., 2012; Gentry et al., 2021). There is a circadian fluctuation called the “perfect storm” during puberty in humans, and it is stated that this chronobiological orientation becomes evident in the twenties (Panjeh et al., 2022).

Changes in the living conditions of the individual, who are in balance with 24-hour natural light cycles at normal times, cause phase mismatch and are associated with a number of health problems (Walker et al., 2020; López-Otín and Kroemer, 2021). In particular, people who live between time zones where artificial light is widely used and there are 24-hour uninterrupted jobs and social activities are often exposed to conditions where their internal circadian rhythms become incompatible with the light-darkness experienced (Kuhlman et al., 2018; Potter et al., 2016). In addition, modern technology such as electric lights emitting blue light and computer, tablet and phone screens, and lifestyles such as shift or irregular work schedules disrupt circadian coherence in humans (Smith et al., 2009).

Endogenous circadian rhythms are known to affect neurobehavioral functions, including physiological alertness and cognitive performance (Goel et al., 2013; Enright and Refinetti, 2017). Adan et al. (2012) stated that there is a time interval during the day when individuals have better cognitive performance and this is related to their chronobiological patterns.

As a matter of fact, students' chronobiological patterns and their performance in various fields have been the subject of research frequently (Gallego-Gómez et al., 2021; Mirghani, 2017). When the circadian fluctuation peaks are added to the university life, which means a new working environment and social environment, the academic performance of university students may be affected by this situation. Medical students go throughout a long training process with an intensive course in undergraduate education (Piumatti et al., 2021). Medical education, unlike other disciplines, is a process that requires students to be in a clinical environment at different times of the day in the last few years of their education. It is known that especially during clinical periods, medical students continue their shifts in the hospital (Shah et al., 2019).

In clinical settings, students have to both learn and perform their clinical duties (Nijhawan et al., 2021). In addition, students have to complete the criteria for graduation by

being evaluated with exams (Casey et al., 2009). The academic performance of medical students at graduation is usually determined after a long period of theoretical and practical training. Studies examining the academic performance levels of medical school students in terms of various factors have reported that academic performance is related to the timing of sleep and wakefulness (Al-Khani et al., 2019; Bahammam et al., 2012). According to Valdez (2019), cognitive performance varies throughout the day, and so a student cannot show the same learning performance during every study time. The study habits of students whose circadian cycles change according to the learning environment and material may also change. As a matter of fact, it is seen that the study habits of students in different periods can also change, and it is emphasized that each period should be evaluated within its own dynamics (Rehman et al., 2016; Shaik et al., 2017). These study approach changes that occurred in different periods may be affected by the chronobiological patterns of the students. Rather than looking at the situation simply as a performance score, it may be helpful to examine the relationship between study approaches and natural chronobiological patterns.

When the literature is examined, Akram et al. (2018) examined both study approaches and chronobiological patterns of medical students in the context of academic performance. They did not observe a direct effect of chronotype on academic performance but claimed that chronotype may have an indirect effect through learning approaches. Akram et al. did not take into account the effect of students' sociodemographic characteristics in their study. However, students' academic performance may be affected not only by these characteristics but also by some socio-demographic conditions, including their place of residence, interest and aspirations for medical school. As a matter of fact, Kiran and Javaid (2020) have associated the academic performance of medical students with many different factors such as staying in a dormitory, study habits, lack of sleep, and high parental expectations, which can cause more problems in terms of environment and distraction. Living alone at home, living in regular family life, or having to share a room with many other students can differentiate a student's approach to studying. In this context, the aim of this study is to examine all these factors and the academic performance score, and also to investigate how the chronobiological pattern of the students affects the study approach.

For this purpose, it is aimed to seek answers to the following **research questions**;

1. Is there a significant difference between the sociodemographic characteristics of medical students and their academic performance scores?
2. Is there a statistically significant relationship between the study approaches of medical students and their academic performance scores?
3. Is there a statistically significant difference between the chronobiological patterns of medical students and their academic performance scores?
4. Is there a statistically significant difference between the chronobiological patterns of medical students and their study approaches?
5. Are the medical students' study approaches and chronobiological patterns different based on their place of residence?

2. METHODS

2.1. Procedure

The study was planned as a cross-sectional study. Before starting the study, approval was obtained from Düzce University Faculty of Medicine Non-Interventional Health Research Ethics Committee (Protocol No: 2019/217).

2.2. Participants

The universe of the research consists of 176 six-year students, in our Faculty of medicine. There are a couple of reasons why six-year students are preferred in this study; with the pandemic, medical education has undergone a great change in all courses. All theoretical courses were given online in the preclinical period. Clinical semester students were not included in the rotations to avoid contact with the patient. In this case, it was thought that the assessment by dividing the students into periods would not yield very healthy results. Only six-year students participated in both education and clinical practices. For this reason, six-year students whose data can be collected more easily and whose academic performance can be evaluated according to the transcript value, which is the graduation degree, were found suitable for the study. The sample group of the research consisted of 163 students who voluntarily accepted to participate in the research and filled out the questionnaires completely. The purpose of the study was explained to the students who formed the sample group selected on a voluntary basis and their consent was obtained. The questionnaires and scales used for the data were distributed to the students by the researcher. The students, respectively; they were asked to fill out a questionnaire in which their socio-demographic characteristics were questioned, “The revised Two Factor Study Process Questionnaire (R-SPQ2F)’’ to determine their study habits, and the "Morning-Evening Questionnaire (MEQ)" to determine their chronobiological patterns. The data collection phase of the study lasted approximately 3 months.

2.3. Data Collection Tools

Sociodemographic data form

The socio-demographic data form consisting of questions was used in which the students were asked about age, gender, the residence of students, reason for choosing a medical school. The socio-demographic data collection questionnaire was tested with a pilot application of 20 people before starting the study.

The revised Two Factor Study Process Questionnaire (R-SPQ2F)

Students' study approach data were collected using the R-SPQ-2F questionnaire which was developed by Biggs et al. (2001). The scale consists of 20 questions, ten of which measure the superficial approach and ten of which measure the deep approach. In addition to deep and superficial approaches, surface motivation, deep motivation and surface strategy, and deep strategy sub-dimensions, each consisting of 5 items, were also defined in the scale. A 5-point Likert scale was used to evaluate the study approaches (1= never or only rarely true of me & 5= always or almost always true to me). The Turkish validation study of the original

scale was carried out. It has been determined that the Turkish scale validly measures which of the deep and surface study approaches students adopt (Yılmaz and Orhan, 2011).

Morning-Evening Questionnaire (MEQ)

In the study, MEQ was used to measure circadian phase preference due to its ease of application and use, and cost-effectiveness. The self-assessment morningness and eveningness questionnaire (MEQ) implemented in the present study was developed by Horne and Östberg (1976). MEQ has 19 multiple-choice questions with four to five options against each question and with a specific score for each option and these scores are from zero to six. The questionnaire used mostly consisted of subjective statements. The individual completing the questionnaire associates sleep and activity times with the best biological rhythm of personal emotions. MEQ scores range from 16 to 86, with higher scores reflecting a higher preference for dressing gowns and lower scores reflecting evening type. Individuals are distinguished into three chronotypes; Morning type (MT), Evening type (ET), and Neither type (NT) type, with this questionnaire. If the score obtained from the scale is between 59-86, the participant is considered as "Morning type". If the score is between 16-41, the participant is evaluated as "Evening type", and between 42-58 as "Neither type". Turkish validity-reliability studies of the scale were performed by Pünduk et al. (2005), and the Turkish version of the scale was found to be valid and reliable.

Academic performance

In this study, the academic performance scores of the students were determined as the overall grade point averages they received in the first five years. The first three academic years of the six-year undergraduate program in our Faculty of Medicine consist of preclinical lectures and laboratory practices. The academic year consists of seven modules in a year, and at the end of each module, a multiple-choice theoretical exam is given. At the end of each year, a final exam is also held, and the grade average of the exams held throughout the year is processed as the year-end grade. End-of-module exam questions are prepared with a question bank system, where each academician can enter with a special password. The Question Bank System has a dynamic structure that evaluates the measurement and evaluation quality of the questions at the end of each exam with feedbacks. In the fourth and fifth years, which are the clinical years, students take both theoretical and practical courses in clinical internships. At the end of each internship, the weighted average of the theoretical and practical exams is calculated for each student and is evaluated as the end-of-year grade. In the last year, medical students enter theoretical and clinical courses and practices. No exam or evaluation grade is given in the sixth year.

2.4. Statistical analyses

Appropriate descriptive statistics (mean, standard deviation, median, standard error, minimum, maximum, and percentage) of all data in the study were calculated. Kolmogorov-Smirnov/Shapiro-Wilk Test tests were used for the conformity of the variables to the normal distribution. For the variables found to fit the normal distribution; Student's t-Test was used to compare two independent groups, and ANOVA between three independent groups was used.

For the variables found to not fit the normal distribution; Mann-Whitney U Test or Kruskal Wallis Test was used as a statistical method. Pearson or Spearman's rho correlation coefficient was used in the relations between the variables. SPSS 22.0 program was used for statistical evaluations.

3. RESULTS

A total of 163 students (n=90) male and (n=73) female were included in the study. The mean age of the students included in the study was determined as 24.21±1.03 (min: 22.00, max: 29.00). The socio-demographic information of the students is given in Table 1.

Table 1. Socio-demographic information of the students

	Socio-demographic features	N(%)
Gender	Female	73 (44.8)
	Male	90 (55.2)
Reason for choosing a medical school	Professional interest and desire	85 (%52.1)
	Family request	27 (%16.6)
	Economic reasons	38 (%23.3)
	Others	13 (%8.0)
Residence of students	Student dormitory	33 (%20.2)
	Residence at home with friends	45 (%27.6)
	Residence at home with family	26 (%16.0)
	Alone at home	59 (%36.2)

There was no significant difference between the gender of the students and their academic performance scores (p=0.880). There was no significant difference between the students' place of residence, reasons for choosing a medical school and their academic performance scores (p=0.79, p=0.441, respectively).

The deep approach average score; 28.23±8.64, mean score of superficial approach; 28.66±9.24, deep motivation approach mean score; 14.09±4.47, mean score of deep strategy approach; 14.14±4.57, surface motivation approach mean score; 13.54±4.93, surface strategy approach mean score; it was determined as 15.12±4.67. When sub-dimensions of study approaches and academic performance are examined in detail according to the R-SPQ-2F questionnaire; A positive correlation of 0.512 was found between Deep Motivational and academic performance score, and this relationship was statistically significant (p<0.001). A same-sided relationship of 0.495 was found between the Deep Strategic approach and the academic performance scores, and this relationship was statistically significant (p<0.001). A negative correlation of 0.587 was found between the Superficial Motivational approach and the academic performance score, and this relationship was statistically significant (p<0.001). A negative correlation of 0.581 was found between the superficial strategic approach and the academic performance score, and this relationship was statistically significant (p<0.001).

There is a correlation of 0.521 in the same direction between the deep approach and the academic performance score, and this relationship is statistically significant (p<0.001). There is a negative correlation of 0.608 between the superficial approach and the academic performance score, and this relationship is statistically significant (p<0.001, Table 2).

Table 2. Correlation between students' study approaches and academic performance score

Study approaches	Academic performance score	P
Deep motivational	0.512*	**<0.001**
Deep Strategic	0.495*	**<0.001**
Surface Motivational	-0.587*	**<0.001**
Surface Strategic	-0.581*	**<0.001**
Deep approach	0.521*	**<0.001**
Surface approach	-0.608*	**<0.001**

* Correlation is significant at the 0.01 level (2-tailed)

When the chronobiological patterns of the students were evaluated with the morning and evening types scale, 39.2% (n=64) of the students were determined as evening type, 44.8% (n=73) as neither type, and 16.0% (n=26) as morning type. It has been determined that the academic performance score of the students who are evening-type is 65.55±6,436, the score of the academic performance of neither type students is 71.85±6.958, and the score of the academic performance of the students who are morning type is 74.54±4.536. There was no significant difference between the academic performance scores of morning-type students and the academic performance scores of neither type students (p=0.235). Academic performance scores of morning type students were significantly higher than those of evening type students (p<0.05). Academic performance scores of neither type students were found to be significantly higher than those of evening students (p<0.05). The chronobiological patterns and academic performance scores of the students are given in Table 3.

Table 3. Students' chronobiological patterns and academic performance averages

Chronobiological patterns	Students' academic performance averages	Comparison	P
Evening type	65.55±6.436 [64(60-89)]*	ET-NT	**<0.001**
Neither type	71.85±6.958 [72(60-85)]*	ET-MT	**<0.001**
Morning type	74.54±4.536 [75 (66-84)]*	NT-MT	0.235

* [median (min-max)]

When the chronobiological patterns of the students and their study approaches are evaluated together, the deep study approach scores of ET students were 23.33±7.31, the deep study approach scores of NT students were 30.08±7.47, and the deep study approach scores of MT students were 35.12±8.22. MT students adopted significantly higher deep study approach scores than ET students (p<0.001). It has been determined that the ET students also have significantly higher surface approach scores than the ET students (p <0.001, Table 4).

Table 4. Comparison of students' chronobiological patterns and study approaches point averages

Chronobiological patterns	***Students' deep study approach point averages***	***Comparison***	**P**
Evening type	23.33±7.31 [20.50 (11-40)]*	ET-NT	**<0.001**
Neither type	30.08±7.47 [29 (13-44)]*	ET-MT	**<0.001**
Morning type	35.12±8.22 [38 (18-44)]*	NT-MT	0.056
Chronobiological patterns	***Students' surface study approach point averages***	***Comparison***	**P**
Evening type	33.92±8.86 [36(13-45)]*	ET-NT	**<0.001**
Neither type	26.77±7.44 [26(13-46)]*	ET-MT	**<0.001**
Morning type	21.00±7.34 [20.5 (13-41)]*	NT-MT	**0.015**

* [median (min-max)]

There was no significant difference between the residence places of the students, their chronobiological patterns, and study approaches (p=0.168, p=0.126, 0.493, respectively).

4. DISCUSSION AND CONCLUSION

In this study, socio-demographic features, the effect of chronobiological patterns and study approaches on the academic achievement of grade VI students studying in the Faculty of Medicine were examined. In addition, it was investigated how the chronobiological pattern of the students affected their study approach.

In the present study, it was determined that the academic performance of the students who were morning types was significantly higher. Similarly, the relationship between morning chronotype and high academic performance has been demonstrated in both medical education and other educational studies (Mirghani, 2017, Tonetti et al., 2015). Studies indicate that circadian rhythm changes may be observed in some medical interns and residents due to both work tempo and academic load (Basner et al., 2017). Slipped sleep-

wake time, reduced sleep time, are commonplace for medical students. Strohl et al. (2003) recommend considering the different dynamics of the medical school in planning medical education. The academic performance of students in the evening type is significantly lower, suggesting that medical students with academic performance problems should be counselled on circadian rhythm regulation.

It was determined that the academic performance of the students who had deep learning habits was significantly higher in our study. Similarly, in a study conducted in Saudi Arabia, it was reported that students with a deep approach had higher grade point averages (Shaik et al., 2017). It is emphasized that the deep learning approach should always be taken into account by the instructors, through the addition of new information by connecting with previous knowledge (Nabizadeh et al., 2019). In medical education, it is widely assumed that students' deep learning approaches are optimal and that taking a surface approach is associated with ineffective or temporary learning outcomes (Reid et al., 2005). Likewise, Bickerdike et al. (2016), in their study using the Learning and Study Approaches Inventory, associated lower academic performance with the increased use of the surface learning strategy in students. In many studies on this subject, the surface study approach, which focuses on the instant use of the material learned by rote, is associated with poor academic performance results (Mirghani, 2017; Vermunt, 2005).

Akram et al, (2018) who examined the chronobiological and learning approaches of students in the context of academic performance, found that there was no significant difference between students' chronobiological patterns and academic performance. However, the authors argued that chronotype may have an indirect effect through study approaches. To test this context, when we compared students' deep learning and chronobiology scores, we found that students with the morning chronotype were prone to deep learning. Since only one-fourth of the students participating in the study were morning type and those with morning type had a deep learning approach, it can be thought that most of the other students were satisfied with superficial and temporary information.

We think that it is necessary to develop new strategies to increase the ability of medical students to permanently acquire vital information that they will use in their profession. Stegers-Jager et al. (2012), in medical schools, they stated that it is necessary to better understand why some students are academically successful and why others have difficulty passing their courses. In this direction, they suggested investigating the variables affecting academic performance by considering all the factors.

In this context, when the socio-demographic data of our study results were evaluated in detail, no significant difference was observed in academic performance between male and female students in terms of gender in the students included in our study. Similar to our study, it was found that there was no significant difference between the academic performance of medical students and their gender (Salih et al., 2021). The authors stated that a single factor cannot be decisive in the academic performance of students.

According to our research results, it has been determined that the reason for choosing medical school does not affect academic performance. Gedefaw et al. (2015), in a study they conducted at a medical school in Ethiopia, found that students who voluntarily entered medical school as their first choice had higher academic performance scores. Alfayez et al. (1990) stated that there may be differences in the study approaches of students with different motivations to study medicine, and they analyzed both the students' school entry purpose and motivation and their study approaches together. As a result of their analysis, they concluded that while choosing the surface study approach decreased the academic performance grade, it did not cause a significant change in the purpose and motivation of entering the school. Their results support that study approaches, as in the current study, are an important determinant of academic performance.

In our study, no significant relationship was found between the place of residence of the students and their academic performance. According to the results of a descriptive study similar to our study, it was found that the academic performance of the students did not show significant statistical differences in terms of gender, marital status and place of residence (Nabizadeh et al., 2019). Similarly, in the studies conducted in Iran and Bosnia, there was no significant difference between the performance level of medical students and residents (Davuodi et al., 2007; Džubur et al., 2020).

The current study has several limitations that need to be considered. Our study is limited to only grade VI students of our faculty. The results cannot be generalized to all medical students and should be supported by further studies with larger samples. The data of all semester students were not analyzed. Students may have taken a different study approach than they reported in the preclinical and clinical periods. Data from students were collected once. Since there is no process and follow-up, students' instant answers are likely to represent that period. In addition, since the chronobiology measurement tool used in the study is a subjective tool, there is a need for studies with objective criteria for similar purposes.

In conclusion, it was determined that the academic performance of the morning type students was significantly higher than the evening type students. At the same time, it was determined that the academic performance of students with a deep learning approach was higher. One of the important results of the research is; is to determine that medical students' chronobiological patterns and study approaches have the potential to affect each other. Knowing at what time of the day the students learn better and at what time of the day their performance is higher can affect the academic performance results. These results need to be discussed with a larger sample size and students from different grades.

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