




Comparison of Chronotypes and their Relationship with Academic Performance and Quality of Life in University Students

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Abstract

Objective An individual's chronotype affects circadian characteristics associated with bedtime, waking, and other daily activities. It is known that academic achievement is strongly dependent on personality traits. The present study aimed to investigate the relationship regarding chronotype, quality of life, and academic performance of university students by comparing three educational fields: medicine, technology, and art.

Materials and Methods The present cross-sectional study was conducted with 400 medicine, technology, and art students enrolled at universities in Tehran between 2018 and 2019, with convenience sampling from January 2020 to January 2021. The students filled out online questionnaires, including a demographics questionnaire, a quality of life assessment questionnaire (the World Health Organization Quality of Life: Brief Version, WHOQOL-BREF), the Morningness-Eveningness Questionnaire (MEQ), the Pittsburgh Sleep Quality Index (PSQI), and the Depression, Anxiety, and Stress Scale-21 items (DASS-21). The statistical analysis was performed using the IBM SPSS Statistics for Windows software, version 22.0 ($p < 0.05$).

Results A total of 400 students were enrolled in the present study, including 115 medicine, 153 technology, and 132 art students (67.3% of female and 33.7% of male subjects, with a mean age of 21.06 ± 2.063 years). In spite of the absence of significant differences among the chronotypes of the three groups, there was a significant correlation regarding the chronotypes in all groups and quality of life ($p = 0.005$).

Keywords

- ▶ chronotype
- ▶ academic performance
- ▶ quality of life
- ▶ university student

received
September 5, 2022
accepted
September 11, 2023

DOI <https://doi.org/10.1055/s-0043-1777776>.
ISSN 1984-0659.

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Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Morning-type individuals presented better quality of life and better quality of sleep ($p < 0.001$; $r = 0.175$). No significant associations were found involving the students' academic performance and their chronotypes ($p > 0.05$; $r = 0.026$).

Conclusion Considering the chronotype's effect of improving the quality of life of students and, therefore, their academic performance, more studies are essential to effectively improve the academic performance of individuals with different chronotypes.

Introduction

Sleep is an impressive behavior which is well known as a vital and critical biological process for body functions, mental health, and quality of life.¹ The circadian rhythm is a regular pattern of physiological processes with a duration of 24 hours.² A trait linked with circadian rhythms is the so-called chronotype, which pertains to the priorities related to bedtime, waking, daily activities and other aspects, and is classified into three types regarding the predominance of the sleep-wake pattern: morning-, evening-, and neither-type, which does not have a specific dominant rhythm.³ A total of 40% of the adult population is considered to belong to one of the two extreme groups; on the other hand, 60% are neither-type.⁴

Morning-type individuals go to bed early and wake up early, and achieve their peak mental and physical performance in the first hours of the day.^{3,5} In contrast, evening types usually have more irregular sleep and wake schedules, because they spontaneously tend to be awake at night while waking up at socially-acceptable times during the week.⁶ Furthermore, daytime sleepiness is a major problem, reported by 50% of college students compared with 36% of adolescents and adults. In a study,⁷ 60% of students reported tiredness or daytime sleepiness or yawning at least 3 days a week. Thus, evening-type individuals tend to present daytime napping habits, unplanned oversleeping, excessive daytime sleepiness, and sleep disorders. Studies show that preference for the evening phase is related to inappropriate psychological functioning, including depression, anxiety, stress, and difficulty coping, drug use and abuse, behavioral and emotional problems, and suicide. In summary, evening-type individuals present academic procrastination, weaker memory, and class absenteeism due to oversleeping and reduced academic performance.⁸

Health-Related Quality of Life (HRQoL) is a multidimensional measure regarding the physical, emotional, mental, and social components of the well-being and performance of individuals.⁹ In an assessment of evening-type students based on the Global Health Scale,¹⁰ the subjects scored lower on vitality, physical and mental health, body image, relationships with their parents and teachers, and school activities.¹⁰ On the other hand, in a literature review, morning-type subjects presented a significantly higher quality of life and less insomnia than evening type individuals, but this depends to a large extent on individual characteristics such as the overall ability to adapt to conditions. Evening-

type individuals feel more tired, report lower sleep quality, and complain of more insomnia than those who are morning-type, which may be due to a discrepancy between social activities and their biological clocks.^{9,11}

Due to the diversity in the courses of different academic fields, in the required assignments, and in the hours specialized classes are held, the chronotype can affect quality of life and academic performance. Therefore, in the present study, three different academic fields with different priorities in terms of the skills required to perform tasks were chosen for comparison: medicine (which requires memory and concentration), technology (which requires precision and high analytical skills), and art (which requires long hours of work and high levels of creativity, as well as accompanying other students). The students were supposed to answer questionnaires on their first and second academic semesters, and we had decided to ask the questions face-to-face; however, due to the coronavirus disease 2019 (Covid-19) pandemic in 2020 and the nonattendance that was forced upon students in universities, there was no other choice than to complete the questionnaires about the past face-to-face through online classes.

Based on our general observations and different studies, although contradictory, we expected that there would be a significant relationship between academic performance and chronotype. We also considered whether the field of study would also have an impact, so we compared three different fields of study that had not been examined in any other study. An investigation of the chronotypes of students and the relationship/association with academic performance and quality of life, with the implementation of appropriate interventions, could help to reduce the complications caused by poor sleep quality and daytime low-quality activities.

Materials and Methods

The present descriptive, analytical, cross-sectional study was conducted with 400 medicine, technology and art students enrolled at universities in Tehran between 2018 and 2019, with convenience sampling from January 2020 to January 2021.

To calculate the sample size and estimate the difference between the quality of life and the sleep disorders, we used a method mentioned in a similar, previously published study.¹² At the limit of 20 points, with the assumption of $\alpha = 5\%$ and power of 80%, the minimum sample size of 100 people in each comparison group. According to the study of

academic performance and comparison between three subgroups of students, a minimum number of 400 subjects was determined. The formula to determine the sample size is as follows:

$$n = 2 \frac{(Z\alpha + Z\beta)^2 \sigma^2}{d^2} = \frac{2(1.96 + 0.84)^2 40^2}{20^2} = 100.$$

The students in the three fields chosen had classes during the day, which coincided with the starting time of the routine of the universities. None of them had night classes, so their class schedules were very similar.

The exclusion criteria were lack of consent to participate in the study and failure to fill out all of the questionnaires. The sample was composed of 115 medical, 153 technical, and 132 art students. Due to the Covid-19 pandemic, the questionnaires were filled out online. At first, the objectives of the research were explained to the students, then, links to the questionnaires were sent to online student groups with the coordination of the student representative of each field. The questionnaires were as follows: a demographics questionnaire, the World Health Organization Quality of Life: Brief Version (WHOQOL-BREF), the Morningness-Eveningness Questionnaire (MEQ), the Pittsburgh Sleep Quality Index (PSQI), and the Depression, Anxiety, and Stress Scale-21 items (DASS-21). In each group, volunteers announced their willingness to participate and filled out the questionnaires.

The study was approved under the ethics code of IR.IUMS.FMD.REC.1399.346. The demographics questionnaire contained items on personal characteristics of the students, including age, gender, marital status, number of households, the field of study, place of residence, and the grade point average (GPA) at the end of the semester, which was used as the indicator of academic performance. The questionnaires were identified only by code, to ensure the confidentiality of the information, and the subjects had the right to withdraw from the study at any stage.

Measures

As aforementioned, the online survey included scales related to chronotypes, quality of sleep, and quality of life:

1. The MEQ is used to distinguish between chronotypes, with scores ranging from 16 to 86, which correspond to 5 categories: 70 to 86–definite morning-type; 59 to 69–moderate morning-type; 42 to 56–intermediate; 31 to 41–moderate evening-type; and 16 to 30–definite evening-type. In a study conducted in Iran by Rahafar et al.⁷ with 268 subjects, the Cronbach alpha coefficient for the MEQ was of 0.71. The Persian version of this questionnaire is considered to present good validity and reliability to determine the types of circadian rhythm. The Cronbach alpha for the MEQ in the present study was of 0.826.
2. The PSQI) differentiates between poor' and 'good sleepers by evaluating seven areas: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the previous month. Scoring is based on a 0

to 3 Likert scale, and a score of 3 reflects the negative extreme. A total score > 5 is indicative of a poor sleeper, while a score ≤ 5 indicates a good sleeper.¹³ The Persian version of this questionnaire has a validity of 86.5 and a reliability of 89.5.⁶ The Cronbach alpha for the PSQI in the present study was of 0.75.

3. The WHOQOL-BREF is a brief version of the 100-item World Health Organization Quality of Life Assessment (WHOQOL-100). This scale examines the quality of life in four domains: physical health, psychological health, social relationships, and environmental health, and it also assesses overall quality of life and general health. The WHOQOL-BREF contains 26 questions: the first one asks about quality of life in general; the second question is about the general health status; and the following 24 questions assess quality of life in the four domains previously mentioned.¹⁴ In 2006, a research¹⁵ was conducted with 1,167 people in Tehran to check the validity and reliability of this questionnaire. The participants were divided into two groups: those with and those without chronic diseases. The test-retest reliability values for the subscales were as follows: physical health – 0.77; mental health – 0.77; social relationships – 0.75; and environmental health – 0.84.¹⁵ The Cronbach alpha for the WHOQOL-BREF in the present study was of 0.933.
4. The Depression, Anxiety, and Stress Scale (DASS) was designed to assess depression and anxiety and to investigate the failure of earlier scales in differentiating between the two conditions. The original DASS contains 42 items that evaluate 3 dimensions of affective states: depression (DASS-D), anxiety (DASS-A), and stress (DASS-S). The DASS-21—a shorter version of the DASS – was developed by Lovibond and Lovibond⁸ (1995) with a lower execution time and more common application in clinical samples to screen for symptoms of different levels of depression, anxiety, and stress. The DASS-21 assesses the same three dimensions. each containing 7 questions.¹⁶ In the Persian language, by studying a nonclinical population, Salari-Moghaddam et al.⁹ showed that the scores of the three subscales are not dependent on gender and level of schooling, but the depression subscale is dependent on marital status. Moreover, in their study,⁹ the scores on the depression subscale presented a correlation of 0.7 with the scores on the Beck Depression Questionnaire, and the scores on the anxiety subscale scores presented a correlation of 0.6 with the scores on the Four Systems Anxiety Questionnaire. All three scales significantly differ between the clinical groups (including major depressive disorder, generalized anxiety disorder and obsessive-compulsive disorder) and the group without a clinical diagnosis. The Cronbach alpha coefficient was of 0.85 for the depression and the anxiety subscales, of 0.87 for the stress subscale, and, the total scale, it was of 0.94.⁹ The Cronbach alpha for the DASS-21 in the present study was of 0.938.

Statistical Analysis

The data were analyzed using the IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States) software,

Table 1 Demographic characteristics of the students according to the field of study.

Group Variable	Medicine		Technology		Art		All fields		Chi-squared test <i>p-value</i> *	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage		
Gender	Male	33	28.7	53	34.6	45	34.1	131	32.8	0.545
	Female	82	71.3	100	65.4	87	65.9	269	67.3	
Marital status	Married	22	19.1	40	26.1	43	32.6	105	26.3	0.062
	Single	91	79.1	113	73.9	87	65.9	291	72.8	
	Widowed/ divorced	2	1.7	-	-	2	1.5	4	1.0	
Place of residence	House owned by parents/ close relatives	101	87.8	145	94.8	110	83.3	356	89.0	0.008
	Dormitory	6	5.2	3	2.00	3	2.3	12	3.00	
	Shared house with friends	2	1.7	1	0.7	7	5.3	10	2.5	
	Others	6	5.2	4	2.6	12	9.1	22	5.5	

Note: *Values of $p < 0.05$ were considered statistically significant.

version 22.0. The quantitative and qualitative variables were presented as percentages, frequencies, and mean and standard deviation (SD) values using frequency distribution tables. The comparison of the subgroups in the case of qualitative nominal variables was performed using the Chi-squared test, and in every case in which this test was not accurate enough due to the low expected frequency, the groups were merged. The subgroups were compared in terms of the qualitative-rank variables and quantitative variables with nonnormal distribution using the Kruskal-Wallis test, and analysis of variance (ANOVA) was used for the quantitative variables with normal distribution. Pearson correlation coefficients were used to determine the correlations regarding chronotypes, academic performance, and quality of life. Finally, multivariate regression was used to remove confounding variables such as gender, marital status, age, and place of residence. In all cases, values of $p < 0.05$ were considered statistically significant.

Results

First of all, it is extremely necessary to explain about the conditions of the questionnaire completion and study conduct. The present study included sampling to fill out the questionnaire that was performed in the first academic semester when the classes were online due to the coronavirus. While the questionnaires were filled out regarding the first and second semesters when the classes were held in-person and under routine conditions of the universities. Therefore, the only change caused by the pandemic in the present study was that, instead of being filled out face to face, they were filled out online. Since this information provided was on routine class times, we believe that the students' chronotypes were not affected by the pandemic.

The sample was composed of 400 subjects: 115 medical students, 153 technical students, and 132 arts students. In

total, 67.3% of them were women, and 33.7% were men, with a mean age of 21.06 ± 2.063 years. Data pertaining to the demographics questionnaire are presented in ►Table 1.

Regarding the findings of MEQ between the GPA (as an academic performance criterion) and the percentage of people in the qualitative spectrum of morningness-eveningness (chronotype), there were no statistically significant differences among the students of the three fields. Moreover, no significant correlation was observed regarding academic performance and the average MEQ scores. In summary, the chronotype of the participants was not associated with changes in academic performance ($p = 0.606$; $r = 0.026$).

Furthermore, there was a significant correlation between chronotype and quality of sleep. As exhibited in ►Figure 1, with the increase in MEQ scores, the PSQI score (the lower the score, the better the quality of sleep) decreased significantly; thus, we can be concluded that the morning-type was associated with better quality of sleep ($p < 0.001$; $r = 0.175$).

The mean scores on the depression, anxiety, and stress subscales of the DASS-21 were of 14.6 ± 11.9 (median = 12), 10.1 ± 8.9 (median = 8), and 5.5 ± 10.6 (median = 18) respectively. These three dimensions presented a negative significant correlation with the MEQ scores and a positive significant correlation with the PSQI scores (►Table 2); the highest number of correlations observed were between chronotype and stress and between sleep quality and anxiety (►Table 2). The most negative correlation observed was between chronotype and stress after the removal of confounders such as gender, marital status, age, and place of residence. The stress levels of the students increased 0.196 times with the change of chronotype from morning to night.

The highest scores on the WHOQOL-BREF (better quality of life) were associated with environmental health, and the lowest, with physical health. Morning-type and better sleep quality have been associated with better physical and environmental health. In the evaluation of the correlations

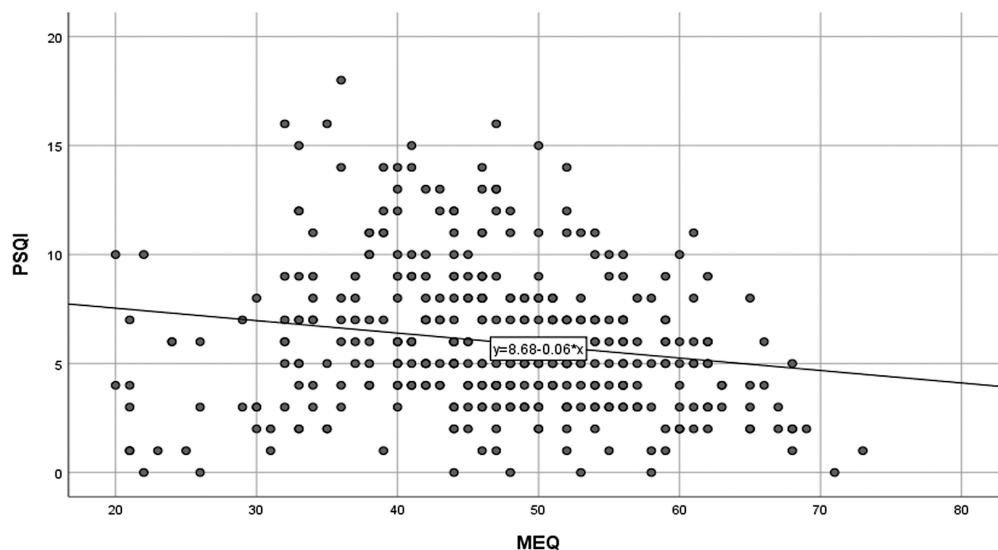


Fig. 1 Correlation between chronotype (MEQ scores) and quality of sleep (PSQI scores) ($r = 0.175$; $p < 0.001$). Abbreviations: MEQ, Morningness-Eveningness Questionnaire; PSQI, Pittsburgh Sleep Quality Index.

Table 2 Pearson correlation coefficients regarding the DASS-21 subscales and the MEQ and PSQI scores.

DASS-21 subscale	MEQ (value of r)	PSQI (value of r)
Depression	-0.190	0.429
Anxiety	-0.133	0.472
Stress	-0.246	0.428

Abbreviations: DASS-21, Depression, Anxiety, and Stress Scale-21 items; MEQ, Morningness-Eveningness Questionnaire; PSQI, Pittsburgh Sleep Quality Index.

involving all aspects of quality of life and the MEQ and PSQI scores, sleep quality and chronotype were associated with significant changes in quality of life ($p < 0.001$) (► **Table 3**).

Discussion

The present study was conducted to investigate the effect of the chronotype on the quality of life and academic performance of medicine, technology and art students. Due to the existence of conflicting information regarding the association of chronotype and academic performance, we decided to investigate this issue, and we expected that this relationship would be confirmed based on our general observations and on the findings of previous studies¹⁷⁻¹⁹ that showed that morning-type students were more associated with higher academic performance than evening-type students. We also questioned whether the field of study would have any impact on this issue, so we compared three different fields that had not been investigated in previous studies. We found no significant association regarding chronotype and academic performance, but there was a significant association between chronotype and quality of life: morning-type students were associated with a better quality of life.

Chronotypes and Field of Study

In the present study, the chronotypes of the sample were not significantly different, apparently due to the lack of influence of the individual characteristics of the students on their choice of field of study. In the current education system of

Iran, students must take a comprehensive entrance exam (called *Konkour*) at the end of high school, which defines their academic field. Said field of study would essentially determine their futures in terms of career, income, and even family; thus, most students do not choose their favorite fields, and other criteria such as social status, family factors and friends, as well as economic issues take priority over individual interests.²⁰ Therefore, comparing the chronotype of students of different fields of study in Iran is limited to domestic studies. However, to the extent of our knowledge, even in foreign studies, they did not find an authentic document on this matter. Nevertheless, in 2013, Anbari et al.²¹ reported that the relationship between satisfaction with the academic field and mental health is of special importance to improve academic performance and progress, as well as the learning rate.

Chronotypes, Sleep Quality, and Academic Performance

Sleep disorders, including lack of sleep, affect the daily performance of students. The feeling of tiredness at the onset and sleepiness throughout the day, as well as decreased concentration and lack of attention in activities, are among the effects of sleep disorders and of the chronotype.¹⁰ Medeiros et al. have shown that chronotypes affect the sleep-wake cycle, and irregularity in this cycle and sleep deprivation also affect learning.²²

In a study published in 2018, Akram et al.²³ assessed the possible relationship between chronotype and learning approach (deep learners versus surface learners); the academic performance of morning- and evening-type individuals did not differ, but deep learners had better academic outcomes than their counterparts, and morning-type subjects indulged in deep learning, while evening-type individuals indulged in surface learning. Therefore, it can be said that the interaction between chronotype and learning approach significantly determined academic achievement. These findings gave the impression that the chronotype could impact academic performance not directly, but indirectly, through the learning approach.²³ On this matter, the present study has shown the lack of a direct effect of the chronotype on academic performance.

Table 3 Pearson correlation coefficients regarding quality of life based on the WHOQoL-BREF and MEQ and PSQI scores.

Aspects	Mean	Standard deviation	Median	Range	Value of r	
					MEQ score (<i>p-value</i> *)	PSQI score (<i>p-value</i>)
Physical health	45.3	12.8	46.1	0–78.6	0.113 (0.024)	-0.423 (< 0.001)
Psychological health	53.1	13.7	54.2	16.7–83.3	0.095 (0.058)	-0.449 (< 0.001)
Social relationships	54.3	21.1	58.3	0–100	0.097 (0.053)	-0.322 (< 0.001)
Environmental health	59.8	16.1	59.4	9.4–100	0.130 (0.009)	-0.324 (< 0.001)
Total	82.0	13.4	82	37–114	0.412 (0.005)	-0.461 (< 0.001)

Abbreviations: MEQ, Morningness-Eveningness Questionnaire; PSQI, Pittsburgh Sleep Quality Index; WHOQoL-BREF, World Health Organization Quality of Life: Brief Version.

Note: *Values of $p < 0.001$ were considered statistically significant.

In 2016 Itzek-Greulich et al.²⁴ reported that morning-type subjects achieved better grades than evening type subjects in classes taught in the morning, unlike the classes taught in the afternoon. Additionally, in 2015, van der Vinne et al.²⁵ reported that evening-types had poorer academic performance than morning types on morning examinations, but not on afternoon examinations. Liaghatdar and Ashoorion²⁶ (2011) discussed how, in the planning of the syllabus in higher education, difficult and special courses are usually taught in the early morning, and night students suffer from academic decline in difficult courses that require better cognitive performance. The authors²⁶ recommended that difficult special courses be offered at times when all student groups have better cognitive performance.

Lima et al.¹¹ conducted a study in 2002 with the aim of determining the effect of different starting times of classes on the chronotypes of 27 medical students; in line with the present study, they used the MEQ and PSQI. Better sleep quality, sleep onset delay, and longer sleep duration were observed with a late schedule. Meanwhile, despite the changes in starting times, the chronotype patterns of the sample did not change.¹¹ According to the findings of the aforementioned studies, we can deduce that significant changes in the academic performance of students will not be witnessed by changing the starting hours of classes alone.

Seoane et al.²⁷ published a systematic review in 2020 about "sleep disruption in medicine students and its relationship with impaired academic performance". The meta-analysis showed that poor sleep quality and excessive daytime sleepiness were mildly but significantly associated with impaired academic performance. In the present study, the negative effect of sleep quality on quality of life supports this finding by Seoane et al.²⁷

The relationship between chronotype and academic performance has been investigated in several similar studies, which have reported a weak to moderate correlation.^{17,18,28-30} In the present study, this correlation was predictably not significant, considering that most participants (60.5%) presented an intermediate chronotype.

Chronotype and Quality of Life

According to our findings, the quality of life did not differ significantly among the three subgroups of students. In addition, the investigation of the correlation involving all aspects of quality of life and the MEQ and PSQI scores revealed that the chronotype was associated with changes in the quality of sleep and of life. Furthermore, better sleep quality was associated with better psychological status, and nonmorning chronotypes were associated with worse psychological status.

Roeser et al.³¹ (2012) assessed if eveningness is negatively correlated with quality of life among adolescents. In their study, morning-type adolescents reported significantly better quality of life and fewer insomnia symptoms compared to evening type adolescents. In the total sample, insomnia symptoms mediated the relationship between chronotype

and quality of life. In evening-types, the strongest predictor of HRQoL was the degree of sleep-related cognitive dysfunction; in morning-types, it was general self-efficacy.

In line with Roeser et al.,³¹ in the present study, non-morning-types reported significantly lower quality of life than morning-types in all aspects: physical health, psychological health, social relationships, and environmental health.

The findings of the study by Wong et al.³² presented the greatest similarity with those of the current study, for they have reported that , academic performance, physical health, and psychological health could be predicted based on the duration and quality of sleep. They³² also reported that certain sleep behaviors directly predicted daytime functions, while other behaviors had an indirect effect on daytime functions through negative moods, such as anxiety.

Assessing a multi-university sample of college students, Becker et al.³³ (2018) reported that anxiety and depression symptoms were uniquely connected to disruptions in most sleep component domains of the PSQI. However, anxiety (but not depression) symptoms were uniquely associated with more sleep disturbances and use of sleep medication, whereas depression (but not anxiety) symptoms were uniquely associated with increased daytime dysfunction. Depression and anxiety symptoms were each independently associated with poor sleep status.³³

In this regard, the present study has confirmed the remarkable impact of anxiety on the quality of sleep and, thus, the quality of life of the students. Therefore, healthy sleep patterns are essential for better adaptation in university years.

The strengths of the present study included sampling students of three different fields. The difference in the attitudes of the students in each of the subgroups, the specialized and nonspecialized courses offered in each of the fields, and even the social relationships, the socioeconomic status and the family culture, could affect the sleep-wake pattern, quality of life, and academic performance. Thus, the fact that we assessed students of different fields has made the present study more valuable, especially, since to the best of our knowledge, almost all of the studies published on this topic only assessed medical students.

Limitations

The only limitation of the present research was that the questionnaires had to be filled by the participants themselves, so the scores may be influenced by the different perceptions of the participants regarding the questions or the choice of options due to unfamiliarity with Likert scoring. This restriction was an unexpected consequence of the Covid-19 pandemic, and it can be removed if the questionnaires are completed face-to-face under normal conditions.

Conclusion

The present study indicated that the chronotype of students has no significant effect on academic performance,

but it has effects on their quality of life. However, the studies conducted so far have not stated that changing the class starting times is a definite influencing factor to reduce sleep quality problems, such as lack of sleep, sleepiness and daytime fatigue, and reduced concentration and vigilance in the performance of tasks that require a lot of precision and attention. Notwithstanding, society empirically still emphasizes improving their academic performance in the case of a better quality of sleep. Therefore, more studies are essential to establish an effective approach that can improve the academic performance of different chronotypes.

Funding

The author(s) received no financial support for the research.

Conflict of Interests

The authors have no conflict of interests to declare.

Acknowledgements

The authors wish to thank Dr. Seyed Mohammad Hossein Mahmoodi and Ghazzalleh Ghazi Tabatabai for their sincere collaboration.

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