Original Article

Compare the educational achievement of medical students with different circadian rhythms in difficult courses of basic sciences

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Abstract

Background: Advantageous times for different people are different to some extent, considering the effective physiological changes during the circadian rhythm, in terms of the peak time of physiological activities. The goal of this study is to compare the educational achievement of students, with different morning–evening habits, in completing difficult and easy courses.

Materials and Methods: This research is a retrospective descriptive–analytical study, which has been conducted on students of the fifth semester of General Medicine in the Faculty of Medicine, Isfahan University of Medical Sciences. The morning–evening habits of the students were determined by the Horne-Strauss 19-item questionnaire. The students were asked to determine the courses that were 'difficult' and 'easy,' using a researcher-made questionnaire. The students' scores in the considered courses during the five semesters were obtained from the Education Department of the Faculty and analyzed using the descriptive *t*-test, analysis of variance (ANOVA), and the multivariate regression test in the SPSS software.

Results: Sixty-three students (67% girls and 33% boys) participated in this study, of whom 11, 60, and 29% were morning, morning–evening, and evening students, respectively. The mean scores of the difficult courses in all five semesters were reduced in the evening pattern compared to the morning and morning–evening patterns. Reduction of the mean score in the difficult courses, in the evening group, compared with the morning–evening and morning groups was observed in all five semesters among girls, but in three semesters among boys.

Conclusion: This study showed that evening students experienced academic failure in difficult courses, which required a more cognitive performance. It is recommended that difficult specialized courses be presented at hours when all student groups have a better cognitive performance.

Key Words: Circadian rhythm, course planning, educational achievement, evening, morning

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INTRODUCTION

Many studies have shown that all body organs are affected by biological rhythms.[1,2] Since a long time ago, daily rhythm has been known as a criterion for distinguishing different people by observing the performance of their activities at different hours of the day.[3,4] Considering effective physiological changes

of the circadian rhythm, people differ in terms of the peak time of their physiological activities. On the basis of this, morning and evening people can be distinguished from each other. Morning people usually sleep and wake up earlier and have a higher ability and efficiency than evening people, early in the morning. The body temperature of these people reaches its highest point 70 minutes earlier than evening people.[5]

In physiological terms, circadian changes are also found in the brain. The two hemispheres have different circadian changes, but differences in nervous impulses in the early hours of the morning, maximum consciousness, and sleep deprivation can be recorded using electroencephalography (EEG).[6]

Some researchers believe that consciousness is the most important factor that distinguishes these two groups from each other. The peak time of consciousness in the morning people is late morning hours and that of evening people is late evening hours. Although these two groups are distinct from each other in terms of day time preference for physical and mental activities, the consciousness of these people before and after sleeping, and other behaviors, such as need for food, comprise of variables that have attracted the attention of researchers.[7,8] Based on the resting and activity rhythm, Cavalera in 2008 and Fabry in 2007, classified people into three classes of morning, evening, and morning-evening. Morning people are more responsible, reliable, and emotionally stable in their routine life than evening people. Morning-evening people are those who have an intermediate behavioral pattern and are between these two extremes.[4,9]

A study has shown that practice can affect the biological rhythm or completely change it.[6] In recent times, other studies have investigated different biological and genetic factors in the routine habits and rhythms of activities.[10-14] In some studies, gene,[15] month of birth,[16] maturity period,[17] environmental and cultural factors,[18] gender, age, personality, life habits, and drugs (such as caffeine) have been regarded to be effective.[19,20] The cortisol hormone in the morning people starts to rise one hour earlier than that in the evening people, and it rises more slowly in the evening people.[21]

Tankova *et al.* believe that people are more the evening type at younger ages (about 13), and as age increases, morning habits will emerge. They also consider the critical age of this habit to change at 50 years. Gender has a negligible effect on the daily cycle of people and the female gender starts working one hour earlier than

the matching male gender.[4,20] Factors affecting sleep rhythm are known as masking factors and include personal habits, the presence of stimulating factors, boring or stimulating factors, eating, physical status, ambient temperature, background sound, light, and drugs (such as caffeine). Physical and mental activities can also act as masking factors.[6]

Folkard and Monk, in1980, quoting Song and Stuff, 2000, showed that short-term memory was affected by the circadian rhythm in tests.[8] In another study, the emotional conditions of the studied people were studied at different hours of the day, which showed that the mental condition of customers changed at different hours of day and morning people were more emotional.[4] Another factor related to cognitive performance and circadian rhythm was the difficulty of a task. In terms of easy tasks, the best hours of the day did not highly affect the quality of performance, while it seemed that the performance of the people was affected by the appropriate hours of the day for difficult activities.[22] Natale and Alzani also believed that despite the effect of motivation on cognitive performance, the efficiency of the person in complex activities was reduced due to the reduction of consciousness at different hours of the day.[23]

Supposing specialized courses have a special importance in the capabilities of medical students and these courses are mostly presented in the early hours of the day, in case evening students have learning and cognitive disorders in the early hours, they will not learn these courses properly and will have problems in future. Medical students face considerable shift problems and it is difficult to determine and predict their performance at different hours of the day in their professional life. Measurement of their internal features and habits can be regarded as useful for planners. A research has shown that processing the depth of different people is higher at the desirable time of the day, when they have better mental performance, a better recollection of the study subjects from their long-term memory, and show better performance in rapid cognitive activities.[22] This study intends to determine the evening-morning patterns of medical students in the fifth semester and specify their relationship with their achievement in difficult and easy courses during the five semesters.

MATERIALS AND METHODS

This research was a retrospective descriptive-analytical study, which was performed in the Faculty of Medicine, Isfahan University of Medical Sciences. The study population comprised of medical students of the fifth semester, and sampling was done as a

census. The sample size included 71 students. The inclusion criterion was that the students had taken the courses in the fifth semester and inserted their student number on the questionnaire. For this reason, those students of the fifth semester were selected whose morning-evening patterns were stabilized during their study period after some semesters; also, they did not have the experience of night shifts and working in night shifts did not affect their habits. Selecting students with no experience of night work can be a good predictor for their adaptation to night shift work.[3]

Different methods have been found for measuring the morning-evening pattern of people in the references, each of which has been designed to measure habits of different age and working groups.[24-29] There are two classes of methods for measuring the biological patterns: Subjective and objective. The objective methods are more reliable and have a higher accuracy. In these methods, the speed and accuracy of the responses are evaluated, to study the effect of the internal rhythm of the body on performance; for example, methods of ordering, logical reasoning, memory retrieval, educational achievement in schools, and measuring the accuracy of reading.[6] Most of the studies that have intended to examine personal differences related to morning-evening habits have led to self-reported (subjective) questionnaires, in which the respondents are asked to mention their preferences for performing their activities at special times of the day. The Horne-Ostberg morning-evening questionnaire is one of the most common subjective questionnaires for measuring the above-mentioned stages, which has been translated into different languages.[24] Other instruments are also available in the literature, which have been used by different researchers for predicting the performance of the personnel in the industry and nursing fields.[3]

Evaluating circadian rhythm using a subjective approach is very complicated in terms of the cognitive performance of people. This performance is not only affected by learning, aptitude, and other masking factors (such as light, background sound, and other cases), but also the brain itself can adjust its performance using its internal and parallel processes and use compensatory mechanisms for performance adjustment.[6]

First, the Horne-Ostberg morning-evening English questionnaire was translated to Persian and its validity was confirmed by some medical education authorities who were skilled in the language. Then, it was distributed among 50 medical students of the same semester and its reliability was determined as

0.72 by the Cronbach's Coefficient Alpha. The final morning-evening questionnaire had 19 items, like its main version, and its scoring method was the same as that of the main questionnaire, by summing each of the items. Each respondent gained a score between 19 and 86. A score range of 19-42 was considered for the evening group, 42-58 for the morning-evening group, and 58-86 for the morning group. At the same time, a questionnaire was designed that asked the learners about the difficulty of courses in the five semesters. In this questionnaire, the students were asked to determine the difficulty of their courses in the five semesters (5 = very difficult, 4 = difficult, 3 = medium, 2 = easy, 1 = very easy). The critical level for determining the difficulty of courses was considered to be 50%, and the degrees of 4 and 5 were considered to be very difficult, 3 was medium, and 1 and 2 were very easy. Also, its reliability was measured as 84.4. To maintain the consciousness of the respondents, these questionnaires were filled out from 10 to 12 a.m. of the first days in the sixth semester so that the passing of time did not disturb their memory.

Although the morning-evening pattern is measured using subjective questionnaires and the self-report of personal habits is a criterion for measurement in this study, this variable was studied in contrast to the educational achievement of students, which is objectively measured. The examination hours were received from the Head of Examinations in the Education Department of the Faculty. Through the SAMA software, which was available to the Department of Educational Services of the Faculty, scores of the students were received. The students were ensured that the information of the questionnaires was confidential and would be only given to the researcher. If they liked, the research results could be announced to them. The data were analyzed using the SPSS-18 software, with the *t*-test, descriptive, ANOVA, and multivariate regression tests. Also, a $P < 0.05$ was considered to be significant.

RESULTS

In this study, 63 students participated, among whom 67% were girls. Their mean age was 21.1 ± 0.6 years (ranging from 20 to 23 years). Based on the results of the morning-evening questionnaire analysis, 11.8% of the respondents were morning, 27.9% were evening, and 60.3% were morning-evening [Table 1]. On the basis of the results of the course difficulty questionnaire, the courses of physiology, pathology, theoretical parasitology, and fungology in semester five and general pathology, limb anatomy, bacteriology, clinical physiology, physiology, and genetics in semester four were the

difficult courses. In semester three, anatomy of nerves, anatomy of head and neck, bacteriology, and immunology, in semester two, abdomen and thorax anatomy, embryology, physiology, biochemistry, and epidemiology, and in semester one, histology, biology, biochemistry, and healthcare were the difficult courses. The time schedule of the courses was also received from the Education Department, based on which all specialized courses that were regarded as difficult were presented in the morning hours and practical and general courses that were regarded as easy were presented in the afternoon. The examination time was found to be from 12 to 2 p.m. according to the Education Department of the Faculty.

The mean scores in all five semesters were reduced in the difficult courses in the evening pattern compared with the morning and morning-evening pattern. This finding was only observed in difficult courses and no considerable reduction was observed in easy courses. Reduction in the mean evening scores of the difficult courses was observed among girls in all five semesters compared to the morning and morning-evening patterns, but it was found among boys in three semesters [Table 2]. There was a significant difference between the morning and evening patterns in the mean scores of difficult courses in the fifth semester among girls, when using the *t*-test ($P < 0.01$). The

Table 1: Comparing medical students based on morning-evening habits in terms of gender (%)

Pattern	Girl	Boy	Total
Morning	8.7	18.2	11.8
Evening	28.3	27.3	27.9
Morning-evening	63	54.5	60.3

Table 2: The mean and standrad deviation of educational achievement of medical students in specialized difficult courses based on morning-evening habits in five semesters of the basic sciences

Educational semester	Gender	Morning	Evening	Morning-evening
Semester 1	Girl	15±1.1	13.8±2	14.5±1.6
	Boy	13.8±1.1	14.3±1.5	13.9±1.6
	Total	14.5±1.2	14±1.8	14.2±1.6
Semester 2	Girl	16±1.3	14.6±1.5	14.9±1.7
	Boy	14.3±1.1	13.8±1.6	13.8±1.6
	Total	15.2±1.4	14.3±1.5	14.5±1.7
Semester 3	Girl	16.4±1.5	14.9±1.8	15.6±1.6
	Boy	14.3±1.4	14.5±1.8	14±2
	Total	15.4±1.8	14.8±1.8	15±1.9
Semester 4	Girl	18±05	15±2.6	15.9±1.7
	Boy	17.6±0.4	15.7±0.96	14.8±1.4
	Total	17.8±0.4	15.5±1.4	15.8±1.7
Semester 5	Girl	17±0.5	15±1.3	15.9±1.6
	Boy	15.5±2.5	15.2±1.8	14.8±1.5
	Total	16.4±1.7	15.1±1.4	15.6±1.6

ANOVA test was used to compare the mean scores of the three patterns and two genders, which was not significant. Data analysis using multivariate regression showed that the morning-evening pattern was not a considerable predictor for variance of score changes and their means. The results of the present study demonstrated that the scores of evening students dropped considerably in the difficult courses.

DISCUSSION

Previous studies have shown that the morning-evening pattern of people could affect their performance quality relating to cognitive actions at different circadian hours.[22] This study was conducted to evaluate the relationship between morning-evening pattern of students and their educational performance in difficult courses, in the five semesters of basic medical sciences.

Most of the students participating in this study had a morning-evening pattern. In a study in Japan, which was conducted on 20- to 50-year-old people, 15, 70, and 15% were morning, morning-evening, and evening persons, respectively,[30] which was in line with the findings of this study. In a study by Chelminski *et al.*, 1600, 18- to 53-year-old students completed Horne-Ostberg questionnaire. Based on the results, 62.4, 29.3, and 8.3% were morning, morning-evening, and evening persons, respectively.[31] The difference in the morning-evening pattern in the present study and that of Chelminski *et al.* could not result from their different age distribution, because with increase in age, more people are expected to have the morning pattern. In the references, it has been mentioned that because most students are young, they are expected to follow the evening pattern. In the present study, students of age 20 to 23 years followed the morning-evening pattern and it should be noted that different societies have special patterns and the pattern of a society cannot be generalized to others.

In the study by Koscec *et al.*, two generations of students from University of Zagreb were studied twice in 1977 and 1998. The results showed that most students had a morning-evening pattern and no change was found in their morning-evening pattern in two decades.[32] Although some changes in morning-evening pattern of the students were expected after two decades, stability of this pattern could be due to the effect of endogenous factors.[4]

The results of the present study showed that evening students had considerable failure in difficult courses. This finding was specifically for difficult courses and different results were obtained for easy courses. In line with the previous studies,[33] this finding could

be attributed to the role of time in the cognitive performance of learners, and it could be concluded that class time had less effect on the scores of easy courses, which could be attributed to less dependence of these courses on the cognitive performance of learners. In other studies, it has been shown that morning students have a better performance than evening students, and students with a different morning-evening pattern prefer various teaching patterns.[9,17] In this study, according to the time schedule of courses received from the Education Department, all specialized courses that were regarded as 'difficult' were presented in the morning, which could be the cause of performance failure of the evening people.

One of the factors that could affect the results of this study was the time of examinations, which was from 12 to 2 pm in this Faculty. If the above examinations had been held in the early hours of the day, it could be predicted that the scores of the evening students would significantly drop; however, planners held that all examinations in the middle hours of the day, would cause all three groups of students to have an acceptable performance. Of course, there are different results in the literature. Anderson *et al.* (1991), showed that information retrieval from long-term memory was related to the morning-evening pattern of people and information retrieval performance from long-term memory decreased over the day hours, but this variable improved in the evening people.[34] In another study, Monk and Leng (1986), classified a group of students to morning and evening groups and performed a six-stage test during the day. They demonstrated that cognitive performance (logical reasoning) of the morning people reached its high point and the performance pattern of the two groups was different from each other.[35] The research results of Roberts and Kyllonen showed that the criteria of memory and processing speed of evening people had an acceptable quality, even in the morning hours.[19]

In another study, the understanding and remembering abilities of morning and evening people were studied and the results of this study showed that the immediate memory of morning people had a better performance in the early hours of day and that of the evening people had a better performance in the evening hours.[22] In other words, many studies have shown that the sleep-wake rhythm and internal rhythm of the body have an effect on the cognitive activities of people and different people show different performances at different hours of the day. It is also predicted that those who work out of their normal body cycle will suffer from dysfunction.[36] In another study, it was shown that Japanese boy students were more evening

persons than girls; however, this difference was not observed in Korean girls and boys. The author of the above-mentioned article considered the effect of the socioeconomic factors as the origin of this difference.[37]

CONCLUSION

The assumption that holding difficult courses in the early hours of the day causes better learning should be reconsidered. Considering the remarkable number of evening students, it is more appropriate to change the class hours to the middle hours of the day. The results of this study should be useful for learners and managers. Learners' recognition of their internal pattern, the effect of day hours on learning, and their learning limitations at different times of the class, can help in learning materials. Furthermore, managers and planners can plan the time of difficult courses more carefully considering this point and avoid planning classes with high cognitive need in the early morning or late afternoon hours.

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