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Original Article

The effect of chronotype (morningness/eveningness) on medical students' academic achievement in Sudan

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الملخص

هدف البحث: هنالك وعي متزايد حول تأثير اختلال الساعة البيولوجية على الصحة والعمل. في هذه الدراسة نهدف للتحقيق في آثار النمط الزمني للنوم على التحصيل الأكاديمي بين طلبة الطب.

طرق البحث: تم إجراء دراسة مقارنة مستعرضة على ١٤٠ من طلاب الطب (٦٤ بمعدل ممتاز " أ"، و٧٦ بمعدل جيد "ج") يدرسون في المرحلة السريرية بكلية الطب بجامعة أمدرمان، السودان. وقّع المشاركون على موافقة خطية مسبقة كما طلب منهم تدوين وقت النوم، ووقت الاستيقاظ، والوقت اللازم للدخول في النوم، ومدة النوم خلال أيام العمل وأيام العطلة الأسبوعية. ثم دعي المشاركون للرد على الاستبانة. وتم حساب نمط النوم من منتصف-وقت النوم خلال عطلة نهاية الأسبوع والاستيقاظ. كما تم مقارنة متغيرات متعددة للنوم بين المجموعتين. وتم استخدام اختبار- ت والانحدار اللوجستي لتحليل الدلالات الإحصائية.

النتائج: النمط المسائي كان أكثر شيوعا بين الطلاب متوسطي الدرجات مقارنة بذوي الدرجات الممتازة. كان هناك فروقات ذات دلالة إحصائية كبيرة بين المجموعتين بما يخص وقت النوم خلال عطلة نهاية الأسبوع، ووقت الاستيقاظ، ومدة النوم. إضافة إلى ذلك، كان واضحا أن هناك فروقات كبيرة لوقت النوم خلال أيام الأسبوع، والوقت اللازم للدخول في النوم، وتأخرالاستيقاظ بين أيام الأسبوع وعطلة نهاية الأسبوع. ولم تلاحظ فروقات بين المجموعتين خلال أيام الأسبوع في وقت الاستيقاظ ومدة النوم، والنمط الزمني للنوم بين الجنسين، وتأخر وقت النوم بين أيام الأسبوع وعطلة نهاية الأسبوع.

الاستنتاجات: الطلاب متوسطي الدرجات أكثر احتمالا للنوم المتأخر خلال أيام الأسبوع وعطلة نهاية الأسبوع، وينامون أكثر خلال عطلة نهاية الأسبوع، ويفضلون النمط المسائي.

الكلمات المفتاحية: النمط الزمني للنوم؛ طلاب الطب؛ نمط النوم؛ مدة النوم؛ التحصيل الأكاديمي

Abstract

Objectives: There is increasing awareness about the effects of circadian misalignment on health and work. In the present study, we aimed to investigate the effects of chronotype on academic achievement among medical students.

Methods: A cross-sectional comparative study was conducted among 140 medical students (64 who averaged an A grade and 76 who averaged a C grade) completing the clinical phase at the medical college of Omdurman University, Sudan. The participants were asked to sign a written informed consent and to keep a diary detailing their bedtime, wake-up time, sleep latency, and sleep duration during working days and weekends. Then, the participants were invited to respond to a questionnaire. The chronotype was calculated from the mid-sleep time during the weekend and sleep debt. Various sleep parameters were then compared between the two groups. A t-test and logistic regression analysis were used to test the statistical significance.

Results: The medical students with average grades were more of the evening chronotype than the students with excellent grades ($p < 0.05$). Significant differences were found between the two groups regarding weekend bedtime, wake-up time, and sleep duration. In addition, significant differences were evident for weekday bedtime, sleep latency, and wake-up lag between weekdays and weekends. No differences were observed between the two groups during weekday wake-up time and sleep duration, chronotype between gender, and bedtime delay between weekdays and weekends ($p > 0.05$).

Conclusion: Students whose average grade was a C were more likely to have a later bedtimes during weekdays and

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weekends, sleep more during weekends, and were more evening.

Keywords: Academic performance; Chronotype; Medical students; Sleep duration; Sleep pattern

Introduction

Human cognitive and physiological functioning varies throughout the day due to the circadian rhythm, while the sleep–wake cycle is regulated extensively by neural mechanisms (e.g., suprachiasmatic nucleus). However, environmental factors can substantially influence the timing and expression of sleep and wakefulness.[1]

Sleep can be altered by various factors such as the overuse of the internet and social media, sleep medications, and coffee intake. Furthermore, sleep can be profoundly altered by different medical conditions including depression, obstructive sleep apnoea, idiopathic hypersomnia, and chronic sleep deprivation.[2]

Previous literature reported negative associations between poor sleep quality and physical and mental health, academic achievement, and the well-being of college students.[3,4]

Previous researchers documented the relationship between sleep quality and academic performance. Further studies have shown a high prevalence of sleep problems among college students.[5] Medical students sleep six hours/day on average in contrast to the eight hours observed in other groups.[6]

Morningness/eveningness refers to the difference between individuals regarding diurnal preference, the sleep–wake pattern of activity, and alertness in the evening or morning. Individuals with a morning chronotype who exhibit extreme morning tendencies (e.g., a trend towards rising early in the morning, perform mentally and physically best in the morning hours, and going to bed early in the evening) are called early Larks (morning chronotype). Those with an evening chronotype are referred to as Night Owls. These individuals rise later in the morning, stay awake later at night, and perform at their best in the late afternoon or evening. These preferences are assumed to have unique genetic, biological, contextual, and psychosocial components. Diurnal preferences have been linked to various habitual and nonhabitual issues such as eating habits, sleeping behaviour among University students, smoking, and drug use.[7]

Early chronotype or morningness has been linked to physical and mental health, self-esteem, school functioning, and intimate relationship, while late chronotype or eveningness has been shown to be associated with mental illness, infections, smoking, and poor sleep quality.[8]

The regularity and synchronization of the sleep–wake cycle are crucial regardless of the chronotype. Among medical students, synchronization is misaligned and disturbed by numerous factors such as curricular load, extracurricular activities, the influence of hospital demands, pressure for high academic achievement, and emotional stress. Sleep–wake cycle and sleep duration could also influence and condition the learning process and humour.[9,10]

A recent study conducted in a school that adopted a dual schedule (both morning and evening classes) after a fire accident in a nearby school showed that an early schedule is detrimental to both morning and evening chronotypes in terms of sleep deprivation and daytime sleepiness. Furthermore, those students with an evening chronotype were at increased risk for daytime dysfunction regardless of the school schedule.[11]

Previous literature observed that a mismatch between circadian (internal) and social (external) times could lead to chronic sleep deficiency. Furthermore, examination time has been shown to significantly influence grades, with students with the morning chronotype scoring higher in early and late morning exams than those with the late chronotype. This group difference in grades scored disappeared in the early afternoon.[12]

Although sleep habits might not be a direct determinant of academic accomplishment, these previous studies demonstrate the need to explore the factors that contribute to and predict the medical student's academic performance.[5]

No researchers have studied the eveningness/morningness chronotype among medical students in Sudan. Sudan is a vast country with social and climate diversity, so sleep studies conducted in Western countries may not apply to this country; therefore, we conducted this research. In the present study, we aimed to assess morningness/eveningness among medical students at Omdurman Islamic University and its relationship with academic achievement.

Materials and Methods

This cross-sectional comparative study was conducted at the Faculty of Medicine, Omdurman Islamic University from June to August 2015. One hundred and forty medical students from the clinical phase were included: sixty-four who scored an A grade average (Excellent) in the previous semester, and seventy-six with a C grade average (Pass). Participants were invited to sign a written informed consent and respond to a structured questionnaire. An orientation meeting was held for the participants to explain how to fill out the survey. The grades A and C were chosen for the comparison because we thought that students with A and B grades are too similar in terms of performance and those with a D grade (fail) would present a very small sample. The questionnaire was distributed after routine class activities. The students with grades other than A and C, those with chronic diseases that can affect their sleep, shift workers, and current smokers were asked to leave the lecture theatre. The questionnaire was distributed to the remaining students. The phone numbers of the investigator and trained facilitators were provided so that they could answer any questions that came up during the completion of the questionnaire; these personnel also collected the finished survey. The end sample size was 140 out of a total of three hundred students. Ten questionnaires were then excluded due to incomplete data or not recording their grades because we thought it could be difficult to include them in the comparison. The survey was approved by a Community Medicine

Consultant and the investigator. Data were collected on days other than when examinations were held to avoid stress. The following data were collected: age, sex, weekday and weekend bedtime and wake time, subjective sleep duration during the weekdays and weekends, the time taken to fall sleep, and the lag in hours between weekday and weekend bedtime and wake-up time. The mid-sleep time was estimated as the midpoint between sleep onset (bedtime plus sleep latency) and wake time, and the chronotype was calculated from mid-sleep time on free days (weekends) subtracting 0.5 for the sleep debt, which is the sum of the weekend sleep duration (the length of sleep onset time until wake time) minus the weekly average sleep duration.[5] The Statistical Package for Social Sciences (SPSS, version 20) was used for data analysis. A t-test was applied to compare students with grades A and C. The results of the female and male students were also compared. The binary logistic regression analysis was used to test the significant predictors of grades and differences across gender. The data were presented as the means ± SD with a p-value < 0.05 considered significant. The ethical committee of the Faculty of Medicine, Omdurman Islamic University approved the research.

Results

The study included 140 medical students (64 with excellent grades and 76 with average grades). Their ages ranged from 21 to 23 years with a mean of 22.53 ± 1.89 for those with excellent grades and 22.64 ± 1.93 for those with average grades with no significant difference (p-value = 0.727). No significant difference was evident regarding the weekday wake-up time (7.13 ± 1.76 vs. 7.78 ± 2.25 p-value = 0.063). Sleep duration on the weekdays was higher among the excellent group (8.10 ± 7.72 vs. 6.55 ± 2.12) with no significant difference, while it was higher on weekends among the average-grade students (9.53 ± 3.00 vs. 8.28 ± 3.42) with significant difference (p-value = 0.023). The weekend bedtime was later among the average-grade students (2.79 ± 2.24 AM vs. 00.80 ± 3.61 AM) compared to the excellent-grade medical students with a high significant difference (p-value = 0.000). The average-grade medical students wake up later during the weekends than the excellent-grade students (11.90 ± 3.47 AM vs. 9.00 ± 2.59 AM) with a high significant difference (p-value = 0.000). Bedtime during the weekdays was 23.97 ± 1.97 among the excellent-grade medical students, while it was 1.18 ± 1.67 AM for the average group with a high significant difference (p-value = 0.000). It is worth noting that the average group medical students displayed more evening chronotype tendencies than the excellent group with significant difference (p-value = 0.000).The time taken to sleep was higher among the average-grade medical students than their excellent counterparts (30.00 ± 28.51 and 14.98 ± 15.35 min respectively) with a high significant difference (p-value = 0.000). A high significant difference was found between the excellent-grade students and the average-grade students regarding the lag of wake up between weekdays and weekends (2.00 ± 1.99 vs. 3.86 ± 2.17 h) with a high significant difference (p-value = 0.000), while no significant difference was observed between the excellent-grade students and average-grade students regarding the lag in bedtime during the weekdays and weekends (p-value = 0.146). When the binary logistic regression analysis was conducted, the sleep duration and bedtime during the weekends, the time taken to sleep, and the lag in bedtime and wake-up time between weekdays and weekends remained robust significant predictors of grades. See Tables 1 and 2.

No significant differences were evident between men and women regarding school grades (p-value = 0893), chronotype (3.71 ± 1.14 vs. 4.37 ± 1.43, p-value = 0.08), or bedtime during weekdays (24.25 ± 1.29 vs. 24.66 ± 1.93, p-value = 0.408). Sleep duration and bedtime during the weekends remain strong predictors of sleep patterns in females after the logistic regression analysis. Tables 3 and 4 display comparisons between male and female sleep habits.

Discussion

Light–dark alteration is the strongest external circadian "zeitgeber" for a human. There is a rapid transformation towards eveningness in modern society due to the increase in technological preferences, with a substantial effect on chronotype (personal preference). Eveningness may impact physical and mental health and academic achievement.[13] In the current study, average-grade medical students were more likely to have an eveningness chronotype, supporting the above observations. A similar survey conducted among medical students in Brazil concluded that the evening chronotype can potentially impair academic performance.[6]

Previous literature showed that individuals with the morning chronotype slept worse and displayed the highest circadian misalignment during night shifts. In contrast, misalignment was displayed during morning work in individuals exhibiting the evening chronotype.[14] In the present study, in our college, which is adopting the morning schedule, the students with average grades were more likely to have the evening chronotype. Although it is difficult to conclude a cause and effect relationship, a plausible explanation could be that circadian misalignment results from the morning curricular.

Table 1: Comparison of the sleep characteristics between the excellent (A) and average (B) medical students.

Character mean ± SD	Excellent grades	Average grades	p-value[a]
Age	22.53 ± 1.89	22.64 ± 1.93	0.727
Weekday wake-up time	7.13 ± 1.76	7.78 ± 2.25	0.063
Sleep duration/weekdays	8.10 ± 7.72	6.55 ± 2.12	0.096
Sleep duration weekends	8.28 ± 3.42	9.53 ± 3.00	0.023
Weekend bedtime	24.80 ± 3.61	26.79 ± 2.24	0.000
Weekend wake-up time	9.00 ± 2.59	11.90 ± 3.47	0.000
Chronotype	3.89 ± 1.24	4.60 ± 1.48	0.003
Weekday bedtime	23.97 ± 1.97	25.18 ± 1.67	0.000
Time to sleep/minutes	14.98 ± 15.35	30.00 ± 28.51	0.000
Lag in bedtime between weekends and weekdays	1.15 ± 1.77	1.58 ± 1.69	0.146
Delay in wake-up time between weekends and weekdays	2.00 ± 1.99	3.86 ± 2.17	0.000

[a] t-test.

Table 2: The significant predictors of grades after the binary logistic regression analysis.[a]

Character	B	Sig.	95.0% CI
Weekend sleep duration	−0.288	0.004	0.616−0.912
Weekend bedtime	−0.469	0.001	0.478−0.818
Sleep latency	−0.041	0.008	0.931−0.989
Bedtime lag between weekdays and weekends	.0.438	0.010	1.111−2.163
Wake-up lag between weekdays and weekends	−0.326	0.015	0.556−0.938

[a] The negative mark indicates that the higher the sleeping character, the lower the academic grade.

Table 3: A comparison of the sleep characteristics between males and females.

Character mean ± SD	Males (No = 19)	Females (No = 121)	*p*-value[a]
Age	23.56 ± 3.20	22.44 ± 1.64	0.027
Weekday wake-up time	6.31 ± 0.83	7.65 ± 2.13	0.014
Sleep duration/weekdays	9.87 ± 5.31	6.96 ± 2.07	0.046
Sleep duration weekends	7.46 ± 2.23	9.19 ± 3.30	0.045
Weekend bedtime	25.03 ± 1.93	25.98 ± 3.22	0.249
Weekend wake-up time	8.53 ± 2.25	10.87 ± 3.45	0.009
Chronotype	3.71 ± 1.14	4.37 ± 1.43	0.080
Weekday bedtime	24.25 ± 1.29	24.66 ± 1.93	0.408

[a] t-test.

Table 4: The significant predictors of female gender in the present study after the binary logistic regression analysis for.[a]

Character	B	Sig.	Exp. (B)
Weekend sleep duration	0.473	0.005	1.604
Weekend bedtime	0.459	0.011	1.583
Constant	−14.073	0.015	0.000

[a] Long weekend sleep duration and late weekend bedtime were significant predictors of women in the present study.

In the current data, no differences were evident in chronotype regarding age and sex, which is in line with a previous study. A similar study conducted in Malaysian college level students observed that chronotype was not related to the cumulative grade, a result that is in contradiction with the present data.[15] The different cultural backgrounds and higher academic demands of medical colleges could explain the difference.

The current study showed an irregular sleep−wake pattern among the participants with delayed sleep and wake-up time during weekends, particularly among the average-grade medical students, which is in agreement with Lund et al.[6] who conducted a survey among a large population and concluded similar results.

The current data showed a profound discrepancy between working and free day sleep timing (social jetlag) among the students with average grades when compared to those students with excellent grades (the average students went to bed later on free days, woke up later in the morning, and slept for longer durations than on working days with significant difference). These results are similar to Haraszti et al.[16] who observed that students who slept later on free days achieved worse grades in the morning, while the reverse was found in the afternoon test takers.

The current study showed that the students with average grades had shorter sleep duration, late bedtime, and delayed wake-up time during weekdays, but they had later wake-up time, and longer sleep durations during the weekends. These findings are similar to previous studies,[17] which concluded that students with marginal academic performance reported later bedtimes and shorter sleep durations during school nights and greater weekend delays in bedtime. These studies also confirmed the delay in bedtime and wake-up times during the weekends and echoed the present findings. The average-grade students were of the late chronotype in the current study, and because the majority of the college curriculum is scheduled for in the morning, against their natural circadian clock, a misalignment could happen, similar to what night shift workers experience in the early morning (morning chronotype). This results in compensation during the weekends, which leads to longer sleep times (late wake-up time), and the cycle is repeated. The late chronotype, when scheduled to work in the early morning, could be sleepy during the day, which could affect their alertness and mental functioning and hence academic performance. Screening for the morningness/eveningness chronotype and proper scheduling of activities according to the natural circadian rhythm could improve physical and mental well-being and academic achievement.

The current data showed that the female students waked up later and had shorter sleep duration during weekdays than males. Additionally, they tended to wake up late and had longer sleep durations during weekends, but no difference was evident in chronotype between gender, which is in agreement with previous studies.[13] Screening for circadian preference and avoiding misalignment by proper scheduling of curricular activities could improve academic performance among medical students. Raising awareness about sleep hygiene among administrative and staff members is highly needed. Encouraging afternoon and evening classes for students with the late chronotype through the establishment of colleges that adopt the suitable curricular could be of great help.

Conclusion

The average-grade medical students tend to be of the evening chronotype more than the excellent-grade students, with no difference between women and men. Scheduling activities based on chronotype could improve the academic performance among medical students. Further, larger multicentre studies to assess the factors that influence eveningness/morningness are highly needed.

The limitations of this study are the small size of the survey sample and the fact that the survey was conducted at a single college, meaning generalization cannot be insured. Other limitations of this study are that we did not cover the whole range of the students with grades from A to D, and we did not control for the few expatriates in our college. The high number of females in the present study (representative of the higher number of women at the college) could change

the study outcomes because females are more cautious and could focus on certain aspects of the study. Additionally, the various factors that could influence eveningness/morningness were not examined individually.

Recommendations: Larger multicentre studies are needed to assess the different factors that could affect the circadian process and help implement preventive measures when appropriate. Raising awareness about good sleep hygiene and circadian misalignment among medical students, staff members, and the whole community is recommended. Proper scheduling of curricular and related activities to fit the internal circadian clock of students and college staff and the development of colleges that adopt both morning and afternoon schedules are needed.

Conflict of interest

The author has no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jtumed.2017.03.007.

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