Comparison of chronotype and learning motivation in medical university students

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Abstract

Background People differ in their preferred time for intellectual activities. Morningness-eveningness preferences describe the preferred time for performing daily activities and are determined by chronotype. Chronotype reflects circadian preference in humans and is divided into morning, intermediate, and evening types. Learning motivation is a key predictor of student success and may influence learning and study, academic performance, intention to continue medical research, and well-being. Helping students develop learning motivation may improve their educational achievement and health. There are opposing studies regarding chronotype and academic achievement. We hypothesized that chronotype affects the learning motivation of medical school students.

Methods We used the reduced Morningness-Eveningness Questionnaire (rMEQ), and the Motivated Strategies for Learning Questionnaire (MSLQ) for Russian, Polish, Japanese, and Australian students in the first and second years of medical university. A total of 540 medical students answered the questionnaires. The MSLQ contains six subscales: intrinsic goal orientation, extrinsic goal orientation, self-efficacy for learning and performance, control of learning beliefs, task value, and test anxiety.

Results The rMEQ was used to classify the students into three types, which were morning (26.7%), intermediate (60.5%), or evening chronotypes (12.7%) based on their scores. The learning motivation scores for the intrinsic and extrinsic goal orientations, task value, and self-efficacy were lower in evening chronotypes.

Conclusions Our findings suggest that the evening chronotype had a lower learning motivation than the morning chronotype. Evening-oriented students may need a more flexible schedule, and a shift of the most important courses in the university to the afternoon may help them to attain higher motivation for learning medicine.

Keywords Chronotype, Learning motivation, Medical students

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Introduction

Circadian system in humans determines chronotype and represents the relationship between phase endogenous rhythm and external synchronizers. Chronotype reflects circadian preference in humans and is divided into morning, intermediate, and evening types [1]. Humans vary in the time of a day that they prefer to sleep and their length of sleep. Children present earlier chronotype, progressively delaying during development, and then reaching a maximum in lateness at about the age of 20 [2, 3].

Thus, young people may experience a discrepancy between the social and biological rhythm due to early school start times. Interestingly, morning-evening chronotypes differ across the world [4, 5].

A study by Randler et al. [6] reported that environmental factors (longitude, latitude, environmental temperature) influence chronotype and are also altered by social cues. Chronotypes may also impact academic performance indirectly through learning approaches [7, 8]. Research on chronotype and academic performance in university students reveals that students presenting morning chronotype generally achieve higher grades than evening types [9, 10]. This advantage persists even when accounting for class and exam times, possibly due to evening types experiencing more sleep deprivation [10, 11]. Furthermore, morning chronotypes also demonstrate better academic self-regulation and coping strategies during remote learning situations [12]. A previous study showed the morning-type university students have better academic achievement than evening-type or intermediate-type students [13].

It has been reported that evening chronotypes obtain lower grades at school [14, 15]. On the other hand, a study by Balcı & Caliskan (2022) [16] reported no relationship between chronotype and academic achievement. Furthermore, the morning chronotypes were found to perform better academically than evening chronotypes, with differences more pronounced in males than females [3, 17].

In recent years, learning motivation among university students has received increasing attention [18, 19], as it may affect their learning performance [20, 21]. Motivation has been defined as: the process of motivating and being motivating; a motivating drive, stimulus, or influence that causes a student to act [22]. Learning motivation is a key predictor of student success. It contributes to better academic performance [23], and student motivation to study has a positive relationship on their well-being [24].

Motivation can have intrinsic and extrinsic aspects. Intrinsic motivation is self-determination for an activity; therefore, it is the most autonomous form of motivation. Extrinsic motivation, on the other hand, drives a person to engage in an activity for some outcome such as to obtain success. Lack of learning motivation may increase the rate of students repeating the same grade or dropping out. Helping students develop learning motivation may assist in facilitating their educational achievement and well-being. Although many studies have attempted to diagnose and solve motivation problems in higher education, there has been limited research focusing on medical students and their motivation to engage in learning [25]. Thus, a better understanding of factors influencing their motivation is crucial for medical education.

Kusurkar et al. [26] established the validity of evidence for measuring the strength of motivation for medical school students. Motivation influences learning and study, academic performance, intention to continue medical research, and choice of speciality. Student background and cultural factors may influence motivational and cognitive characteristics and affect students' success or failure [27]. There are cross-culture differences in students learning and preferences for educational methods [28]; thus, because of increased globalization, medical students with competencies to meet diverse societies health and social needs are needed [29]. Because of differences in medical education in different countries and cultures, it is necessary to perform international comparative research through different medical education universities [30]. Some of these factors, including cross-cultural differences may be related to chronotype [31]. Few studies have focused on learning motivation among medical students around the globe and differences in chronotype [32, 33]. Thus, our study aimed to assess the relationship between chronotype and learning motivation among medical students in several countries.

We hypothesized that chronotype (morning type or evening type) affects the learning motivation of medical school students. Since students with the eveningness chronotype may have difficulties in waking up in the morning and have more sleepiness, they may be less motivated to learn and achieve academic success. Herein, we examine medical students from four countries to determine the relationship between their chronotype and learning motivation.

Methods

Participants and places

A total of 619 students were initially provided with an electronic survey, 549 returned the survey (88.6%), and nine were excluded (1.6%) (Fig. 1). The participant characteristics are given in Table 1.

Participants completed the reduced Morningness–Eveningness Questionnaire (MEQ) and Motivated Strategies for Learning Questionnaire (MSLQ). We excluded students with missing values and students from third and

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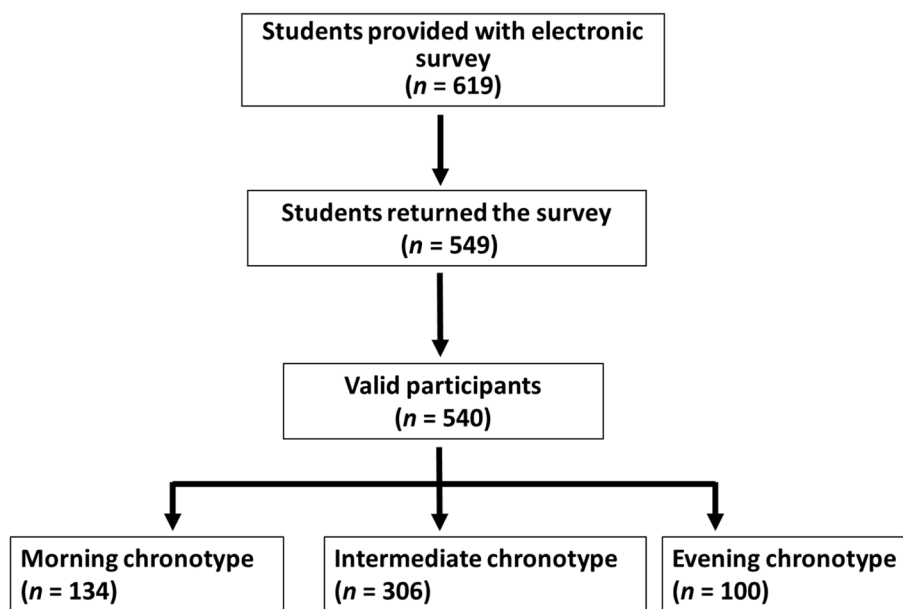
Fig. 1 Flow diagram of participants. A total of 619 were initially provided with an electronic survey, 549 returned the survey, and nine were excluded. Participants were classified as morning chronotype (*n*=134), intermediate chronotype (*n*=306), and evening chronotype (*n*=100)

Table 1 Participants and settlement characteristics

Parameters	Russia Tyumen	Australia Perth	Japan Nagakute	Poland Poznan
Latitude, **degrees**	57°N	31°S	35°N	52°N
Longitude, **degrees**	65°E	115°E	136°E	16°E
Number of participants, **n**	341	30	104	65
Sex (M/F), **n**	103/238	8/22	52/52	22/43
Age, **years**	18.0 (17.0–24.0)	21.5 (20.0–40.0)	-	20.0 (18.0–25.0)
BMI, **kg/m²**	21.4 (15.6–35.4)	21.5 (15.9–32.6)	-	21.0 (17.7–28.4)
Eating daily breakfast, **n (%)**	295 (86.5)	24 (80.0)	95 (91.3)	63 (96.9)
Smoking, **n (%)**	15(4.4)	0	-	9 (14)

The data are given as medians and range, *n*=540

Abbreviations: *BMI* body mass index, *M* male, *F* female

fourth grade. We selected students among first- or second-year students due to other studies that indicate that students' motivations during their medical school stay toward training and medical practice can differ during the pre-clinical and clinical study [34].

The completeness rate was 0.87. A priori power analysis using R version 4.3.3 showed the sample size were 44.6 participants to detect significance (k=4, f=0.25, power=0.8, significant level=0.05). Valid participants (*n*=540) were selected from among first- or second-year medical students in the following universities: Poznan University of Medical Sciences (Poznan, Poland); (65 students who responded from a total of 180 students); Aichi Medical University (Nagakute, Japan); (104 students who responded from a total of 107 students); Tyumen Medical University (Tyumen, Russia); (341 students, who responded from a total of 350 students); and the University of Western Australia (Perth, Australia); (30 who responded from a total of 101 students). We selected students among first- or second-year students due to other studies that indicate that students' motivations during their medical school stay toward training and medical practice can differ during the pre-clinical and clinical study [34].

Students were informed about the survey during class, that not taking part or not completing the study would

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have no negative consequences upon the individual, and that their data would be anonymous. The questionnaire was distributed through Google Forms (Google LLC) in Poland, Russia, and Australia, and the questionnaire in Japan was used in paper format. The assessment was made with rMEQ in the official Japanese version [35], Polish version [36], and Russian version. The MSLQ was also in the Japanese version [37], Polish [38], and Russian version [39]. This web-based survey verified the recommendations of CHERRIES (Checklist for Reporting Results of Internet E-Surveys) for web survey quality [40].Participants filled the questionnaire after reading a descriptive introduction on the topic.

All study procedures and materials were approved by the Institutional Review Boards at: Aichi Medical University, Aichi, Japan; Poznan University of Medical Sciences, Poznan, Poland; Tyumen Medical University, Tyumen, Russia; and University of Western Australia, Perth, Australia. The study was performed following the Helsinki Declaration. The questions were considered to not be of any ethical concern. Informed consent to participate was obtained from the study in Poland, Russia, and Australia. The study in Japan was performed by opt-out method if participants were excluded.

Questionnaires

The questionnaire took about 20 min to answer and consisted of three parts: (1) general questions about age, sex, height, and weight; dietary habits, diseases, the use of any medication, and smoking; (2) questions about chronotype patterns; and (3) questions about learning motivation.

1) Morningness-Eveningness questionnaire.

Chronotype was determined using the reduced MEQ (rMEQ), as described previously by Horne & Ostberg (1976) [1, 2]. This tool was used to categorize the respondents into morning, evening, or intermediate chronotypes. On this basis, they were divided according to the presented type of chronotype: morning (scoring $\geq$ 18), evening (scoring $\leq$ 11), and intermediate type (scoring 12–17).

Chronotype determines the peak hours of physical and psychological performance, and sleep and awakening preferences.

2) Motivated Strategies for Learning Questionnaire.

The MSLQ assesses motivation and learning strategies. It consists of six motivation subscales and nine learning strategy subscales [41, 42]. The motivation scales are grouped into six subscales: Intrinsic Goal Orientation (IGO), Extrinsic Goal Orientation (EGO), Task Value (TV), Control of Learning Beliefs (CLB), Self-Efficacy for Learning and Performance (SEL), and Test Anxiety (TA). IGO refers to the degree to which students perceive

themselves to be participating in a task for inner reasons such as challenges or interests. EGO refers to the degree to which students perceive themselves to be participating in a task for reasons such as grades or rewards. TV refers to involvement in the learning. CLB refers to students believing their efforts to learn will result in positive outcomes. SEL refers to confidence and belief in the ability to perform a task. TA refers to worries about test. The students answered on a seven-point Likert scale from "not at all true of me" to "very true of me". The Cronbach's alpha were 0.75 for IGO, 0.78 for EGO, 0.74 for TV, 0.76 for CLB, 0.75 for SELP and 0.84 for TA.

Statistics

The results are presented as means $\pm$ standard deviations or medians and ranges as appropriate. Normality of distribution was tested using the Shapiro-Wilk test and equality of variances by Levene's test. Comparison of unpaired groups was performed using the unpaired t-test (for data that follow normal distribution and homogeneity of variances) or paired t test (for data that follow normal distribution). Comparison of two unpaired groups was performed using the Mann–Whitney U-test or for paired model the Wilcoxon test (data did not follow normal distribution or ordinal data). Comparisons of more than two groups were performed using the Kruskal-Wallis test, with the Dunn's post-hoc test. Categorical data were analysed with the Chi-square test.

Multiple linear regression analysis was conducted to investigate the factors affecting learning motivation. The relationship between variables was analyzed with Pearson's rank correlation. All results were considered significant at $p < 0.05$. Statistical analyses were performed with STATISTICA 13.0 software (StatSoft Inc.), SPSS version 28 (IBM SPSS Statistics) and R version 4.3.3 (Free Software Foundation).

Results

Morningness–eveningness chronotypes amongst students

The students from four countries were classified as morning chronotypes (26.7%), intermediate chronotypes (60.5%), or evening chronotypes (12.7%) based on their scores. The chronotypes were characterized in terms of demographics and distributions across the countries (Table 2). Chi-square test showed the distribution of chronotype are different between countries ($p < 0.001$). The morning chronotype was most common among Australian students compared to the evening chronotype, whereas the evening chronotype was most common among Japanese and Polish students compared to the morning chronotype. The largest group in total were those classified as the intermediate chronotype.

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Table 2 Participants' chronotypes

	Chronotypes			*p*-value	Chi-Squared Statistic	Degrees of Freedom	Cramer's V
	Morning	Intermediate	Evening				
Chronotypes of participants, n (%)	134 (26.7)	306 (60.5)	100 (12.7)				
Poland, n (%)	16 (24.6)	31 (47.7)	18 (27.7)	<0.01	59.8	6	0.24
Russia, n (%)	83 (24.3)	214 (62.7)	44 (13.0)				
Australia, n (%)	20 (66.6)	8 (26.7)	2 (6.6)				
Japan, n (%)	15 (14.4)	53 (50.9)	36 (34.6)				

Students ($n = 540$) were categorized into morning types, $n = 134$; intermediate types, $n = 306$; and evening types, $n = 100$. Data were analyzed with Chi-square test and with Cramer's V for chi squared test

A value of $p < 0.05$ was considered as significant

Motivation profile of medical students

To determine MSLQ by chronotype, each parameter of the MSLQ (IGO, EGO, TV, CLB, SEL, and TA) was calculated. We found that the evening type scored lower in the IGO, EGO, TV, and SEL parameters of the MSLQ than the morning and intermediate types ($p < 0.001$). The results for the intermediate type were similar to those of the morning type for IGO, EGO, TV, CLB, SEL, and TA. The exact values for each section and chronotype are detailed in Table 3.

Relation between chronotype and learning motivation

There was no significant correlation between each motivation parameters and MEQ score in each country. Meanwhile, a poorly marked, negative correlation between MEQ score and EGO and TV was observed among Russian students, and p – value for this correlation for Polish students was close to 0.05, suggest poor negative correlation between analysed variables (Table 4). A multiple regression analysis was conducted to verify the optimal model to find parameters affecting learning motivation in EGO, IGO, TV, CLB, SEL, and TA. However, explanatory power was underpowered to show the effective parameters to MSLQ parameters.

Discussion

This cross-sectional study was conducted to identify the factors affecting the learning motivation of medical students. Furthermore, we performed cross-cultural comparisons to help increase generalizability. We analyzed medical students' chronotypes, learning motivation, and lifestyle.

The distribution of chronotypes was different among countries, especially among Australians the morning chronotypes were more common compared to the evening chronotype. Environmental factors, such as sunrise or ambient temperature, may affect chronotypes [2, 7]. Our findings support a previous study that reported that people near the equator have a higher morning preference than those in higher latitudes [7], as we found that Australian students had mostly morning chronotypes.

The most relevant finding in our research was that chronotype affected learning motivation. We found that the motivation scores of IGO, EGO, TV, and SEL were lower among the evening chronotype group than those of the morning and intermediate chronotypes. A study by Escribano & Díaz-Morales (2016) [43] reported that morning chronotypes had higher learning goals and performance goals, and these goals were positively related with self-reported academic performance. Moreover, a study on undergraduate medical students reported that morning chronotypes included deeper learners and evening learners included surface learners, however, the morning and evening types did not differ in academic performance [8].

Goal orientation represents the student's recognition of the reasons for engaging in a particular learning task. On the MSLQ, goal orientation can be intrinsic goal orientation (IGO) or extrinsic goal orientation (EGO). IGO originates primarily from internal reasons such as a desire to succeed in a challenge. When we measured the level of IGO in a group of medical students, we found that IGO score among the evening chronotype group was lower than that of morning and intermediate chronotypes ($p < 0.05$). A study by Lyke & Young [44] reported that students with higher IGO scores had a deeper understanding of the task. In addition, Vansteenkiste et al. [45] reported that IGO promotes short- and long-term persistence of learners. This result suggests that students who are evening-oriented have less intrinsic motivation to learn medicine as a pleasure and interest.

A study by Mehta et al. [46] found that students with higher scores in TV, IGO, SEL, and CLB had more optimistic experiences in an active learning session. The evening chronotype had the lowest level of self-efficacy compared to the morning and intermediate chronotypes.

Table 3 MSLQ score according to chronotype

A

Parameters of MSLQ	Chronotype			p-value
	Morning	Intermediate	Evening	
Intrinsic Goal Orientation **(IGO)**	5.0 (2.0-7.0)	4.8 (1.0-7.0)	4.3 (1.0-7.0)	<0.01
Extrinsic Goal Orientation **(EGO)**	4.8 (1.0-7.0)	4.8 (1.0-6.8)	4.3 (1.0-7.0)	<0.01
Task Value **(TV)**	5.3 (2.2-7.0)	5.2 (1.3-7.0)	4.7 (1.0-7.0)	<0.01
Control of Learning Beliefs **(CLB)**	5.3 (2.0-7.0)	5.0 (1.0-7.0)	5.0 (1.8-7.0)	0.12
Self-efficacy for Learning and Performance **(SEL)**	4.6 (1.6-7.0)	4.6 (1.0-7.0)	4.1 (1.0-6.8)	<0.01
Test Anxiety **(TA)**	4.5 (1.2-7)	4.4 (1.0-6.8)	4.2 (1.4-6.8)	0.12

B

Variable	Comparison	p-value	Effect Size (Vargha & Delaney's A)
IGO	Morning vs Intermediate	1.0	0.53
IGO	Morning vs Evening	<0.01	0.66
IGO	Intermediate vs Evening	<0.01	0.37
EGO	Morning vs Intermediate	0.56	0.54
EGO	Morning vs Evening	<0.01	0.65
EGO	Intermediate vs Evening	<0.01	0.40
TV	Morning vs Intermediate	<0.01	0.59
TV	Morning vs Evening	<0.01	0.68
TV	Intermediate vs Evening	0.01	0.40
SELP	Morning vs Intermediate	1.0	0.52
SELP	Morning vs Evening	<0.01	0.65
SELP	Intermediate vs Evening	<0.01	0.38

The data are given as medians and ranges, $n = 540$. *MSLQ* Motivated Strategies for Learning Questionnaire. Kruskal-Wallis test was conducted to examine the differences in MSLQ scores according to the chronotype (A) and post-hoc test for multiple comparisons (B). The results were adjusted by adding degrees of freedom, Kruskal-Wallis H statistic, and effect size (Vargha & Delaney's A for Dunns' test)

A value of $p < 0.05$ was considered as significant

A study by Shapiro et al. [47] reported that the more one believed they may achieve a goal, the more success they had committing to that goal.

This study describes motivational components and their relationship with the chronotype of medical students from four different universities. This study's results suggest that individuals who had the evening chronotype had lower learning motivation than the morning and intermediate chronotypes, as motivation scores of IGO, EGO, TV, and SEL were lower in the evening chronotype group. Understanding the relationship between chronotype and learning motivation may be an effective learning strategy for medical students. A combination of chronotype and learning motivation may have a potentiating effect on academic performance. Our results suggest that evening-oriented students need a more flexible schedule and a shift of the most important courses in the university to the afternoon may help students to attain higher motivation for learning

medicine. Because of the demands of modern society, students must fit their chronotype around a school or work schedule that may impose wake-up times and activation timing that runs counter to their innate circadian preference. Misalignment between internal timing and the work/social schedule results in social jet lag [48, 49]. Studies evaluating the impact of an individual's chronotype on their academic achievement have indicated that morning chronotypes have an educational advantage over evening chronotypes. This is probably because evening chronotypes are generally more sleep-deprived than morning chronotypes due to the early schedule of most schools, which can impair their performance both early and late in the day [10, 13]. The study by Rodríguez Ferrante et al. (2023) [50] highlighted that early school start times not only disadvantage students with later chronotypes but also affect most adolescents' sleep habits and well-being, and a better alignment

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Table 4 The Pearson correlation for the MSLQ score & MEQ score

Parameters		Russia $n=341$	Poland $n=56$	Japan $n=99$	Australia $n=28$
IGO score & MEQ score	R coefficient	ns	ns	ns	ns
	p-value	0.58	0.63	0.10	0.12
EGO score & MEQ score	R coefficient	-0.14	-0.26	ns	ns
	p-value	0.02	0.06	0.76	0.09
TV score & MEQ score	R coefficient	-0.16	ns	ns	ns
	p-value	0.01	0.81	0.24	0.56
CLB score & MEQ score	R coefficient	ns	ns	ns	ns
	p-value	0.62	0.47	0.84	0.56
SEL score & MEQ score	R coefficient	ns	ns	ns	ns
	p-value	0.44	0.31	0.17	0.32
TA score & MEQ score	R coefficient	ns	ns	ns	ns
	p-value	0.73	0.24	0.88	0.74

Abbreviations: MEQ Morningness-Eveningness score, *MSLQ* Motivated Strategies for Learning Questionnaire, *IGO* Intrinsic Goal Orientation, *EGO* Extrinsic Goal Orientation, *TV* Task Value, *CLB* Control of Learning Beliefs, *SEL* Self-efficacy for Learning and Performance, *TA* Test Anxiety, *ns* non-significant

A value of $p < 0.05$ was considered as significant

between school timing and students' biological rhythms might enhance future opportunities for adolescents.

The present study has several limitations and results regarding these limitations should be interpreted with caution. First, the sample size of countries differed due to less-than-expected recruitment. Second, the correlation coefficients obtained were generally low. Third, there are also likely different individual confounding effects on learning motivation due to students' that were not accounted for backgrounds directly.

Authors' contributions
MS conceived the study, managed the participants, and wrote the manuscript; MR performed statistical analyses and addressed the participants; TH performed statistical analyses; BK, DG, and NB managed the participants; EK, AB and JW critically reviewed the manuscript, and DK designed and supervised the study and wrote the manuscript draft.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committees of Aichi Medical University, Aichi, Japan (No. 17-M024). Poznan University of Medical Sciences, Poznan, Poland; Tyumen Medical University, Tyumen, Russia; and University of Western Australia, Perth, Australia was performed following the Helsinki Declaration. Informed consent to participate was obtained from the study in Poland, Russia, and Australia. The study in Japan was performed by opt-out method if participants were excluded.

Consent for publication
All authors have read the manuscript and have agreed to submit it in its current form for consideration for publication.

Competing interests
The authors declare no competing interests.

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