DOI: https://doi.org/10.26529/cepsj.1790

The Relationship between Chronotype and Academic Achievement among Slovene University Students: The Mediating Role of Trait Self-Control and Sleep Quality

Katarina Maučec*[1] and Vita Štukovnik[2]

Several studies have identified a relationship between an individual's chronotype and academic performance. Specifically, individuals with a morning preference often outperform those with an evening preference. Our research explored whether trait self-control and sleep quality mediate this association. We conducted an online survey completed by Slovenian university students. Chronotype, trait self-control, and sleep quality were measured using the Morningness-Eveningness Questionnaire, the Brief Self-Control Scale, and the Pittsburgh Sleep Quality Index. Additionally, the participants' academic achievement was assessed using an objective measure (the average grade for the winter 2022/2023 exam period) and a subjective measure (students' own assessment of their performance compared to their peers). The results show that all researched concepts are positively correlated. Additionally, mediation analyses revealed that trait self-control significantly mediated the relationship between chronotype and both measures of academic achievement. Conversely, while sleep quality did not mediate the relationship between chronotype and objective academic achievement, it did partially mediate the relationship between chronotype and the subjective achievement measure. These insights provide a novel comprehension of the intrinsic modalities that might link chronotype and academic performance.

Keywords: chronotype, academic achievement, trait self-control, sleep quality, university students

1 *Corresponding Author. Health Promotion Center, Laško Community Health Centre, Laško, Slovenia; kmaucec12@gmail.com.

2 Faculty of Arts, University of Maribor, Maribor, Slovenia.

Povezanost kronotipa in študijske uspešnosti pri slovenskih študentih: mediatorska vloga samokontrole kot osebnostne lastnosti in kakovosti spanja

Katarina Maučec in Vita Štukovnik

Številne študije so pokazale, da je posameznikov kronotip povezan z njegovo študijsko uspešnostjo. Študentje, ki imajo izražene značilnosti jutranjega tipa, so študijsko uspešnejši kot tisti, ki imajo izražene značilnosti večernega tipa. Namen naše raziskave je bil ugotoviti, ali sta samokontrola kot osebnostna lastnost in kakovost spanja mediatorja v tej povezavi. Izvedli smo spletno anketo, ki jo je izpolnilo 544 slovenskih študentov (56 % žensk, povprečna starost 21,6 leta, *SD* = 2,32). Kronotip, samokontrola kot osebnostna lastnost in kakovost spanja so bili merjeni z uporabo vprašalnika jutranjosti in večernosti (MEQ), kratke lestvice samokontrole (BSCS) in pittsburgškega indeksa kakovosti spanja (PSQI). Študijsko uspešnost udeležencev smo ocenili z objektivno (tj. povprečno oceno zimskega izpitnega obdobja 2022/23) in s subjektivno mero (subjektivno oceno študijske uspešnosti v primerjavi s sovrstniki). Rezultati so pokazali, da so vsi raziskovani koncepti pozitivno povezani. Mediacijske analize so pokazale, da samokontrola kot osebnostna značilnost statistično pomembno mediira odnos med kronotipom in obema merama študijske uspešnosti. Po drugi strani kakovost spanja ni mediirala odnosa med kronotipom in objektivno mero študijske uspešnosti, je pa delno mediirala odnos med kronotipom in subjektivno mero študijske uspešnosti. Naši rezultati nakazujejo na novo razumevanje mehanizmov, ki povezujejo kronotip in študijsko uspešnost.

Ključne besede: kronotip, študijska uspešnost, samokontrola kot osebnostna značilnost, kakovost spanja, študentje

Introduction

Circadian rhythms, intrinsic biological oscillators, govern a multitude of physiological processes and behavioural activities in living organisms, synchronising them with the environmental 24-hour day-night cycle (Vitaterna et al., 2001). A pertinent manifestation of these rhythms in humans is the chronotype, representing an individual's preferential timing for periods of activity and rest, which subsequently influences diverse aspects of daily functioning and overall well-being (Adan et al., 2012).

Individuals typically ascribe to one of two predominant chronotypes: morning and evening types. Morning types demonstrate a predilection for earlier periods of peak activity, preferring earlier times for sleep and waking. Conversely, evening types exhibit a propensity for later activity peaks, typically adhering to later sleep and waking schedules (Wittmann et al., 2006).

Research indicates that an individual's chronotype goes beyond merely dictating their daily preferences; it can significantly affect various aspects of mental and physical health, creating a wide range of individual differences. Importantly, people who are naturally inclined towards 'eveningness' have been found to experience various challenges. Such challenges include mental health issues such as depression and anxiety (Partonen, 2015), as well as behaviours like acting on impulse and taking risks (Fabbian et al., 2016). Furthermore, a substantive body of evidence fortifies the relationship between chronotype and academic achievement. The data suggests a notable trend of superior academic performance among morning types in comparison to their evening-type counterparts within university student populations (Enright & Refinetti, 2017; Mirghani, 2017; Montaruli et al., 2019; Tonetti et al., 2015). Nevertheless, a limited number of studies do not support this trend in certain age groups. Specifically, Figueiredo (2023) has demonstrated that morning and evening types in primary school do not differ in academic performance in the subjects of math and Portuguese. A meta-analysis conducted by Preckel et al. (2011), however, elucidates that the relationship between chronotype and academic achievement operates independently of age, while another by Tonetti et al. (2015) reveals the stability of this association across both genders.

Researchers have worked to understand how chronotype and academic achievement are connected, exploring factors like learning motivation and daily sleepiness as possible links between them. For instance, a susceptibility to reduced learning motivation and heightened daily sleepiness among evening types has been documented, which, in turn, poses detriments to their academic attainments (Roeser et al., 2013). High school students who report attenuated

alertness during diurnal hours also manifest heightened levels of depressive moods, which is concomitantly associated with suboptimal academic performance (Short et al., 2013).

Additionally, the influence of personality traits has been implicated in mediating the relationship between chronotype and academic performance. Specifically, 'morningness' is associated with proactive behaviours, notably elevated conscientiousness (Rahafar et al., 2016), which has been identified as a predictor of academic achievement (Arbabi et al., 2015). Another personality trait that may elucidate these discrepancies is self-control, although research scrutinising its role in the relationship between chronotype and academic achievement is scant. Trait self-control, characterised as the capacity to modulate one's responses to align with standards such as ideals, values, morals, and societal expectations and to facilitate the pursuit of longitudinal goals (Baumeister et al., 2007), has been illustrated to be more prominent among morning types (Digdon & Howell, 2008; Milfont & Schwarzenthal, 2014; Przepiórka et al., 2019; Wang, 2014). Furthermore, trait self-control is a critical determinant of academic prosperity. Wang and Hu (2015) offer a potential explanation for the association between chronotype and trait self-control through the lens of social jet lag, wherein societal demands conflict with individual sleep preferences, creating discrepancies and inducing social jet lag. Consequently, evening types, requiring amplified effort to manage daily societal demands, may deplete their self-control resources, culminating in diminished self-control (Baumeister et al., 1994). An alternative explanatory framework posits that the positive correlation between morningness and trait self-control may be attributable to reduced bedtime procrastination among morning types (Wang & Hu, 2015), as higher trait self-control is inversely related to bedtime procrastination among tertiary education students (Bernecker & Job, 2020; Zhang et al., 2023). Several personality traits, including impulsiveness, sensation-seeking, and persistence, are concomitantly associated with both chronotype and trait self-control. Evening types exhibit heightened impulsiveness (Kang et al., 2015; Selvi et al., 2011; Selvi et al., 2015) and sensation-seeking (Prat & Adan, 2013), while higher trait self-control is inversely associated with impulsiveness (Mao et al., 2018) and sensation-seeking (Pokhrel et al., 2010). Moreover, a positive correlation exists between morningness and persistence (Caci et al., 2004; Lee et al., 2017) and, similarly, between persistence and trait self-control (Gordeeva et al., 2017).

Empirical evidence substantiates that university students manifesting higher trait self-control also exhibit enhanced academic success (King & Gaerlan, 2013; Stadler et al., 2016). Trait self-control predicts academic achievement, transcending cognitive ability, and forecasts both objective (e.g., grade point

average) and subjective academic achievement metrics, whereas cognitive ability solely predicts objective academic achievement indicators (Stadler et al., 2016). Given the association of trait self-control with both chronotype and academic achievement, it is plausible that trait self-control could mediate the relationship between these two constructs.

People with different chronotypes also show distinct differences in their quality of sleep. The concept of sleep quality, despite lacking a universally accepted definition (Ohayon et al., 2017), is discernible through various parameters such as subjective sleep quality, sleep latency, duration, efficiency, disturbances, use of sleep medication, and daytime dysfunction (Buysse et al., 1989). A body of research underscores a predilection towards suboptimal sleep quality among individuals exhibiting eveningness as opposed to morningness (Bavarsad et al., 2015; Carciofo et al., 2014; Kabrita et al., 2014; Vollmer et al., 2017). Individuals exhibiting a preference for morningness frequently demonstrate an augmented daily lifestyle regularity, a characteristic that has been positively correlated with enhanced sleep quality (Monk et al., 2004; Monk et al., 2003). A study by Taillard et al. (2002) illustrates that evening types, in contrast, typically exhibit a variability exceeding two hours in both bedtime and waking times compared to their morning-type counterparts. Moreover, evening types report heightened difficulties in sleep initiation (Sun et al., 2019) alongside an increased prevalence of insomnia symptoms and nightmares (Merikanto et al., 2012), all of which are factors inherently associated with reduced sleep quality (Bollu & Kaur, 2019; Paul et al., 2015; Yi et al., 2006). Furthermore, evening types harbour more dysfunctional beliefs regarding sleep (Adan et al., 2006; Ong et al., 2007), and the modification of such beliefs via cognitive-behavioural therapy has been demonstrated to enhance subjective sleep quality (Edinger et al., 2001).

Additionally, a positive correlation exists between sleep quality and academic achievement, as substantiated by multiple studies (El Hangouche et al., 2018; Gomes et al., 2011; Mirghani et al., 2015; Wong et al., 2013).

Suboptimal sleep quality also tends to result in elevated daytime sleepiness (Zailinawati et al., 2009), which has been inversely associated with academic achievement (Bahammam et al., 2012).

Numerous studies have linked trait self-control and sleep quality to both chronotype and academic achievement, albeit without exploring their potential mediating roles in this relationship. This study seeks to elucidate the underlying mechanisms correlating chronotype with academic achievement, questioning the attribution to biological predisposition and considering alternative mediators such as personality traits and sleep factors. We examine whether lower academic performance in university students preferring eveningness could

be attributed not directly to chronotype but mediated by trait self-control and sleep quality. Thus, this research aims to explore the mediating roles of trait self-control and sleep quality in the association between chronotype and academic success in a sample of Slovenian university students. Maučec and colleagues (2023) initially presented the study's preliminary results at the eSleep Europe Virtual Congress 2023. This article now unveils the expanded findings.

The hypotheses addressed in this study are:

1. The association between chronotype and academic achievement is mediated by self-control in a sample of Slovenian university students.
2. The association between chronotype and academic achievement is mediated by sleep quality in a sample of Slovenian university students.

Method

Participants

The sample was comprised of 544 Slovenian university students (56.1% female; M = 21.61 years, SD = 2.32), spanning various universities and faculties, with the majority being undergraduate students (67.2%). We included university students who achieved grades during the winter semester 2022/23.

Instruments

The Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976): A 19-item measure capturing aspects of morningness across sleep habits, sleepiness, and optimal functioning times. The questionnaire utilises 1 to 5-point scales within its multiple-choice questions, with cumulative scores ranging from 16 to 86, categorising respondents into extreme evening type (16–30), moderately evening type (31–41), intermediate type (42–58), moderately morning type (59–69), and extreme morning type (70–86). The Slovenian version demonstrates a Cronbach alpha of 0.86 and a test-retest reliability of 0.96 (Treven Pišljar et al., 2019).

The Brief Self-Control Scale (Tangney et al., 2004): A 13-item instrument assessing trait self-control, with items rated on a 5-point Likert scale and higher scores indicating greater self-control. The Slovenian adaptation shows a Cronbach alpha of 0.77 (Zorjan, 2014).

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989): A measure evaluating sleep quality across seven domains: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, using 19 questions. Focusing on sleep quality in the past month, scores are calculated with a specific algorithm and combined to

produce seven composite scores and a global sleep quality score. While lower scores denote better sleep quality, a score above 5 distinguishes poor sleepers (Buysse et al., 1989). The Slovenian version of the PSQI used in our study has a Cronbach's alpha of 0.68 (Košir, 2021).

The Objective Academic Achievement: Assessed through students' average grades during the winter semester of 2022/23.

The Subjective Academic Achievement: This was evaluated using a 5-point Likert scale question regarding students' self-perception of academic performance relative to peers in the winter semester of 2022/23.

Research design

Conducted from February 20th to March 5th, 2023, this prospective cross-sectional study utilised an online survey distributed via social media platforms, university newsletters, and email. Informed consent was obtained from each participant prior to survey initiation. All participants anonymously reported their demographic data, responded to standardised questionnaires, and could withdraw at any point without consequence. Participation was voluntary. Adherence to the Declaration of Helsinki was maintained throughout the study.

Initial analyses encompassed descriptive statistics and frequency analyses for demographic data. The representation of chronotypes and the percentage of participants scoring above 5 on the PSQI were calculated. Skewness and kurtosis coefficients verified the normal distribution of data, adhering to criteria set by Hair et al. (2010).

With subsequent Pearson correlation coefficient analyses, we explored relationships between variables, followed by a mediation analysis, employing the PROCESS macro ver. 3.5 (Hayes, 2013). Full or partial mediation models were subjected to Sobel test verification for statistical significance. Analyses were conducted using IBM SPSS ver. 21 (IBM Corp, 2019).

Results

Table 1 presents the descriptive statistics for chronotype, trait self-control, sleep quality, subjective academic achievement, and objective academic achievement (average grade). In terms of chronotype distribution, 3.7% of participants identified as extreme evening types, 19.7% as moderately evening types, 59.7% as intermediate types, 14.2% as moderately morning types, and 2.8% as extreme morning types. Based on the PSQI criterion (a score > 5) denoting poor sleep quality (as per Buysse et al., 1989), 65.9% of the university students in our sample qualified as poor sleepers.

Table 1

Descriptive statistics of the study variables

	M	*SD*	*Min*	*Max*	Skewness	Kurtosis	Cronbach alpha
Chronotype	48.64	10.04	24	81	0.19	-0.07	0.86
Trait self-control	41.46	8.47	17	61	0.05	-0.53	0.83
Sleep quality	6.00	2.90	1	17	0.97	1.03	0.67
Subjective academic achievement	3.42	1.04	1	5	-0.24	-0.35	-
Average grade	8.37	0.93	6	10	-0.36	-0.28	-

Note. M = average; *SD* = standard deviation; *min* = minimum; *max* = maximum Chronotype = Morningness-Eveningness Questionnaire total score; Trait self-control = Brief Self-Control Scale; Sleep quality = Pittsburgh Sleep Quality Index; Average grade = objective academic achievement.

The relationships between chronotype, trait self-control, sleep quality, and objective and subjective academic achievement

Table 2 presents statistically significant correlations among all variables. According to Dancey and Reidy (2007), all correlation coefficients were of low magnitude, with the exception of those between objective and subjective measures of academic achievement. Specifically, morningness showed a positive correlation with trait self-control and sleep quality. Additionally, morningness exhibited positive correlations with both subjective academic achievement and average grade.

Furthermore, both measures of academic achievement demonstrated positive correlations with trait self-control and with sleep quality.

Table 2

Pearson correlation coefficients of studied variables

	Chronotype	Trait self-control	Sleep quality	Subjective academic achievement	Average grade
Chronotype	-				
Trait self-control	0.37**	-			
Sleep quality	-0.16**	-0.30**	-		
Subjective academic achievement	0.18**	0.36**	-0.14**	-	
Average grade	0.14**	0.28**	-0.10*	0.57**	-

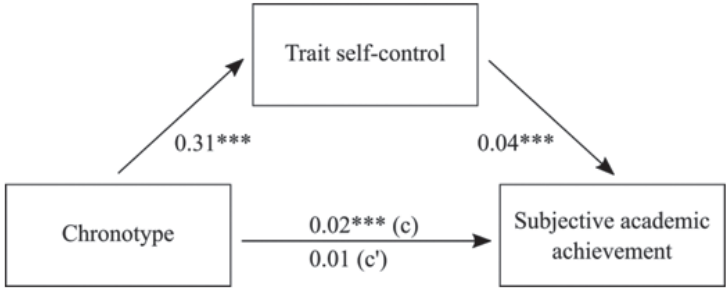
Note. * $p < .05$; ** $p < .01$; Chronotype = Morningness-Eveningness Questionnaire; Trait self-control = Brief Self-Control Scale; Sleep quality = Pittsburgh Sleep Quality Index; Average grade = objective academic achievement.

Mediational role of trait self-control and sleep quality in the relationship between chronotype and academic achievement

We aimed to explore the relationship between chronotype and academic achievement among university students. In the analysis examining the mediational role of trait self-control, a significant total effect was observed between chronotype and subjective academic achievement. Both Path A (representing the effect of chronotype on trait self-control) and Path B (representing the effect of trait self-control on subjective academic achievement) were statistically significant. Notably, when incorporating trait self-control into the relationship between chronotype and subjective academic achievement, the direct effect became non-significant. Further, the Sobel test yielded a *t*-value of 6.33 with $p < 0.001$, indicating that trait self-control serves as a complete mediator in the relationship between chronotype and subjective academic achievement, as depicted in Figure 1.

Figure 1

Mediational role of trait self-control in the relationship between chronotype and subjective academic achievement (Maučec et al., 2023)

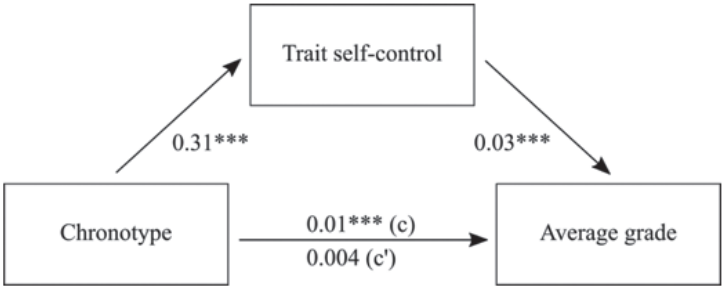


In the examination of the mediational role of trait self-control concerning the relationship between chronotype and average grade (objective academic achievement), a noteworthy total effect was observed between chronotype and average grade.

Additionally, Path B, representing the impact of trait self-control on average grade, was found to be significant. However, upon introducing trait self-control into the relationship between chronotype and average grade, the direct effect proved non-significant. The Sobel test further corroborated the indirect effect with a value of t =5.01 and $p < 0.001$. Consequently, it can be inferred that the relationship between chronotype and average grade is entirely mediated through trait self-control, as illustrated in Figure 2.

Figure 2

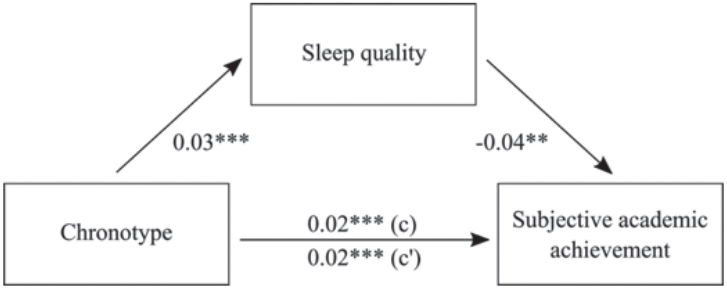
Mediational role of trait self-control in the relationship between chronotype and average grade (Maučec et al., 2023)



In examining the mediating role of sleep quality between chronotype and subjective academic achievement, our results indicate significant associations for both Path A (i.e., the effect of chronotype on sleep quality) and Path B (i.e., the effect of sleep quality on subjective academic achievement). Notably, the introduction of sleep quality into the relationship between chronotype and subjective academic achievement rendered the direct effect significant. The Sobel test further substantiates the indirect effect with a value of $t = 2.37$ and $p = 0.02$. Consequently, the data suggests that sleep quality serves as a partial mediator in the relationship between chronotype and subjective academic achievement (refer to Figure 3).

Figure 3

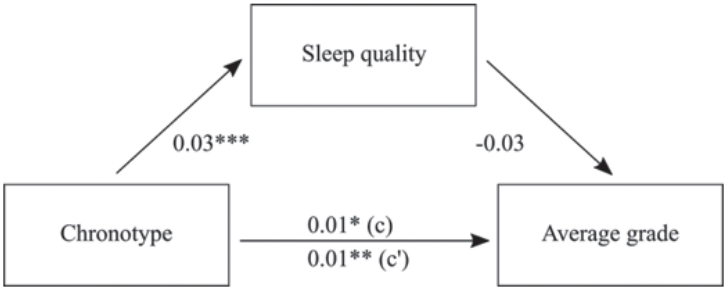
Mediational role of sleep quality in the relationship between chronotype and subjective academic achievement (Maučec et al., 2023)



In our investigation into the potential mediating effect of sleep quality on the relationship between chronotype and average grade, we found that

Path B (i.e., the effect of sleep quality on average grade) lacked significance. Subsequently, introducing sleep quality into the relationship between chronotype and average grade resulted in an insignificant direct effect. Based on these findings, we infer that the relationship between chronotype and average grade operates independently of sleep quality (refer to Figure 4).

Figure 4
Mediational role of sleep quality in the relationship between chronotype and average grade (Maučec et al., 2023)



Discussion

In this study, we aimed to elucidate the underlying mechanisms potentially linking chronotype with academic achievement. Specifically, our focus was on the mediating roles of trait self-control and sleep quality. While numerous studies have established a connection between these two constructs and the interplay of chronotype and academic achievement (Bavarsad et al., 2015; Digdon & Howell, 2008; El Hangouche et al., 2018; Stadler et al., 2016), none have explored the potential mediating roles of trait self-control and sleep quality in this relationship. Our investigation aimed to augment the current understanding of the intricate mechanisms underpinning the aforementioned association. Our study demonstrates a positive association between morningness and academic achievement, measured using both objective and subjective measures. Consistent with prior research, we found that morning types outperform their evening-type counterparts academically (Enright & Refinetti, 2017; Mirghani, 2017; Montaruli et al., 2019; Preckel et al., 2011). Morning types exhibit less daily sleepiness and greater academic motivation, which correlates with improved outcomes (Roeser et al., 2013). Conversely, evening types often show lower conscientiousness levels, a trait crucial for academic success (Arbabi et al., 2015; Rahafar et al., 2016).

Furthermore, our results indicate a significant positive association between chronotype, trait self-control, and academic achievement, with the latter assessed using objective and subjective measures. This observation is consistent with previous literature, which has also highlighted that individuals with morning tendencies generally demonstrate enhanced trait self-control (Digdon & Howell, 2008; Milfont & Schwarzenthal, 2014; Przepiórka et al., 2019) and that university students who exhibit higher levels of trait self-control tend to achieve superior academic outcomes (King & Gaerlan, 2013; Stadler et al., 2016). Moreover, in our study, trait self-control fully mediates the relationship between chronotype and academic achievement. To the best of our knowledge, this latter finding might provide a new perspective, possibly illuminating a previously unidentified mechanism that connects chronotype with academic achievement. It suggests that individuals with a morning preference are adept at modulating their responses, favouring strategies that support the achievement of long-term objectives. This can potentially facilitate more effective learning and better academic performance. Conversely, evening chronotypes demonstrate reduced self-control, which could contribute to their lower academic outcomes. Current literature affirms that individuals with an evening chronotype manifest heightened impulsivity (Kang et al., 2015; Selvi et al., 2011; Selvi et al., 2015), increased sensation-seeking behaviours (Prat & Adan, 2013), and lack of persistence (Caci et al., 2004; Lee et al., 2017). These behavioural patterns suggest a predisposition towards lower self-control traits (Gordeeva et al., 2017; Mao et al., 2018; Pokhrel et al., 2010) and collectively suggest a potential hindrance to academic success for evening chronotypes.

Additionally, recent studies have highlighted an increasing trend of problematic phone usage prevalent among university students with evening chronotypes (Randjelovic et al., 2021). This factor could further compromise the academic performance of the evening-oriented individuals (Hawi & Samaha, 2016; Tian et al., 2021). Notably, this behaviour is also correlated with trait self-control (Servidio, 2019).

Moreover, societal norms often do not align with the sleep patterns preferred by evening chronotypes, resulting in mismatches that lead to phenomena like social jet lag (Wang & Hu, 2015). This misalignment implies that evening-oriented individuals may need to expend additional effort to navigate daily societal obligations, potentially depleting their reservoir of self-control and thereby undermining their ability to modulate their responses (Baumeister et al., 1994). It is noteworthy that students possessing robust self-control also tend to procrastinate less (Steel, 2007), manage their study schedules efficiently, complete assignments punctually (Zhao et al., 2021), and consequently, often attain superior academic grades (Stadler et al., 2016).

In summary, the current findings contribute to a novel understanding of possible underlying mechanisms explaining why morning types attain superior grades compared to evening types. Our study reveals that this phenomenon might not be primarily attributable to biological predisposition but is instead associated with personality traits.

In this research, we were also interested in investigating the potential role of sleep quality in the relationship between chronotype and academic performance. Our findings provide empirical evidence suggesting a positive correlation between sleep quality among university students and their academic achievement. Furthermore, it was observed that individuals with enhanced sleep quality predominantly exhibit morning characteristics. This aligns with previous research demonstrating that evening types often exhibit inferior sleep quality (Bavarsad et al., 2015; Carciofo et al., 2014; Kabrita et al., 2014; Vollmer et al., 2017). In addition, compromised sleep quality has been identified as a risk factor for decreased academic performance (El Hangouche et al., 2018; Gomes et al., 2011; Mirghani et al., 2015; Wong et al., 2013).

Previous research has shown that evening types frequently demonstrate augmented daily lifestyle regularity (Monk et al., 2004; Monk et al., 2003), heightened difficulties in sleep initiation (Sun et al., 2019), greater variability in both bedtime and waking times (Taillard et al., 2002) and increased prevalence of insomnia symptoms and nightmares (Merikanto et al., 2012). These are all factors associated with reduced sleep quality (Bollu & Kaur, 2019; Paul et al., 2015; Yi et al., 2006) and sleep quality is positively related to academic achievement. Therefore, we hypothesised that sleep quality mediates the relationship between chronotype and academic achievement as measured with objective and subjective measures. However, our results do not fully support our hypothesis. Our research underscores the significance of chronotype in its relationship with objective academic performance, regardless of the quality of sleep. This suggests that contrary to trait self-control, sleep quality does not mediate the relationship between chronotype and objective academic achievement. Correspondingly, Okano et al. (2019) found that although chronotype significantly impacted academic achievement, sleep quality did not play a significant role. Although sleep quality can influence academic performance, its significance diminishes when other factors are considered. Önder et al. (2014) explored various academic predictors, noting that sleep quality was not a primary factor, whereas traits like conscientiousness, academic motivation, and social jetlag were more predictive. The researchers also found that university students who are morning types tend to be more conscientious, exhibit higher academic motivation, and accrue less sleep debt compared to their evening counterparts. Such attributes make them more

likely to excel academically. Furthermore, morning types tend to be more future-oriented, displaying greater strategic behaviour and a willingness to delay gratification, as highlighted by Stolarski et al. (2013). Supporting this, Peters et al. (2005) identified the foresight of future consequences as a more significant predictor of academic success than sleep quality alone.

Nevertheless, our research indicates that sleep quality does play a partial mediating role in the association between chronotype and perceived academic success. This indicates that while sleep quality influences the observed relationship, it does not provide a complete explanation of the dynamics between these factors. This finding highlights the complex interdependencies among chronotype, sleep quality, and academic performance measures. Further research is needed to elucidate the reasons why sleep quality is a partial mediator in the relationship between chronotype and subjective academic achievement but does not mediate the connection with objective academic metrics.

Conclusions

Our findings underscore the significant roles of trait self-control and sleep quality in mediating the relationship between chronotype and academic achievement. When accounting for trait self-control, chronotype ceases to be a direct predictor of academic achievement. Nevertheless, chronotype remains an important predictor when considered alongside sleep quality. Our study introduces a fresh perspective on the determinants of academic achievement, suggesting that it might be less influenced by chronotype and more by personality aspects, notably trait self-control. These findings suggest that future research should continue to explore personality traits and behaviours that might influence this dynamic. This complements previous research, which identified personality traits, like conscientiousness, as pivotal in elucidating the link between chronotype and academic performance. Regarding sleep quality, our study highlights the intricate interplay between sleep quality, chronotype, and academic performance, revealing a complex association that warrants further investigation to fully understand its implications for educational strategies and student well-being.

As with every study, this one also has a few limitations. Given the cross-sectional nature of our study, causality cannot be established, and longitudinal studies are required to probe the causal pathways involved. Longitudinal studies could examine how changes in self-control and sleep quality over time correspond to academic outcomes across different chronotypes. Our reliance on self-reported data, particularly concerning sleep quality and academic grades,

is a limitation that future research should address through objective measures. Furthermore, exploring the impact of exam timings could offer a more nuanced understanding of these relationships. This is especially relevant, given studies suggest that the time of day can influence the interplay between chronotype and academic performance (Zerbini & Merrow, 2017). For enhanced precision, future studies might consider incorporating a more extensive collection of grades.

Future studies should consider the complex interdependencies between chronotype, academic behaviours, and personality traits also to better inform interventions aimed at improving academic performance. Our findings reveal the importance of considering individual differences in chronotype and self-regulation when designing educational strategies and support services for students. Additionally, developing programs that build self-regulatory skills could possibly help improve academic outcomes. Promoting good sleep hygiene practices might also be important, considering the link between sleep quality and perceived academic success.

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Biographical note

Katarina Maučec, MSc in Psychology, graduated in 2023 at the Faculty of Arts, University of Maribor, Slovenia. Currently, she is working at the Health Promotion Center at the Laško Community Health Centre. She is a member of the European Sleep Research Society. Her research focuses on the psychological dimensions of sleep health, including the impact of sleep on cognitive, behavioral, and psychosocial functioning.

Vita Štukovnik, PhD, is a clinical psychology specialist and an assistant professor of psychology at the Department of Psychology, Faculty of Arts, University of Maribor, Slovenia. Her research interests encompass clinical neuropsychology, clinical psychology, and sleep. In her role as a clinical psychologist, she primarily concentrates on the treatment of chronic insomnia and has introduced cognitive-behavioral therapy for insomnia in Slovenia.