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Temporal associations between morningness/eveningness, problematic social media use, psychological distress and daytime sleepiness: Mediated roles of sleep quality and insomnia among young adults

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Abstract

The extant literature has suggested relationships between an individual's chronotype (in relation to morningness/eveningness) and several outcomes, including addictive disorders, psychological distress and daytime sleepiness. Moreover, sleep quality has been proposed to be a mediator in the aforementioned relationships. Consequently, the aim of the present study was to investigate the complex relationship between morningness/eveningness, problematic social media use, psychological distress and daytime sleepiness, with the potential mediators of sleep quality and insomnia. All participants (N = 1,791 [30.1% males]; mean age = 27.2 years, SD = 10.1) completed a battery of psychometric scales, including a reduced version of the Morningness-Eveningness Questionnaire (at baseline), the Pittsburgh Sleep Quality Index and Insomnia Severity Index (1 month after baseline assessment), the Bergen Social Media Addiction Scale, the Hospital Anxiety and Depression Scale, and the Epworth Sleepiness Scale (2 months after baseline assessment). The impacts of morningness-eveningness on problematic social media use, anxiety, depression and daytime sleepiness were found in the mediation models. Furthermore, the mediated effects of insomnia and sleep quality were observed. The present study's results emphasize the importance of promoting healthy sleep habits and sleep hygiene behaviours, and that of early detection of sleep problems among individuals who have the eveningness chronotype, because this would significantly improve their health outcomes.

KEYWORDS
behavioural addiction, chronotype, daytime sleepiness, eveningness, morningness, sleep, social media addiction

1 | INTRODUCTION

An individual's chronotype is used to define an individual's propensity to sleep at specific times of the day via the regulation of their 24-hr circadian clock (Wittmann, Dinich, Merrow, & Roenneberg, 2006). In general, there are three chronotype dimensions according to the sleep and wake-up cycles of an individual: morningness (or "early birds") refers to those individuals who prefer to go to bed early in the evening and perform activities better in the morning hours; eveningness (or "night owls") refers to those who prefer to rise later in the morning and go to bed later and perform activities better in the late afternoon or evening; and neither morningness nor eveningness refers to those whose sleep and activity patterns are between morningness and eveningness. Moreover, different chronotypes have been found to display different characteristics in relation to physical and mental health because the phase lag between the two extremes of the chronotype dimension (i.e., morningness versus eveningness) can be 2–12 hr apart (Adan et al., 2012).

In a comprehensive review (Fabbian et al., 2016), the evidence concerning the association between chronotype and unhealthy behaviours (including substance use as well as substance use disorders) has been demonstrated among adult populations. For example, individuals who are eveningness prone (compared to other chronotypes) have more unhealthy eating habits and engage in less physical activity (Fabbian et al., 2016). Because of these unhealthy behaviours, eveningness can be associated with health problems. Indeed, Haraszti et al. (2014) found that eveningness was associated with greater stress among Hungarian working women, and Bakotic, Radosevic-Vidacek, and Koscec Bjelajac (2017) reported that eveningness was associated with poor sleep and daytime sleepiness. Additionally, higher eveningness has been associated with several behavioural addictions, including internet addiction, smartphone addiction and problematic social media use (Bakotic et al., 2017; Blachnio, Przepiorka, & Díaz-Morales, 2015; Demirhan, Randler, & Horzum, 2016; Kervran et al., 2015).

Similar findings have been observed for adolescents and young adults (e.g., Bakotic et al., 2017; Randler et al., 2016), which indicate that the impacts of chronotype can be across the lifespan. More specifically, adolescents and young adults who are eveningness prone (compared to other chronotypes) report shorter sleep duration during weekdays, delayed sleep onset with extended sleep at weekends, higher levels of daytime sleepiness and more sleep difficulties (Fernández-Mendoza et al., 2010; Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002; Kabrita, Hajjar-Muca, & Duffy, 2014; Koscec, Radosevic-Vidacek, & Bakotic, 2014). Similar to the findings from other adult populations, adolescents and young adults who are eveningness prone have an increased risk of depressive mood and suicidal ideations, with lowered positive affect (Biss & Hasher, 2012; Chelminski, Ferraro, Petros, & Plaud, 1999; Gau et al., 2007). Moreover, Randler (2011) reported an association between eveningness and a less positive attitude towards life and lower self-esteem among adolescents. Also, engaging in frequent unhealthy behaviours (caffeine, tobacco and alcohol use), low academic performance and procrastination have been found to be associated with eveningness among university students (Digdon & Howell, 2008; Fernández-Mendoza et al., 2010; Taylor, Clay, Bramoweth, Sethi, & Roane, 2011).

Based on the aforementioned literature, understanding the role of chronotype appears to be an important topic for healthcare providers who wish to assist people in overcoming unhealthy behaviours. However, to the best of the present authors' knowledge, no previous studies have been conducted to understand the temporal associations between chronotypes, problematic social media use, psychological distress and daytime sleepiness, alongside sleep quality and insomnia. More specifically, sleep quality has been proposed as being a mediator in the association between morningness/eveningness and daytime functioning (including daytime sleepiness, depressed mood and substance use; Bakotic et al., 2017). Therefore, it is reasonable to hypothesize that both sleep quality and insomnia (which can be viewed as a severe condition of poor sleep quality) are mediators in the association between morningness/eveningness and
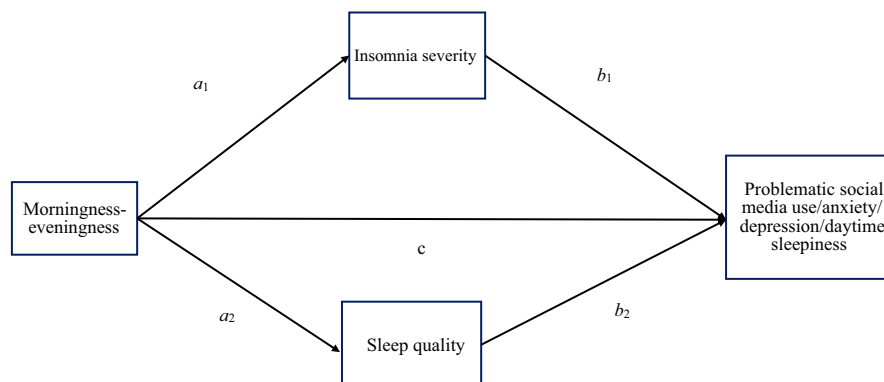

FIGURE 1 Proposed mediation model. a_1: effects of morningness-eveningness on insomnia severity; a_2: effects of morningness-eveningness on sleep quality; b_1: effects of insomnia severity on different outcomes (including problematic use of social media, anxiety, depression and daytime sleepiness); b_2: effects of sleep quality on different outcomes; c: direct effects of morningness-eveningness on different outcomes; $a_1 \times b_1$: indirect effects of morningness-eveningness on different outcomes through insomnia severity; $a_2 \times b_2$: indirect effects of morningness-eveningness on different outcomes through sleep quality

the following outcomes: problematic social media use (similar to substance use), psychological distress (similar to depressed mood) and daytime sleepiness. However, the aforementioned mediation model has only been examined recently with insufficient evidence (Bakotic et al., 2017). Therefore, a study to further examine the mediator roles of sleep quality and insomnia is necessary to gather evidence from the current literature.

The aim of the present study was to investigate the complex relationship between morningness/eveningness, problematic social media use, psychological distress and daytime sleepiness, with the potential mediators of sleep quality and insomnia. The proposed model for examination is presented in Figure 1. Moreover, it was hypothesized that a higher degree of eveningness would be associated with increased levels/severities of (a) problematic social media use, (b) psychological distress (Wittmann et al., 2006) and (c) daytime sleepiness. Furthermore, it was hypothesised that (d) sleep quality would be a mediator between chronotype and the following outcomes: problematic social media use, psychological distress and daytime sleepiness; and (e) insomnia would be another mediator between chronotype and the outcomes of problematic social media use, psychological distress and daytime sleepiness.

2 | METHODS

2.1 | Participants and procedure

The present study was a school-based phased cross-sectional study of college students carried out in three universities in Qazvin (Iran). Through advertising, college students were recruited for the present study. The inclusion criteria were as follows: those who (a) were students, (b) could communicate orally in Persian/Farsi and (c) could complete the questionnaire in written Persian. The exclusion criteria were as follows: those who (a) did not complete the survey (i.e., participants who did not complete all the questions were excluded), (b) were pregnant or (c) were diagnosed with severe psychiatric disorders using structured interview by a psychiatrist. Four psychiatrists who had received formal training conducted the interview using the Mini International Neuropsychiatric Interview (MINI) in a quiet room arranged by each university. The study aims were explained to eligible students and those who agreed to participate were given the survey. A total of 2,100 college students were approached, with 309 excluded according to inclusion and exclusion criteria. Ethical approval for the study was obtained from the Ethics Committee for Biological Research in the Qazvin University of Medical Sciences (IR. QUMS.REC.1398.400). Participants' consent was obtained prior to data collection.

Although the study comprised a cross-sectional design, the participants completed the scales at different time-points. This extended the data collection process to a period of 2 months. More specifically, all the participants completed the scale on morningness/eveningness (i.e., the proposed independent variable in the present study) at baseline; scales assessing sleep quality and insomnia severity (i.e., proposed mediators in the present study) were completed 1 month after baseline assessment; scales assessing problematic social media use, psychological distress and daytime sleepiness (i.e., proposed outcomes in the present study) were completed 2 months after baseline assessment.

2.2 | Instruments

2.2.1 | Reduced version of the Morningness-Eveningness Questionnaire (rMEQ)

The rMEQ was adapted from the Morningness-Eveningness Questionnaire developed by Horne and Östberg (1976). Comprising five items (one item scores from 1 to 4; three from 1 to 5; and one scores by 0, 2, 4 and 6), the rMEQ assesses the chronotype of an individual (i.e., whether she/he is an evening-type [<12 points in rMEQ], a neither-type [12–17 points] or a morning type [>17 points]; Adan & Almirall, 1991). More specifically, the five items assess comfortable rising time, morning freshness, retiring time, subjective peak time and self-evaluation of chronotype (Ágoston, Urbán, Rigó, Griffiths, & Demetrovics, 2019). A review shows that the rMEQ has satisfactory psychometric properties (Di Milia, Adan, Natale, & Randler, 2013); the psychometric properties of the Persian rMEQ also have been comprehensively evaluated and confirmed among university students (Rahafar, Meysam, Sadeghpour, Heidari, & Kasaeian, 2015). The internal consistency of the rMEQ in the present study was good (α = 0.79).

2.2.2 | Pittsburgh Sleep Quality Index (PSQI)

Comprising 19 items (in which scores are converted to a four-point Likert-type scale ranging from 0 to 3), the PSQI assesses sleep quality and disturbances. After summing up the 19 converted item scores, the total score ranges between 0 and 57, with higher scores indicating poor sleep quality. Good internal consistency of the Persian PSQI has been reported (α = 0.77; Moghaddam, Nakhaee, Sheibani, Garrusi, & Amirkafi, 2012). The internal consistency of the PSQI in the present study was good (α = 0.81).

2.2.3 | Insomnia Severity Index (ISI)

Comprising seven items (rated on a five-point Likert-type scale ranging from 0 to 4), the ISI assesses the severity and effects of insomnia. After summing up the seven item scores, the total score ranges between 0 and 28, with a higher score indicating a higher level of insomnia. More specifically, a cut-off score of 9 is recommended as identifying insomnia (Lin et al., 2019). Good internal consistency of the Persian ISI has been reported (McDonald's ω = 0.79; Lin et al., 2019). The internal consistency of the ISI in the present study was good (α = 0.88).

2.2.4 | Bergen Social Media Addiction Scale (BSMAS)

Comprising six items (rated on a five-point Likert-type scale ranging from 1 to 5), the BSMAS assesses the severity of problematic social media use. After summing up the six item scores, total scores range between 0 and 30, with a higher score indicating a higher severity of problematic social media use. More specifically, a cut-off score of 19 has been recommended to identify those at risk of problematic social media use (Bányai et al., 2017). Good internal consistency of the Persian BSMAS has been reported (α = 0.86; Lin, Broström, Nilsen, Griffiths, & Pakpour, 2017). The internal consistency of the BSMAS in the present study was good (α = 0.84).

2.2.5 | Hospital Anxiety and Depression Scale (HADS)

Comprising 14 items (rated on a four-point Likert-type scale ranging from 0 to 3), the HADS assesses two types of psychological distress (seven items on anxiety and seven items on depression). After summing up the seven item scores, anxiety scores range between 0 and 21, with a higher score indicating a higher level of anxiety. Similarly, depression scores range between 0 and 21, with a higher score indicating a higher level of depression. Good internal consistency of the Persian HADS has been reported (α = 0.83; Lin & Pakpour, 2017). The internal consistency of the HADS in the present study was good (α = 0.81 for anxiety subscale; 0.79 for depression subscale; 0.84 for entire scale).

2.2.6 | Epworth Sleepiness Scale (ESS)

Comprising eight items (rated on a four-point Likert-type scale ranging from 0 to 3), the ESS assesses the severity of daytime sleepiness. After summing up the eight item scores, total scores range between 0 and 24, with a higher score indicating greater sleepiness. Good internal consistency of the Persian ESS has been reported (α = 0.79; Imani, Lin, Jalilolgadr, & Pakpour, 2018). The internal consistency of the ESS in the present study was good (α = 0.77).

2.3 | Data analysis

The descriptive statistics were analysed for participant characteristics and the studied variables. Categorical variables were calculated using frequencies and percentages, and continuous variables were calculated using means and standard deviations (SDs). The associations between every two studied variables were examined using Pearson correlations. After conducting the Pearson correlations, structural equation modelling, which can simultaneously include all the independent variables, mediators and outcome variables, was carried out to further understand the associations between the

TABLE 1 Characteristics of the study participants (N = 1,791)

	Mean (SD) or n (%)
Age (year)	27.2 (10.1)
Gender (male)	539 (30.1%)
Relationship status (single)	864 (48.2%)
Current smoker (yes)	293 (16.4%)
BMI (kg/m^2) at baseline	21.2 (4.0)
Daily time spent on social media (hr)	3.5 (1.3)

Abbreviation: BMI, body mass index; SD, standard deviation.

studied variables. The structural equation modelling results were used to determine whether the mediation models proposed can be further investigated (Figure 1).

Several mediation models were constructed to investigate whether sleep quality and severity of insomnia acted as mediators in the temporal associations between chronotype and different health outcomes (including problematic social media use, anxiety, depression and daytime sleepiness). More specifically, four mediation models were constructed with the dependent variables of problematic social media use, anxiety, depression and daytime sleepiness. All the models used the same mediators (sleep quality and severity of insomnia), independent variable (chronotype) and controlling variables (age, gender, body mass index [BMI] and smoking status). In order to strengthen the rationale of the proposed direction, reverse mediation models (i.e., morningness/eveningness being the outcome variable; problematic social media use, anxiety, depression and daytime sleepiness being the independent variables) were additionally conducted. If the reverse models had poor results, the proposed direction was somewhat supported.

Process Marco (Alimoradi, Lin, Imani, Griffiths, & Pakpour, 2019; Hayes, 2103) in SPSS version 24.0 (IBM) was used to perform the mediation models. More specifically, Model 4 in Process Marco with 10,000 bootstrap samples was used to examine the mediated effects for each mediation model. A significant mediated effect was identified if the 95% lower limit confidence interval (LLCI) and upper limit confidence interval (ULCI) for the unstandardized coefficients of mediators did not cover the value of 0 (Lin & Tsai, 2016). Moreover, Process Marco can be utilized in different types of software, including SPSS, SAS and MPLUS (Hayes & Preacher, 2014), and is widely used in empirical studies (Luby et al., 2013; Pereira-Morales, Adan, Bussi, & Camargo, 2018; Probst, Pryss, Langguth, & Schlee, 2016).

3 | RESULTS

Among the participants (n = 1,791), slightly less than one-third were male (30.1%). Also, the mean age of the participants was 27.2 years (SD = 10.1). Almost half the participants were single (48.2%) and less than one-fifth were current smokers (16.4%). On average, the BMI was 21.2 kg/m^2 (SD = 4.0), and the average daily time spent on social media was 3.5 hr (SD = 1.3; Table 1).

The descriptive statistics for the studied variables and the Pearson correlations between every two variables are shown in Table 2. In brief, the rMEQ score was significantly negatively correlated with all the other variables ($r = -0.34$ to -0.22; all p-values < .01). All the other variables were significantly positively correlated ($r = 0.13$–0.44; all p-values < .01). Moreover, Figure 2 shows that the structural equation modelling results supported the further analyses on mediation models.

Table 3 and Figure 3 show the impacts of morningness-eveningness upon problematic social media use, anxiety, depression and daytime sleepiness, as well as the mediated effects of insomnia and sleep quality. More specifically, the total effects of morningness-eveningness (unstandardised coefficient = -0.37, standard error [SE] = 0.03, p < .001) upon problematic social media use were found together with significantly mediated effects of insomnia (bootstrapping LLCI = -0.17; Bootstrapping ULCI = -0.09) and sleep quality (bootstrapping LLCI = -0.16; bootstrapping ULCI = -0.06). The total effects of morningness-eveningness (unstandardised coefficient = -0.61, SE = 0.03, p < .001) on anxiety were found together with significantly mediated effects of insomnia (bootstrapping LLCI = -0.16; bootstrapping ULCI = -0.08) and sleep quality (bootstrapping LLCI = -0.09; bootstrapping ULCI = -0.01). The total effects of morningness-eveningness (unstandardized coefficient = -0.24, SE = 0.03, p < .001) on depression were found together with significantly mediated effects of insomnia (bootstrapping LLCI = -0.10; bootstrapping ULCI = -0.02) and sleep quality (bootstrapping LLCI = -0.12; bootstrapping ULCI = -0.03). The total effects of morningness-eveningness (unstandardised coefficient = -0.56, SE = 0.03, p < .001) on daytime sleepiness were found together with significantly mediated effects of insomnia (bootstrapping LLCI = -0.22; bootstrapping ULCI = -0.13) and sleep quality (bootstrapping LLCI = -0.15; bootstrapping ULCI = -0.07).

The reverse mediation models showed that almost all the mediated effects were non-significant, although the associations between the independent variable (i.e., morningness/eveningness) and dependent variables (i.e., problematic social media use, anxiety, depression and daytime sleepiness) were significant. Therefore, the proposed directions in the present study are somewhat supported.

4 | DISCUSSION

Using a phased cross-sectional design, the present study's results supported the hypotheses that more pronounced eveningness was associated with poorer sleep quality, more severe insomnia, higher levels of problematic social media use, more psychological distress, and greater daytime sleepiness. Moreover, the present study's results aligned with the mediation hypotheses that both sleep quality and insomnia were mediators between chronotype and problematic social media use, psychological distress and daytime sleepiness.

Aligned with prior research findings on chronotype and addiction (Bakotic et al., 2017; Blachnio et al., 2015; Demirhan et al., 2016; Kervran et al., 2015), the present study's findings suggested that eveningness is associated with greater severity of problematic social media use. Findings from substance use studies were compared with the present study's findings because substance use disorder and problematic social media use share some similar features (e.g., salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse) but are clearly not the same (Griffiths, Kuss, & Demetrovics, 2014). However, given that to the best of the present authors' knowledge, there is no previous study examining chronotype and problematic social media use with the mediators of insomnia severity and sleep quality, studies on substance use disorder were used for comparison.

One of the possible reasons for the association between eveningness and problematic social media use is the unfavourable sleep patterns. For instance, Wittmann et al. (2006) conducted a study demonstrating that there was a higher probability of substance use among individuals prone to eveningness, and the main reason for this was the differences in sleep behaviour between chronotypes.

TABLE 2 Descriptive statistics and Pearson correlation matrix of the key study variables

	rMEQ	PSQI	ISI	BSMAS	HADS-Anxiety	HADS-Depression	ESS
rMEQ	--	−0.29	−0.34	−0.25	−0.26	−0.22	−0.29
PSQI		--	0.42	0.28	0.25	0.20	0.30
ISI			--	0.29	0.34	0.18	0.33
BSMAS				--	0.31	0.23	0.13
HADS-Anxiety					--	0.44	0.28
HADS-Depression						--	0.13
ESS							--
Mean	13.48	4.02	11.24	14.46	7.54	6.27	8.91
SD	3.69	1.63	4.81	3.85	2.89	2.01	3.62

Note: All p-values < .01.

Abbreviations: BSMAS, Bergen Social Media Addiction Scale; ESS, Epworth Sleepiness Scale; HADS-Anxiety, anxiety subscale in the Hospital Anxiety and Depression Scale; HADS-Depression, depression subscale in the Hospital Anxiety and Depression Scale; ISI, Insomnia Severity Index; PSQI, Pittsburgh Sleep Quality Index; rMEQ, reduced version of the Morningness-Eveningness Questionnaire.
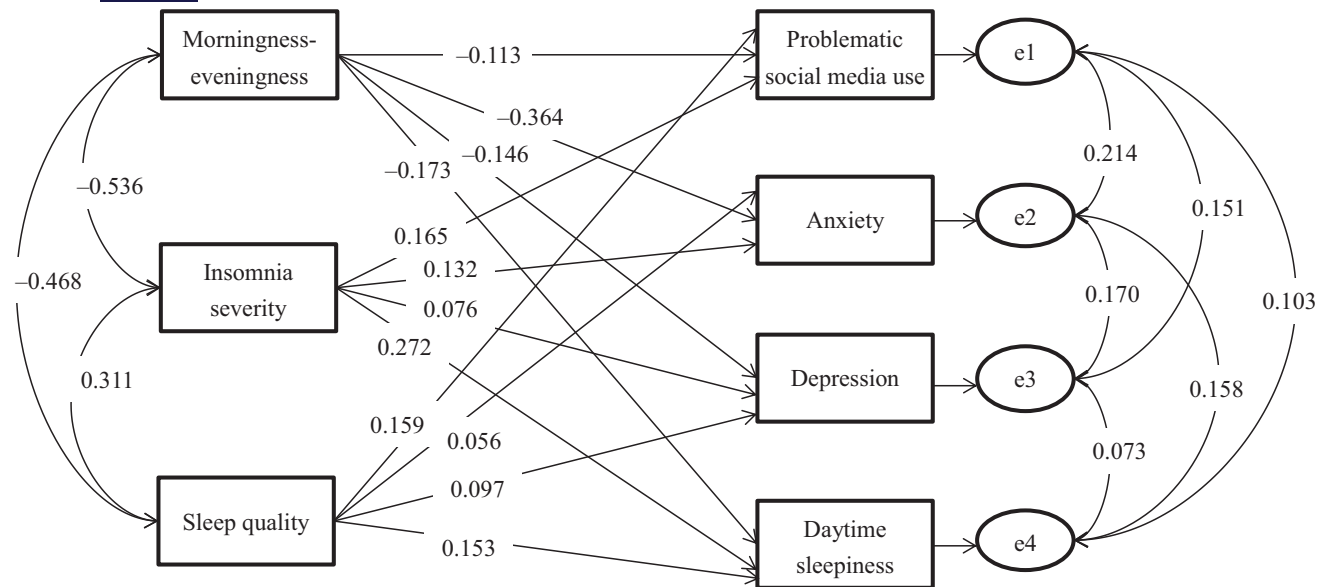
FIGURE 2 Structural equation modelling showing associations between independent variable (morningness-eveningness), mediators (insomnia severity and sleep quality) and outcomes (problematic social media use, anxiety, depression and daytime sleepiness). All p-values < .02

The authors found that individuals who are eveningness prone showed the largest discrepancy between weekend and weekday sleep patterns, and that the discrepancy between weekend and weekday sleep patterns predicted the likelihood of smoking. In another study, Wong, Brower, Fitzgerald, and Zucker (2004) used a longitudinal design to study substance use and found that sleep problems in early childhood predicted an early onset of substance use, including use of alcohol, marijuana, cigarettes and illicit drugs. Bakotic et al. (2017) observed similar findings to a longitudinal study (Tavernier & Willoughby, 2014) that showed sleep characteristics did not fully explain the relationship between morningness and substance use. Therefore, it is possible that differences between chronotypes in personality and lifestyle are important in explaining individuals' substance use.

With respect to psychological distress, extensive empirical evidence concurs with the present study's findings that eveningness is associated with greater depressive mood, higher levels of suicidal ideation and lower positive affect (Biss & Hasher, 2012; Chelminskiet al., 1999; Gau et al., 2007). Several studies have investigated the relationship between eveningness and psychological distress. For example, Roeser, Meule, Schwerdtle, Kuebler, and Schlarb (2012) found that impaired sleep was responsible for higher levels of experienced stress among eveningness-prone individuals. Simor, Zavecz, Palosi, Toeroek, and Koeteles (2015) reported that eveningness-prone individuals suffer from sleep complaints and that a negative emotional state is one of the reasons for this. Bakotic et al. (2017) demonstrated that sleep quality, sleep debt and irregular bedtime patterns are potential factors in the relationship between chronotype and depressive mood. Furthermore, a recent meta-analysis examining the relationship between sleep problems and depression among adolescents (Lovato & Gradisar, 2014) concluded that (in the majority of cases) sleep problems start earlier than the symptoms of psychological distress. Therefore, the association between chronotype and psychological distress could be mediated by sleep quality.

The present study also found that increased daytime sleepiness was associated with eveningness, and that the association could be partly attributed to insufficient and poor sleep (Bakotic et al., 2017). This finding is not surprising given that inadequate sleep duration and/or sleep quality usually leads to sleepiness (Roehrs, Carskadon, Dement, & Roth, 2011). Additionally, sleepiness is predicted by irregularity of the sleep schedule (Giannotti et al., 2002), such as sleep patterns of individuals who are eveningness prone. Delayed sleep pattern, a habitual behaviour that is prevalent among young adults who are eveningness prone (Wittmann et al., 2006), somewhat delays their circadian rhythms and results in greater daytime sleepiness during weekdays (Yang & Spielman, 2001).

In addition to the demonstrated associations found between chronotype and the three outcome variables (i.e., problematic social media use, psychological distress, and daytime sleepiness), the present study extended knowledge relating to the potential underlying mechanism behind the associations. More specifically, the present study's findings suggested that the increased problematic social media use, psychological distress and daytime sleepiness for those who are eveningness prone could be due to their sleep quality and/or insomnia severity. Based on these findings, healthcare providers may want to design programmes that help improve sleep for eveningness-prone individuals, to prevent such outcomes as problematic social media use, psychological distress and daytime sleepiness.

The strengths of the present study include the following. First, a large sample size was recruited in the present study and, consequently, the statistical power is good. Second, different constructs were assessed at different time-points. Therefore, the temporal associations between chronotype, mediators and outcome variables

TABLE 3 Models that tested mediated effects of insomnia and sleep quality

	Unstand. coeff.	SE or (bootstrapping SE)	t-value or (bootstrapping LLCI)	p-value or (bootstrapping ULCI)
Mediated effects on social media addiction				
Total effect of rMEQ on BSMAS	−0.37	0.03	−11.92	<.001
Direct effect of rMEQ on BSMAS	−0.13	0.04	−3.37	.008
Direct effect of rMEQ on mediators				
Insomnia Severity Index	−1.04	0.04	−26.36	<.001
Pittsburgh Sleep Quality Index	−0.42	0.02	−22.76	<.001
Indirect effect of rMEQ on BSMAS				
Total indirect effect	−0.24	(0.03)	(−0.31)	(−.17)
Through Insomnia Severity Index	−0.13	(0.02)	(−0.17)	(−.09)
Through Pittsburgh Sleep Quality Index	−0.10	(0.03)	(−0.16)	(−.06)
Mediated effects on anxiety				
Total effect of rMEQ on HADS-Anxiety	−0.61	0.03	−20.47	<.001
Direct effect of rMEQ on HADS-Anxiety	−0.45	0.04	−11.56	<.001
Direct effect of rMEQ on mediators				
Insomnia Severity Index	−1.04	0.04	−26.22	<.001
Pittsburgh Sleep Quality Index	−0.42	0.02	−22.50	<.001
Indirect effect of rMEQ on HADS-Anxiety				
Total indirect effect	−0.16	(0.03)	(−0.22)	(−.11)
Through Insomnia Severity Index	−0.12	(0.02)	(−0.16)	(−.08)
Through Pittsburgh Sleep Quality Index	−0.05	(0.02)	(−0.09)	(−.01)
Mediated effects on depression				
Total effect of rMEQ on HADS-Depression	−0.24	0.03	−8.11	<.001
Direct effect of rMEQ on HADS-Depression	−0.11	0.04	−2.77	.006
Direct effect of rMEQ on mediators				
Insomnia Severity Index	−1.03	0.04	−25.59	<.001
Pittsburgh Sleep Quality Index	−0.44	0.02	−23.30	<.001
Indirect effect of rMEQ on HADS-Depression				
Total indirect effect	−0.13	(0.03)	(−0.19)	(−.07)
Through Insomnia Severity Index	−0.06	(0.02)	(−0.10)	(−.02)
Through Pittsburgh Sleep Quality Index	−0.07	(0.02)	(−0.12)	(−.03)
Mediated effects on daytime sleepiness				
Total effect of rMEQ on ESS	−0.56	0.03	−18.98	<.001
Direct effect of rMEQ on ESS	−0.28	0.04	−7.46	<.001
Direct effect of rMEQ on mediators				
Insomnia Severity Index	−1.05	0.04	−25.75	<.001
Pittsburgh Sleep Quality Index	−0.40	0.02	−21.38	<.001
Indirect effect of rMEQ on ESS				
Total indirect effect	−0.28	(0.03)	(−0.34)	(−.23)
Through Insomnia Severity Index	−0.17	(0.02)	(−0.22)	(−0.13)
Through Pittsburgh Sleep Quality Index	−0.11	(0.02)	(−0.15)	(−.07)

Note: Age, gender, body mass index and smoking status were adjusted for the model.

Abbreviations: BSMAS, Bergen Social Media Addiction Scale; ESS, Epworth Sleepiness Scale; HADS-Anxiety, anxiety subscale in the Hospital Anxiety and Depression Scale; HADS-Depression, depression subscale in the Hospital Anxiety and Depression Scale; LLCI, lower limit in 95% confidence interval; rMEQ, reduced version of the Morningness-Eveningness Questionnaire; ULCI, upper limit in 95% confidence interval; Unstand. coeff., unstandardised coefficient.
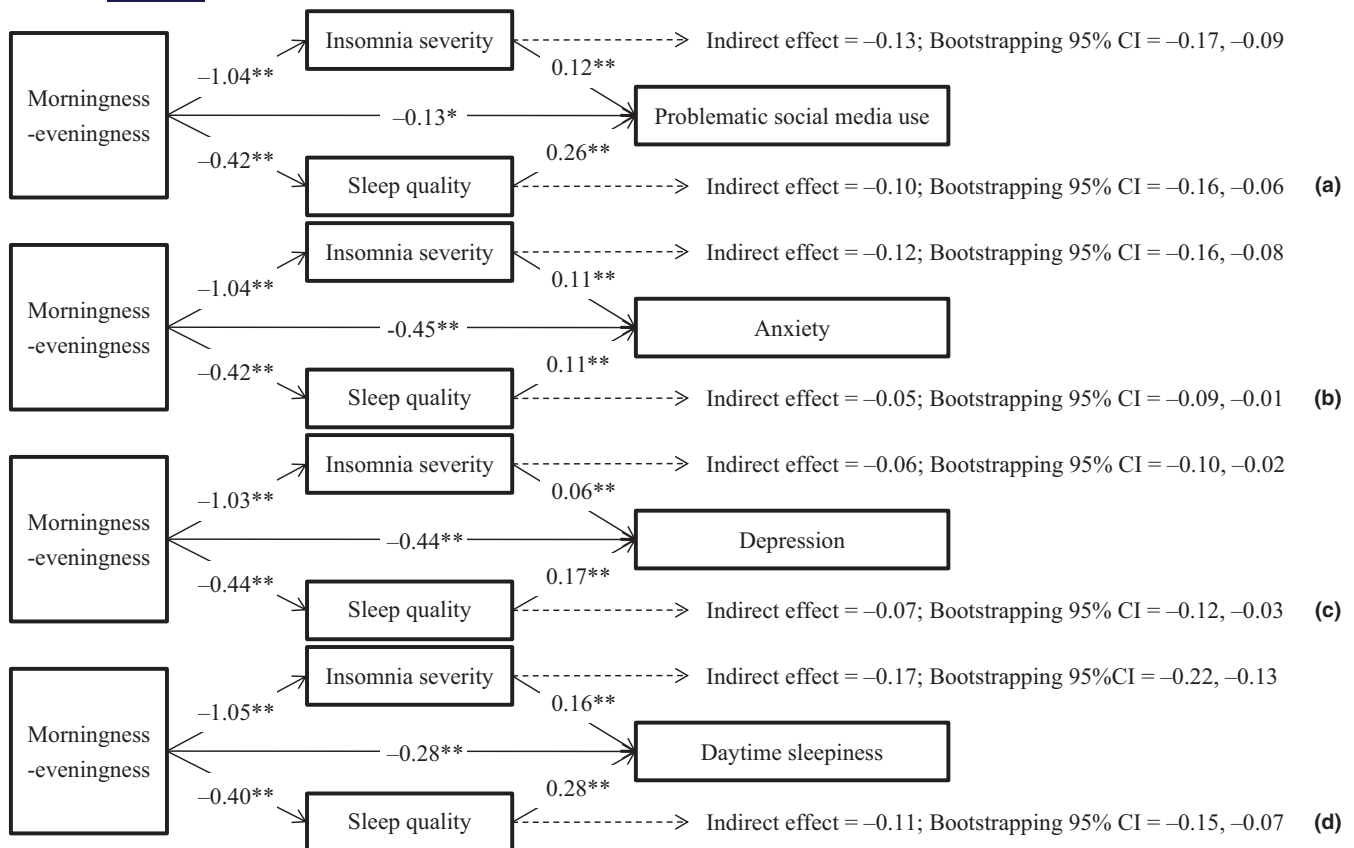
FIGURE 3 Mediated effects of insomnia severity and sleep quality on (a) problematic social media use, (b) anxiety, (c) depression and (d) daytime sleepiness. *$p < .01$; **$p < .001$

have the potential to demonstrate some causality between these variables. Third, all the measures used in the present study had good psychometric properties in terms of reliability and validity. Therefore, the accuracy in assessing these constructs was empirically verified.

However, there are some limitations in the present study. First, although the phased cross-sectional design suggests temporal associations, Sobel (2008) and Pearl (2010) note that mediation analysis only provides partial causality rather than full causality. Therefore, further studies using randomised-controlled trials or longitudinal designs are highly recommended. With a true experimental design, the causality between the independent variable (i.e., chronotype), mediators (i.e., sleep quality and insomnia) and outcome variables (i.e., problematic social media use, psychological distress and daytime sleepiness) could be established. Second, all the measures used in the present study were assessed using self-reports, although all of the psychometric instruments had satisfactory psychometric properties in the present study. Therefore, common biases in self-report, such as recall bias and social desirability, cannot be avoided. Consequently, future studies may consider using objectively measured instruments (e.g., actigraphy for objective sleep; a tracking app to objectively assess time spent on social media) on the variables examined here. Third, the present study treated the two proposed mediators as mutually independent, although sleep quality and insomnia are often inter-related.

Moreover, some may consider that sleep quality and insomnia are causally related. However, given that the association between sleep quality and insomnia was not highly correlated in the present study ($r = 0.42$), this observation somewhat justifies the use of a parallel model in contrast to a more complex serial mediation model.

5 | CONCLUSION

The present study used a phased cross-sectional design to examine the mediating roles of sleep quality and insomnia in the associations between chronotype and three outcome behaviours (problematic social media use, psychological distress and daytime sleepiness). The main findings suggest that perceived sleep quality and insomnia severity are significant mediators in these associations. Higher levels of problematic social media use, more psychological distress and greater daytime sleepiness were found among eveningness-prone individuals, whereas a potential underlying mechanism to explain these associations is poor sleep for those who are evening-ness prone. The present study's results emphasise the importance of promoting healthy sleep habits and sleep hygiene behaviours, and of early detection of sleep problems among individuals with an eveningness chronotype because this could significantly improve their health outcomes.

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CONFLICT OF INTEREST

No conflicts of interest declared.

AUTHOR CONTRIBUTIONS

Study concept and design: AHP, VI and CYL. Data collection: VI and AHP. Drafting the manuscript: CYL, AHP, MDG, AB, AN and ZD. Statistical analysis: AHP, CYL and AB. Preparation and final approval of the manuscript: all authors.

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