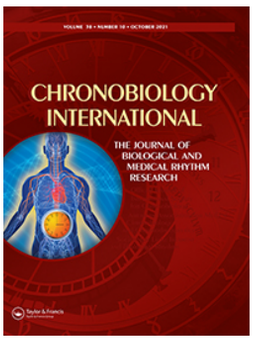

Taylor & Francis
Taylor & Francis Group

Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/icbi20

Insomnia symptoms mediate the association between eveningness and suicidal ideation, defeat, entrapment, and psychological distress in students

Daniel R. R. Bradford, Stephany M. Biello & Kirsten Russell

To cite this article: Daniel R. R. Bradford, Stephany M. Biello & Kirsten Russell (2021) Insomnia symptoms mediate the association between eveningness and suicidal ideation, defeat, entrapment, and psychological distress in students, Chronobiology International, 38:10, 1397-1408, DOI: 10.1080/07420528.2021.1931274

To link to this article: https://doi.org/10.1080/07420528.2021.1931274

Published online: 08 Jun 2021.

CHRONOBIOLOGY INTERNATIONAL
2021, VOL. 38, NO. 10, 1397–1408
https://doi.org/10.1080/07420528.2021.1931274

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

OPEN ACCESS Check for updates

Insomnia symptoms mediate the association between eveningness and suicidal ideation, defeat, entrapment, and psychological distress in students

Daniel R. R. Bradford*, Stephany M. Biello, and Kirsten Russell

School of Psychology, University of Glasgow, Glasgow, UK

ABSTRACT

Chronotype describes a person's general preference for mornings, evenings, or neither. It is typically conceptualized as a continuous unidimensional spectrum from *morningness* to *eveningness*. Eveningness is associated with poorer outcomes across a myriad of physical and mental health outcomes. This preference for later sleep and wake times is associated with increased risk of depression, anxiety, and suicidal ideation in both clinical and community samples. However, the mechanisms underlying the negative consequences of this preference for evenings are not fully understood. Previous research has found that sleep disturbances may act as a mediator of this relationship. The present study aimed to explore the associations between chronotype and affective outcomes in a sample of students. Additionally, it aimed to investigate the potential role of insomnia as a mediator within these relationships. Participants (n = 190) completed an anonymous self-report survey of validated measures online which assessed chronotype, insomnia symptoms, and a range of affective outcomes (defeat, entrapment, suicide risk, stress, and depressive and anxious symptomology). Eveningness was associated with more severe or frequent experiences of these outcomes, with participants that demonstrated a preference for eveningness more likely to report poorer affective functioning and increased psychological distress. Mediation analysis found the relationship between chronotype and these outcome measures was completely or partially mediated by insomnia symptom severity measured by the validated Sleep Condition Indicator insomnia scale. Taken together, these findings add further evidence for the negative consequences of increased eveningness. Additionally, our results show that chronotype and sleep disturbances should be considered when assessing mental well-being. Implementing appropriate sleep-related behavior change or schedule alterations can offer a tool for mitigation or prevention of psychological distress in students that report a preference for later sleep and wake times.

ARTICLE HISTORY
Received 14 October 2020
Revised 16 April 2021
Accepted 13 May 2021

KEYWORDS
Insomnia; suicide; students; chronotype; stress; depression; anxiety

Chronotype describes a person's general preference for mornings (M-types), evenings (E-types) or neither (N-types). It is typically conceptualized as a continuous unidimensional spectrum from *morningness* to *eveningness* with a broadly normal distribution (Gaspar-Barba et al. 2009; Roenneberg et al. 2004, 2003). Chronotype is a product of both genetics and environment (Facer-Childs et al. 2019; Hu et al. 2016; Lane et al. 2016), and is expressed as diurnal variations in characteristics such as energy levels, affect, and both cognitive and physical performance (Facer-Childs et al. 2018; Goldstein et al. 2007; Merrow et al. 2005; Miller et al. 2015).

Eveningness is associated with poorer outcomes for a wide range of major health issues. This includes all-cause mortality, as well as specific conditions such as arterial hypertension and type 2 diabetes (Au and Reece 2017; Coleman and Cain 2019; Knutson and von Schantz 2018; Partonen 2015; Selvi et al. 2012; Wong et al. 2015). Considering mental health and mood, eveningness is associated with higher odds of lifetime depression, as well as increased depression symptom severity, in both clinical and non-clinical samples (Antypa et al. 2016; Chan et al. 2014; Druiven et al. 2020; Hertenstein et al. 2019; Norbury 2019; Park et al. 2018; Selvi et al. 2012). Hidalgo et al. (2009) found E-types were five times more likely to have moderate–intense depressive symptoms than N-types in a nonclinical sample of adults. In clinical samples of people with depressive disorders, differences in depressive symptom severity due to chronotype tend to be even more pronounced (Gaspar-Barba et al. 2009; Selvi et al. 2010). E-types have also been found to have poorer rates of remission from major depressive disorder (Chan et al. 2014). Other mood- and affect-related outcomes have also been associated with chronotype. Lester (2015) found eveningness to be associated with increased perceptions of *defeat* and

CONTACT Daniel R. R. Bradford 0607646b@student.gla.ac.uk School of Psychology, University of Glasgow, Glasgow, UK
*New Affiliation: MRC/CSO Social and Public Health Sciences Unit, University of Glasgow
This article has been republished with minor changes. These changes do not impact the academic content of the article.

entrapment (negative feelings arising from an individual's experience of a "failed struggle" and the perception that the defeat-generating situation cannot be resolved nor escaped; Gilbert and Allan 1998) in a non-clinical sample of 194 undergraduate students. Additionally, E-types are at increased risk of suicidal ideation and behaviors (Bahk et al. 2014; Gau et al. 2007; Rumble et al. 2018; Sheaves et al. 2016). They are also more likely to attempt to die by suicide in a violent manner (Selvi et al. 2011). These results taken together indicate that a person's chronotype may well play a significant role in mental health outcomes.

Eveningness is also associated with poorer sleep (Bakotic et al. 2017; Chan et al. 2014; Chiu et al. 2017). E-types struggle to adapt to typical societal rhythms related to work or school start times (Takahashi et al. 2011; Wittmann et al. 2006). They are also more likely to experience social jet-lag and associated chronic sleep deprivation (Haraszti et al. 2014; Roenneberg et al. 2012). Other examples of sleep disturbances that have been associated with eveningness and have consequences for waking life include increased risk for experiencing nightmares (Selvi et al. 2012) and greater sleep onset latencies (SOL; Barclay et al. 2010). Specifically, this increase in SOL has been linked to a preference for activity in the evenings (Randler et al. 2017) and later bedtimes in E-types (Crowley et al. 2007), in keeping with the increased risk of social jetlag in E-types. Increased SOL will therefore lead to chronic sleep deprivation if a person is obligated to rise at a relatively early time imposed by work or school schedules. This misalignment between endogenous and exogenous circadian rhythms typically prevents E-types attaining adequate quantities of sleep. Sleep deprivation is associated with depression (Conklin et al. 2018) and has also been found to have a causal relationship with increased levels of next-day suicidal ideation (Littlewood et al. 2017). This apparent effect of reduced total sleep time on affect is also compatible with the increased rates of depressogenic cognitions and rumination in E-types (Antypa et al. 2017). Although chronotype is partially dictated by genetic factors (Toomey et al. 2015; Young and Kay 2001) which may also influence affective traits, it is reasonable to assume that poor sleep mediates the chronotype–affect relationship. An example of evidence for this mediated causal relationship between poor sleep and negative affective outcomes is provided by Chiu et al. (2017). Their study found that sleep quality mediated the relationship between chronotype and parental assessment of childhood depression. In sum, chronic sleep deprivation can be caused by a misalignment of social and biological circadian rhythms. In turn, this poor sleep quality appears to mediate the association between eveningness and negative affective outcomes in adolescents and young adults.

Chronotype is a trait appearing early in life, with detectable chronotype-related differences in affect appearing in children and infants (Chiu et al. 2017; Werner et al. 2009). Significant intraindividual variation in chronotype occurs over the lifespan (Roenneberg et al. 2004), with a delay to circadian rhythms (i.e. a shift toward eveningness) typically occurring in adolescence. As such, the consequences of the mismatch between societal and individual rhythms for E-types may be amplified during later adolescence and early adulthood. The negative effect of this physiological delay on sleep quality is further worsened by young adults viewing sleep as low priority (Barone 2017). This combined change in chronotype and sleep behaviors has significant negative effects on daily functioning and psychological well-being via their effects on sleep. Bakotic et al. (2017) found increased eveningness was associated with depressive mood in a sample of undergraduate students, and sleep quality mediated the link between chronotype and depressive mood. Eveningness has also been associated with more severe suicide-related outcomes (Bahk et al. 2014; Matsumoto et al. 2016; Rumble et al. 2018; Selvi et al. 2011, 2010). Work by Lester (2015) in a non-clinical sample of 194 undergraduate students also found eveningness to be associated with increased perceptions of defeat ($r = -.32$) and entrapment ($r = -.26$), both of which are strongly implicated in suicidal behavior (O'Connor 2011; O'Connor and Kirtley 2018; Williams 2014; Winsper and Tang 2014). However, Lester (2015) did not find an association between chronotype and past suicidal ideation or suicide attempts. Further research into the eveningness–affect relationship is of particular importance in students given the high cost of mental ill health in young adulthood (Kessler et al. 2005; McGorry et al. 2019).

Although sleep disturbances have typically been considered symptoms of psychological distress, this relationship is bidirectional. Difficulties with sleep have been shown to better predict subsequent suicidal ideation than depression or hopelessness in young adults (Ribeiro et al. 2012). Poor baseline sleep quality in adolescents has also been associated with higher rates of generalized anxiety disorder at follow-up (Shanahan et al. 2014). Meta-analyses of longitudinal studies of insomnia and subsequent psychopathologies also provide evidence for sleep disturbance as a causal factor of psychological distress (Baglioni et al. 2011; Hertenstein et al. 2019). Interventions to improve sleep also support the bidirectionality between sleep and affect. Cognitive behavioral therapy for insomnia has been shown to significantly reduce the severity of depression and suicidal ideation (Manber et al. 2011; Trockel et al. 2015). Edwards et al. (2015) also demonstrated that improving

sleep quality led to a significant reduction in the number of people with sleep apnea meeting the clinical cutoff for depression as measured by the PHQ-9 Kroenke et al. 2001, with this proportion reducing from 74.6% to just 3.9% following intervention. Similar results have been demonstrated by others (Balcan et al. 2019; Relia et al. 2018). Since eveningness is associated with reduced sleep quality and duration, we propose that insomnia symptoms can partially explain the prevalence of poorer affective outcomes in E-types, rather than eveningness having an intrinsic detrimental effect on well-being.

The present study aimed to explore the associations between chronotype and selected affective outcomes in a sample of students aged 18–24. An additional aim was to explore the role of insomnia as a mediating factor in the chronotype–affect relationship.

Hypotheses

H1: Higher morningness will be associated with positive outcomes in measures of wellbeing and mental health.

H2: Insomnia will mediate the relationship between chronotype and affective outcomes where significant associations exist.

Method

Participants and procedure

The study was designed in line with British Psychological Society guidelines and met the requirements laid out by Portaluppi et al. (2010) for chronobiology research on human participants. Ethical approval was granted by the University of Glasgow College of Science and Engineering Ethics Committee. Participants were recruited via social media, online forums, and university participant pool mailing lists. The inclusion criterion was to be aged 18–24 y old and enrolled as a full-time student. Participants completed an online survey during two data collection periods in different seasons (May–July 2019 and January–February 2020; N.B. data collection ended prior to COVID-19-related restrictions were placed on people's behaviors). The survey was described as about sleep and its links to mood and/or mental health. Participants were provided with a link to a survey hosted on the University of Glasgow Experimentum platform (https://exp.psy.gla.ac.uk) which complies with the General Data Protection Regulation (EU) 2016/679. An information page with warnings about the sensitive nature of the topic was presented alongside contact details for mental health support services. After reading this page and providing consent, participants were asked to complete the measures described below. A debriefing page thanked participants and restated the contact details for support services.

Measures

Demographics

Participants reported their age in years and their gender (male, female, or other).

Chronotype

The reduced Morningness–Eveningness Questionnaire (rMEQ; Adan and Almirall 1991; Loureiro and Garcia-Marques 2015) is a five-item self-report measure of a person's chronotype. Items include preferred awakening time, preferred time of day, and self-appraisal as a morning/neither/evening (M-, N-, E-) type. Scores can range from 4 to 25 with higher scores indicating increased morningness. The rMEQ prescribes five clusters of chronotype: definite M-types (22–25), moderate M-types (18–21), N-type (12–17), moderate E-types (8–11), and definite E-types (4–7). In the present study, definite and moderate types were grouped together for categorical analysis. This is suggested by the authors of the scale for use during psychological research (Adan and Almirall 1991) and has been done in previous studies using this scale (e.g. Akram et al. 2018; Hidalgo et al. 2009). The internal consistency of the rMEQ (and all other measures listed below) was assessed by Cronbach's (1951) $_{\alpha}$ and McDonald's (1999) ω_t statistics: $\alpha = .58$, $\omega_t = .68$.

Insomnia

The Sleep Condition Indicator (SCI; Espie et al. 2014) is an 8-item measure of self-reported insomnia symptoms over the previous month. Each item is scored from 0 to 4, with higher scores typically indicating better sleep quality. However, SCI scores were reversed to allow for more intuitive interpretation of results in the present study. It has good psychometric properties for detecting DSM-5 insomnia disorder, with a score of 17 or more (following reversal of scoring) indicating probable insomnia disorder and clinical levels of dysfunction (Espie et al. 2014; Wong et al. 2017). The internal consistency in the present sample was $\alpha = .88$, $\omega_t = .92$.

Depression, anxiety, and stress

The 21-item short form of the Depression, Anxiety, and Stress Scales (DASS-21; Henry and Crawford 2005; Lovibond and Lovibond 1995) is a composite measure

of depression, anxiety, and stress symptoms. Participants respond to seven questions for each of the three subscales using a 4-point Likert-type scale from 0 ("*Did not apply to me at all*") to 3 ("*Applied to me very much or most of the time*"). These subscores are doubled to make comparable with the original 42-item version of the scale and summed to give a total DASS-21 score. Potential scores for each subscale range from 0 to 42 and total scores from 0 to 126. Higher subscale scores, respectively, indicate more frequent or severe experiences of depression, anxiety, and stress symptoms. Internal consistency for overall DASS-21 scale in the present sample was α = .94, ω_t = .95. Internal consistency for subscales: $\alpha_{depression}$ = .92, $\omega_{t,\ depression}$ = .95; $\alpha_{anxiety}$ = .86, $\omega_{t,\ anxiety}$ = .90; α_{stress} = .86, $\omega_{t,\ stress}$ = .90.

Defeat

The Defeat Scale (Gilbert and Allan 1998) comprises 16 mixed-valence statements related to subjective experiences of feeling defeated, humiliated, or having failed to achieve goals. Participants respond to statements such as *"I feel that I am one of life's losers"* using a 5-point Likert-type scale from *"I never feel like this"* (0) to *"I always feel like this"* (4). Potential scores range from 0 to 64, with higher scores indicating increased perceptions of defeat. The internal consistency in the present sample was α = .95, ω_t = .96.

Entrapment

The Entrapment Scale (Gilbert and Allan 1998) comprises 16 statements related to subjective experiences of being unable to escape from or resolve situations in which an individual feels defeated or to have failed. Subscales measure feelings of entrapment triggered by internal (six items; e.g. "*I would like to escape from my thoughts and feelings*") and external causes (10 items; e.g. "*I feel trapped by other people*") entrapment. Responses are given using a 5-point Likert-type scale from *"Not at all like me"* (0) to "*Extremely like me*" (4). Potential scores range from 0 to 64, with higher scores indicating increased perceptions of entrapment. The internal consistency in the present sample was α = .96, ω_t = .97. The internal consistency for the internal entrapment subscale was α = .93, ω_t = .95. The internal consistency for the external entrapment subscale was α = .93, ω_t = .95.

Suicidal ideation

The Suicidal Ideation Attributes scale (SIDAS; van Spijker et al. 2014) is a 5-item measure of suicidal ideation severity over the previous month which uses an 11-point Likert-type response scale. Each item asks about a different aspect of suicidal ideation, including the frequency of suicidal thoughts, their impact on daily functioning, and how much control a person has over suicidal thoughts. One item also asks how close a person has come to making a suicide attempt with the option to indicate they have made an attempt. Potential scores range from 0 to 50 with higher scores, indicating increased severity of suicidal ideation. A cutoff score of 20 or greater is suggested to indicate a high suicide risk. Internal consistency for the SIDAS was α = .90, ω_t = .92.

Data analysis

Responses were obtained from 191 participants who responded to all measures. Data were screened for partial responses. Individual mean substitution was applied per measure if a participant missed a single item on any or all of the DASS-21 subscales, a single item on the SCI, or up to two items on the Defeat and/or Entrapment Scales. Listwise deletion was applied if more items were missed; one participant's responses were removed for missing two items on the DASS stress scale. Overall data missingness in this sample was 0.15% (19 items of a possible 12,540).

Data were analyzed using RStudio version 1.4.634 (RStudio Team 2020) built on R version 3.6.3 (R Core Team 2020). The normality of the data was assessed by Shapiro–Wilk tests and all measures were found to deviate from normality. Therefore, nonparametric statistical methods were used throughout the analysis. H_1 was assessed using bivariate Kendall's τ_b rank correlations and Mann–Whitney U-tests. H_2 was tested using serial multiple-mediation analysis. Note that the use of mediation analysis on cross-sectional data must be justified based on existing theory (Fairchild and McDaniel 2017; Shrout and Bolger 2002): The role of insomnia as a mediating factor between sleep disturbance and affective outcomes is justified by studies such as those by Chiu et al. (2017) and Simor et al. (2015), as well as other literature discussed above. Mediation analysis was carried out using the *lavaan* R package (v.0.6–3) and nonparametric bootstrap resampling techniques (50,000 bootstrap iterations; Rosseel 2012; Shrout and Bolger 2002).

Results

The sample comprised 34 M-types (17.9%), 96 N-types (50.5%), and 60 E-types (31.6%). Sixty-seven participants met the cutoff score for probable insomnia disorder (35.3%). Thirty-four participants (17.9%) met the cutoff score for high risk in the suicidal ideation measure. Of these 34, 79.4% also met the cutoff for probable clinical insomnia. Self-reported chronotype (Q5 in rMEQ) was strongly associated with the total rMEQ score (Kendall's τ_b = .79; 95% CI 0.73–0.84; $p < .001$).

Descriptive statistics are presented in Table 1 with bivariate association coefficients.

Groupwise comparisons

Kruskal–Wallis tests indicated significant differences between chronotype groups on all outcome measures but showed no difference in age. Subsequent Mann–Whitney U-tests showed no significant differences between M- and N-types except for chronotype. However, E-types had significantly poorer scores for all outcomes compared to both M- or N-types (see Tables 2 and 3). These results support H_1 and show that eveningness is associated with more severe psychological distress and poorer sleep.

Mediation analysis

Mediation analysis with chronotype as the independent variable and insomnia as the mediator showed this indirect pathway to be significant for all outcome variables (see Figure 1 and Table 4). For both stress and suicidal ideation, the inclusion of insomnia as a mediator rendered the direct effect of chronotype on these outcomes insignificant. This provides support for H_2 and suggests that the poorer affective outcomes associated with eveningness may be at least partially explained by the poor sleep experienced by E-types.

Discussion

This study examined the relationship between chronotype and affective outcomes, as well as the mediating role of insomnia symptoms in a sample of students. Our analyses provide support for H_1: increased eveningness was negatively associated with all outcome measures with the exception of stress. Additionally, results of the mediation analyses provide partial support for H_2: insomnia partially mediated significant proportions of the total effect of chronotype on affective outcomes and completely mediated the relationships between chronotype and stress, as well as chronotype and suicidal ideation. These results combine to suggest that E-types are at an increased risk of poorer mental health outcomes, but this risk may be attributable to the negative effects of poor sleep quality.

The results and effect sizes found in the present study are in keeping with existing literature on the chronotype–affect relationship (e.g. Bakotic et al. 2017; Simor et al. 2015; You et al. 2020). The poorer affective outcomes of E-types in the present sample reflect the results of Tan et al. (2020) and their sample of undergraduates where E-types scored lower on a measure of happiness than N- and M-types. Similarly, the results of our mediation analyses that of Chiu et al. (2017) where sleep quality mediated the chronotype–depression relationship. The role of insomnia as a mediating factor between chronotype and negative emotionality found by Simor et al. (2015) in their sample of adults (mean age = 25.3 ± 5.8y) is also supported by the present study. However, our results show that the mediating role of sleep quality in the relationship between chronotype and depression/stress appears to extend to a broader range of affective outcomes. These outcomes include perceived defeat and entrapment, as well as suicidal ideation.

Our findings – combined with the broader literature – suggest that an evening chronotype is not necessarily an intrinsic source of negative affect. The poorer outcomes most often associated with higher eveningness appear to be partially consequences of poor sleep quality related to this preference for evenings. This poor sleep is a result of misalignment of preferred daily rhythms and external constraints, such as school and work schedules. This is in keeping with findings such as those of Dimitrov et al. (2018) where depressive mood was associated with sleep midpoint on work/school days but not on days where participants had more control over their schedule (i.e. weekends and holidays). The implications of these findings are that the negative outcomes associated with being an E-type are malleable. Future studies investigating the associations between fixed/flexible schedules and chronotype, or the interaction of chronotype and potential protective factors against negative affect, would be informative. For example, E-types high in trait extraversion can benefit from engaging in social occasions which typically take place later in the day, a time when they feel their best (Drezno et al. 2019). By aligning internal and external daily rhythms, the link between eveningness and negative mental health outcomes can be mitigated.

Alternatively, if the alignment of internal and external rhythms cannot be achieved, then we can look to behavioral change for improvement in affective outcomes. The abundance of research into the treatment of insomnia and delayed sleep-wake phase disorder has produced a number of behavior-modifying approaches including clinically effective cognitive-behavioral therapies for insomnia (CBTI) interventions (Trauer et al. 2015; van der Zweerde et al. 2019). However, chronotype may act as a moderator on the effectiveness of CBTI. Bei et al. (2015) examined the effect of a 6-week group CBTI on insomnia intervention in an outpatient clinical sample of people experiencing insomnia. Their results showed significantly smaller improvement in depressive mood in E-types than in N-types, with

Table 1. Bivariate associations (Kendall's τ_b with 95% confidence intervals in parentheses) and descriptive statistics. Mdn = median, IQR = interquartile range, M = mean, S = standard deviation.

		1.	2.	3.	4.	5.	6.	7.	8.	9.	Mdn (IQR)	M (S)
1.	Age										21 (19–23)	20.7 (2.04)
2.	Insomnia	.03 (−.11, .17)									13 (7–19)	13.2 (7.62)
3.	Chronotype	.06 (−.08, .20)	−.24 (−.37, −.10)								13 (10–16)	13.4 (3.90)
4.	DASS-21	−.06 (−.20, .08)	.44 (.33, .55)	−.22 (−.35, −0.08)							34 (16–58)	40.1 (22.7)
5.	Depression	−.10 (−.24, .04)	.40 (.27, .51)	−.22 (−.36, −.08)	.73 (.66, .79)						10 (4–20)	12.9 (11.3)
6.	Anxiety	−.05 (−.19, .09)	.39 (.26, .51)	−.21 (−.34, −.07)	.70 (.62, .76)	.48 (.36, .58)					8 (2–18)	11.4 (9.94)
7.	Stress	.02 (−.12, .16)	.41 (.28, 52)	−.17 (−.31, −.03)	.76 (.69, .82)	.52 (.41, .62)	.58 (.47, .66)				14 (8–22)	15.8 (10.0)
8.	Defeat	−.09 (−.23, .05)	.39 (.26, .51)	−.20 (−.34, −.06)	.57 (.47, .66)	.65 (.55, .72)	.42 (.30, .53)	.44 (.32, .55)			19.5 (12–30.75)	22.8 (13.8)
9.	Entrapment	−.05 (−.19, .10)	.36 (.23, .48)	−.26 (−.39, −.13)	.61 (.51, .69)	.66 (.57, .74)	.45 (.33, .56)	.48 (.36, .58)	.65 (.56, .72)		14.5 (5–26)	18.0 (15.6)
10.	Suicidal Ideation	−.02 (−.16, .12)	.34 (.21, .46)	−.14 (−.28, .00)	.48 (.36, .48)	.50 (.38, .60)	.39 (.26, .50)	.39 (.26, .50)	.51 (.40, .61)	.52 (.41, .62)	3 (0–13)	8.82 (11.6)

N-types in turn showing significantly smaller improvement than M-types. In contrast, an internet-based CBTI intervention study using midlife adults by Lien et al. (2019) found similar improvements in depressive mood and insomnia severity in both M- and E-types. Further exploration of the interaction between CBTI-effectiveness and chronotype is required. Combined with the knowledge that lifelong health-behavior change can be effectively implemented by altering automatic and habitual behaviors during emerging adulthood (e.g. Cleo et al. 2017), E-types may benefit more from approaches focused on maintaining habitual good sleep hygiene routines if CBTI is less effective in this group. Although chronotype is partially defined by genetics, it is possible to modify through behavioral interventions. Modifying sleep–wake behaviors can thus mitigate some of the consequences of being an E-type bound to societal schedules related to a conventional 9–5 work day. Facer-Childs et al. (2019) carried out a randomized control trial of advancing sleep–wake timings by approximately 2h in a sample of E-types. Compared to the control group (also E-types) that received no intervention, the treatment group experienced significant improvements in measures of depression and cognitive performance. The intervention was relatively unintrusive, mainly focusing on the timing of meals, exercise, and light exposure. Additionally, even less intensive interventions based on sleep-related psychoeducation may bring about similar changes in sleep behaviors of young adults and adolescents high in eveningness (Harvey et al. 2018). Chung et al. (2019) found that higher eveningness was associated with increased bedtime procrastination (e.g. TV watching) in young adults, highlighting a potential daily opportunity to improve sleep quality through habit formation or modification. Whilst these initial findings (obtained within a real-world setting) are promising, further replication is required given the complex relationship between light therapy, sleep timing, and severity of mood state in individuals with an evening chronotype. However, in sum, there are multiple existing methods for improving sleep quality which can mitigate the suggested negative effect of eveningness on affective outcomes.

Chronotype in the present study was measured using the short form of the Morningness–Eveningness questionnaire. This measure asks about a person's activity preferences on free days (i.e. those where sleep-wake times are not dictated by external factors, such as work or school). A more in-depth analysis of the misalignment between externally dictated sleep–wake/energy schedule requirements and personal preferences would provide more insight into the role of chronotype and sleep disturbance on affective outcomes.

Table 2. Two-tailed Mann–Whitney U-test statistics for M-types v. E-types. Mdn = median, IQR = interquartile range, U = Mann–Whitney U-test statistic, r = effect size (|Z|/√N; Field et al. 2012, 665). Significance levels of between-group differences: * $p < .05$, ** $p < .01$, *** $p < .001$. Holm-Bonferroni corrected for 30 tests (3 pairings of chronotype, with 10 variables each) significance levels: † $p < .05$, †† $p < .01$, NS not significant. If no daggers, then no change to significance level following correction. No significant difference in age between groups.

	M-types (*N* = *34*)		E-types (*N* = *60*)			
	Mdn	IQR	Mdn	IQR	U	r
Age	20	20–23	21	18–22	959.5	.05
Insomnia***††	11	5–15.5	19	12.5–22	1492.5	.38
Chronotype***	19	18–20	9	8–10	0	.83
DASS-21**†	21	14–52	53	28–82.5	1430.5	.33
Depression**†	5	2–12	16	7.5–28	1407.5	.31
Anxiety**†	6	2–15.5	16	7.5–24.5	1403.5	.31
Stress^{**NS}	12	8–18	18	12–32	1358.5	.27
Defeat^{**NS}	18	10.25–26.75	28	15–42.5	1388	.30
Entrapment***††	7.5	1.25–2375	21.5	12.5–40.25	1508	.40
Suicidal Ideation^{*NS}	2.5	0–14.25	7.5	2–23.5	1271	.20

Table 3. Two-tailed Mann–Whitney U-test statistics for N-types v. E-types. Mdn = median, IQR = interquartile range, U = Mann–Whitney U-test statistic, r = effect size (|Z|/√N; Field et al. 2012, 665). Significance levels of between-group differences: * $p < .05$, ** $p < .01$, *** $p < .001$. Holm-Bonferroni corrected for 30 tests (3 pairings of chronotype, with 10 variables each) significance levels: † $p < .05$, †† $p < .01$, NS not significant. If no daggers, then no change to the significance level following correction. No significant difference in age between groups.

	N-types (*N* = *96*)		E-types (*N* = *60*)			
	Mdn	IQR	Mdn	IQR	U	r
Age	20.5	19–23	21	18–22	2804	.02
Insomnia***	10.5	5–16	19	12.5–22	4293	.41
Chronotype***	14	13–15.25	9	8–10	0	.84
DASS-21***††	28	15.5–52.5	53	28–82.5	3947.5	.31
Depression***††	8	2–18	16	7.5–28	3834.5	.28
Anxiety***††	7	2–14	16	7.5–24.5	3916.5	.30
Stress**†	13	7.5–20	18	12–32	3717	.24
Defeat***††	16.5	11–27.25	28	15–42.5	3957	.31
Entrapment***	12	5–20	21.5	12.5–40.25	4073	.35
Suicidal Ideation***††	2	0–9	7.5	2–23.5	3959.5	.32

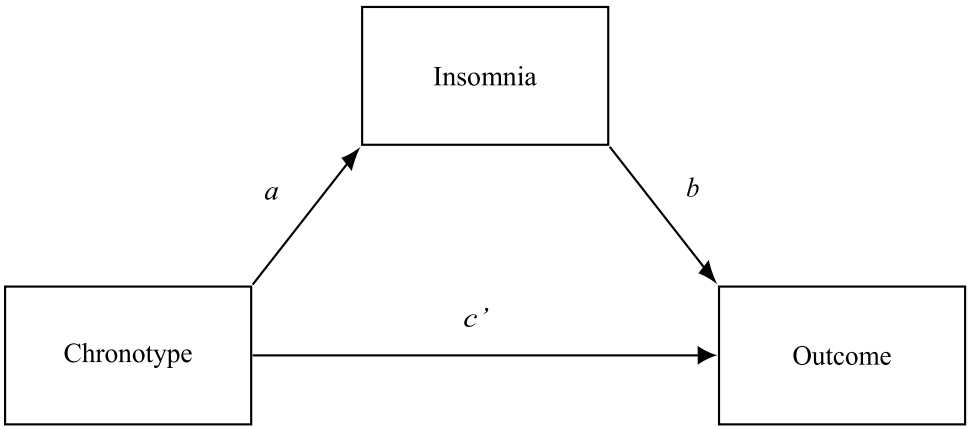

Figure 1. Mediation model for chronotype and outcomes via insomnia.

Comparison of school/work days with free days could be made by using an alternative measure of circadian preference, such as the Munich Chronotype Questionnaire (Roenneberg et al. 2003). Analysis of the differences between free and constrained days could explore potential dose–response relationship in terms of rhythm misalignment. This would build on work by You et al. (2020) that found that the amplitude of variation in

Table 4. Bootstrapped point estimates and 95% bias-corrected confidence intervals (in parentheses) for direct and indirect effects as represented in Figure 1. Point estimates and 95% confidence intervals of indirect and direct pathways resulting from multiple serial mediation analysis. Generated using 50000 bootstrapping iterations. Italics indicate insignificant relations (i.e. where confidence intervals include zero). P_m = proportion mediated as a percentage of total effect size using point estimates = a × b/(c′ + a × b). Ratio = ratio of scale-normalized change in outcome variable to scale-normalized change in chronotype (e.g. a ratio value of −0.39 means that a 10% increase in chronotype score is associated with a 3.9% decrease in outcome score).

Outcome	a	b	a × b	c′	a × b + c′	P_m (%)	Ratio
DASS-21	−0.62 (−0.90, −0.33)	2.13 (1.74, 2.49)	−1.32 (−1.98, −0.72)	−1.03 (−1.86, −0.21)	−2.34 (−3.41, −1.30)	56.2	−0.39
Depression	−0.62 (−0.90, −0.33)	0.73 (0.55, 0.90)	−0.45 (−0.71, −0.24)	−0.50 (−0.86, −0.13)	−0.95 (−1.36, −.52)	47.4	−0.47
Anxiety	−0.62 (−0.90, −0.33)	0.66 (0.51, 0.82)	−0.41 (−0.63, −0.23)	−0.37 (−0.69, −0.06)	−0.78 (−1.16, −0.41)	52.6	−0.39
Stress	−0.62 (−0.90, −0.33)	0.74 (0.58, 0.89)	−0.46 (−0.70, −0.25)	*−0.16 (−0.47, 0.15)*	−0.46 (−0.70, −0.25)	74.6	−0.31
Defeat	−0.62 (−0.90, −0.33)	1.00 (0.81, 1.18)	−0.62 (−0.97, −0.33)	−0.48 (−0.91, −0.05)	−1.10 (−1.64, −0.57)	56.3	−0.36
Entrapment	−0.62 (−0.90, −0.33)	0.90 (0.66, 1.11)	−0.56 (−0.89, −0.30)	−0.98 (−1.52, −0.46)	−1.54 (−2.15, −0.93)	36.3	−0.50
Suicidal Ideation	−0.62 (−0.90, −0.33)	0.75 (0.54, 0.96)	−0.47 (−0.76, −0.24)	*−0.10 (−0.51, 0.30)*	−0.57 (−1.04, −0.09)	82.05	−0.24

energy and motivation across the course of the day was a much stronger correlate with stress than chronotype directly (r= .39 and .14, respectively). Again, a more detailed exploration of the potentially multifactorial nature of chronotype (Konttinen et al. 2014; Preckel et al. 2019; Putilov 2017; Putilov et al. 2015, 2019) may generate more interesting and useful results for how to handle negative affective consequences of circadian rhythm misalignment. As highlighted in a review by Taylor and Hasler (2018), future studies of chronotype will ideally include more prospective research and increased use of objective sleep and wake measurements.

A strength of this study is the use of validated measures throughout. The use of validated measures for sleep quality and suicidal ideation addresses the specific criticism of sleep-related suicide research made by Tubbs et al. (2019) which was that too often only single-item measures are used for these constructs. Another strength of this study is the broadening of outcomes to include more than depression, which is commonly the only outcome assessed in similar studies related to chronotype. If circadian/social rhythm misalignment leads to negative effects on a variety of mental health outcomes (as opposed to depression or mood alone) then correction of this misalignment offers a simple and practical transdiagnostic intervention. Further, if the causative role of this misalignment – and its effects on sleep – can be established by prospective studies, then the underlying pathways can be better understood.

This cross-sectional study cannot inform the direction of potential causal pathways between eveningness and negative affective outcomes. Whilst prospective research does point to the possibility that evening chronotype may precede depression (Haraden et al. 2017; Van Den Berg et al. 2018), more longitudinal work is needed to determine the directionality of this relationship. These studies have the potential to provide valuable insights into whether (i) eveningness predisposes individuals to an increased risk of depression, (ii) depressive symptomology influences individuals chronotype or (iii) the relationship between depression and chronotype is bi-directional (Au and Reece 2017; Kivelä et al. 2018). Particular caution around presumptions of this directionality must be exercised due to the complex and idiopathic relationships between sleep–wakefulness and affective outcomes, such as depressive symptom severity. However, research on insomnia's effect on subsequent mood and mental health outcomes (e.g. Bernert et al. 2017; Littlewood et al. 2019) combined with research on chronotype's causal association with poor sleep quality points toward a directional chronotype–insomnia–affect pathway (Bakotic et al. 2017; Facer-Childs et al. 2019; Konjarski et al. 2018). This putative causal relationship is supported by the results of the present study. Additional prospective research is needed to better establish this pathway. Preferably this would include objective sleep–wake behavior tracking along with ecological momentary assessment studies that measure affect and circadian-informed variables (e.g. energy levels, motivation, sleepiness) coincidentally. Additionally, as insomnia provides only partial mediation of the chronotype–affect relationship, other explanatory factors must also be investigated to better resolve the association of eveningness with poorer mental health outcomes.

Conclusion

This study has shown that eveningness is associated with poorer affective outcomes in young adult students. It has also demonstrated the potential role of insomnia as a mediating factor within this relationship. Taken together, these findings have the potential to improve the assessment and prevention of psychological distress in young adults who report a preference for later sleep and wake times. Our results suggest that interventions that target insomnia and sleep-related behavior change have the potential to mitigate the effect of poor sleep quality related to misalignment of internal and external rhythms in this population. Ultimately, these interventions may protect against or miti-

gate a range of negative affective outcomes in young adult students.

Declaration of Interest Statement

The authors have no conflicts of interest to report.

Funding

This work was carried out as part of a master's degree, so no funding support was required.

Acknowledgement

Daniel R. R. Bradford would like to thank the anonymous reviewers as well as Dr. Denise Brown and Dr. Mirjam Allik of the MRC/CSO Social and Public Health Sciences Unit. All provided valuable feedback and advice that significantly improved the quality of this manuscript.

ORCID

Daniel R. R. Bradford http://orcid.org/0000-0002-7523-8764
Stephany M. Biello http://orcid.org/0000-0002-3497-5215
Kirsten Russell http://orcid.org/0000-0002-7034-2749

References

Adan A, Almirall H. 1991. Horne & Östberg morningness-eveningness questionnaire: a reduced scale. Pers Individ Differ. 12(3):241–253. doi:10.1016/0191-8869(91)90110-W

Akram N, Khan N, Ameen M, Mahmood S, Shamim K, Amin M, Rana QUA. 2018. Morningness-eveningness preferences, learning approach and academic achievement of undergraduate medical students. Chronobiol Int. 35 (9):1262–1268. doi:10.1080/07420528.2018.1474473

Antypa N, Verkuil B, Molendijk M, Schoevers R, Penninx BWJH, Does WVD. 2017. Associations between chronotypes and psychological vulnerability factors of depression. Chronobiol Int. 34(8):1125–1135. doi:10.1080/07420528.2017.1345932

Antypa N, Vogelzangs N, Meesters Y, Schoevers R, Penninx BWJH. 2016. Chronotype associations with depression and anxiety disorders in a large cohort. Depress Anxiety. 33(1):75–83. doi:10.1002/da.22422

Au J, Reece J. 2017. The relationship between chronotype and depressive symptoms: a meta-analysis. J Affect Disord. 218:93–104. doi:10.1016/j.jad.2017.04.021

Baglioni C, Battagliese G, Feige B, Spiegelhalder K, Nissen C, Voderholzer U, Lombardo C, Riemann D. 2011. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. J Affect Disord. 135 (1–3):10–19. doi:10.1016/j.jad.2011.01.011

Bahk Y-C, Han E, Lee S-H. 2014. Biological rhythm differences and suicidal ideation in patients with major depressive disorder. J Affect Disord. 168:294–297. doi:10.1016/j.jad.2014.07.001

Bakotic M, Radosevic-Vidacek B, Bjelajac AK. 2017. Morningness–eveningness and daytime functioning in university students: the mediating role of sleep characteristics. J Sleep Res. 26(2):210–218. doi:10.1111/jsr.12467

Balcan B, Thunström E, Strollo PJ, Peker Y. 2019. Determinants of depressive mood in coronary artery disease patients with obstructive sleep apnea and response to continuous positive airway pressure treatment in non-sleepy and sleepy phenotypes in the RICCADSA cohort. J Sleep Res. 28(4):e12818. doi:10.1111/jsr.12818

Barclay NL, Eley TC, Buysse DJ, Archer SN, Gregory AM. 2010. Diurnal preference and sleep quality: same genes? A study of young adult twins. Chronobiol Int. 27 (2):278–296. doi:10.3109/07420521003663801

Barone TL. 2017. "Sleep is on the back burner": working students and sleep. Soc Sci J. 54(2):159–167. doi:10.1016/j.soscij.2016.12.001

Bei B, Ong JC, Rajaratnam SM, Manber R. 2015. Chronotype and improved sleep efficiency independently predict depressive symptom reduction after group cognitive behavioral therapy for insomnia. J Clin Sleep Med. 11 (9):1021–1027. doi:10.5664/jcsm.5018

Bernert RA, Hom MA, Iwata NG, Joiner TE. 2017. Objectively assessed sleep variability as an acute warning sign of suicidal ideation in a longitudinal evaluation of young adults at high suicide risk. J Clin Psychiatry. 78(6):e678–e687. doi:10.4088/JCP.16m11193

Chan JWY, Lam SP, Li SX, Yu MWM, Chan NY, Zhang J, Wing Y-K. 2014. Eveningness and Insomnia: independent risk factors of nonremission in major depressive disorder. Sleep. 37(5):911–917. doi:10.5665/sleep.3658

Chiu W-H, Yang H-J, Kuo P-H. 2017. Chronotype preference matters for depression in youth. Chronobiol Int. 34 (7):933–941. doi:10.1080/07420528.2017.1327441

Chung SJ, An H, Suh S 2019. What do people do before going to bed? A study of bedtime procrastination using time use surveys. Sleep. 43(4). doi:10.1093/sleep/zsz267

Cleo G, Isenring E, Thomas R, Glasziou P. 2017. Could habits hold the key to weight loss maintenance? A narrative review. J Hum Nutr Diet. 30(5):655–664. doi:10.1111/jhn.12456

Coleman MY, Cain SW. 2019. Eveningness is associated with greater subjective cognitive impairment in individuals with self-reported symptoms of unipolar depression. J Affect Disord. 256:404–415. doi:10.1016/j.jad.2019.05.054

Conklin AI, Yao CA, Richardson CG. 2018. Chronic sleep deprivation and gender-specific risk of depression in adolescents: a prospective population-based study. BMC Public Health. 18(1):724. doi:10.1186/s12889-018-5656-6

Cronbach LJ. 1951. Coefficient alpha and the internal structure of tests. Psychometrika. 16(3):297–334. doi:10.1007/BF02310555

Crowley SJ, Acebo C, Carskadon MA. 2007. Sleep, circadian rhythms, and delayed phase in adolescence. Sleep Med. 8 (6):602–612. doi:10.1016/j.sleep.2006.12.002

Dimitrov A, Veer IM, Kleeblatt J, Seyfarth F, Roenneberg T, Ising M, Adli M, Keck ME, Kramer A, Berger M. 2018. . Chronotype is associated with psychological well-being depending on the composition of the study sample. J Health Psychol. 25:1236–1247. doi:10.1177/1359105317751618

Drezno M, Stolarski M, Matthews G. 2019. An in-depth look into the association between morningness–eveningness and well-being: evidence for mediating and moderating effects of personality. Chronobiol Int. 36(1):96–109. doi:10.1080/07420528.2018.1523184

Druiven SJM, Hovenkamp-Hermelink JHM, Knapen SE, Kamphuis J, Haarman BCM, Penninx BWJH, Riese H, Meesters Y, Schoevers RA, Riese H. 2020. Stability of chronotype over a 7-year follow-up period and its association with severity of depressive and anxiety symptoms. Depress Anxiety. 37(5):466–474. doi:10.1002/da.22995

Edwards C, Mukherjee S, Simpson L, Palmer LJ, Almeida OP, Hillman DR. 2015. Depressive symptoms before and after treatment of obstructive sleep apnea in men and women. J Clin Sleep Med. 11(9):1029–1038. doi:10.5664/jcsm.5020

Espie CA, Kyle SD, Hames P, Gardani M, Fleming L, Cape J. 2014. The sleep condition indicator: a clinical screening tool to evaluate insomnia disorder. BMJ Open. 4(3):e004183. doi:10.1136/bmjopen-2013-004183

Facer-Childs ER, Boiling S, Balanos G. 2018. The effects of time of day and chronotype on cognitive and physical performance in healthy volunteers. Sports Med Open. 4. doi:10.1186/s40798-018-0162-z

Facer-Childs ER, Middleton B, Skene DJ, Bagshaw AP. 2019. Resetting the late timing of 'night owls' has a positive impact on mental health and performance. Sleep Med. 60:236–247. doi:10.1016/j.sleep.2019.05.001

Fairchild AJ, McDaniel HL. 2017. Best (but oft-forgotten) practices: mediation analysis. Am J Clin Nutr. 105(6):1259–1271. doi:10.3945/ajcn.117.152546

Field AP, Miles J, Field Z. 2012. Discovering statistics using R. London: Sage.

Gaspar-Barba E, Calati R, Cruz-Fuentes CS, Ontiveros-Uribe MP, Natale V, De Ronchi D, Serretti A. 2009. Depressive symptomatology is influenced by chronotypes. J Affect Disord. 119(1–3):100–106. doi:10.1016/j.jad.2009.02.021

Gau SS-F, Shang C-Y, Merikangas KR, Chiu Y-N, Soong W-T, Cheng -AT-A. 2007. Association between morningness-eveningness and behavioral/emotional problems among adolescents. J Biol Rhythms. 22(3):268–274. doi:10.1177/0748730406298447

Gilbert P, Allan S. 1998. The role of defeat and entrapment (arrested flight) in depression: an exploration of an evolutionary view. Psychol Med. 28(3):585–598. doi:10.1017/S0033291798006710

Goldstein D, Hahn CS, Hasher L, Wiprzycka UJ, Zelazo PD. 2007. Time of day, intellectual performance, and behavioral problems in morning versus evening type adolescents: is there a synchrony effect? Pers Individ Differ. 42(3):431–440. doi:10.1016/j.paid.2006.07.008

Haraden DA, Mullin BC, Hankin BL. 2017. The relationship between depression and chronotype: a longitudinal assessment during childhood and adolescence. Depress Anxiety. 34(10):967–976. doi:10.1002/da.22682

Haraszti RÁ, Ella K, Gyöngyösi N, Roenneberg T, Káldi K. 2014. Social jetlag negatively correlates with academic performance in undergraduates. Chronobiol Int. 31(5):603–612. doi:10.3109/07420528.2013.879164

Harvey AG, Hein K, Dolsen MR, Dong L, Rabe-Hesketh S, Gumport NB, Blum DJ, Wyatt JK, Hinshaw SP, Silk JS. 2018. Modifying the impact of eveningness chronotype ("night-owls") in youth: a randomized controlled trial. J Am Acad Child Adolesc Psychiatry. 57(10):742–754. doi:10.1016/j.jaac.2018.04.020

Henry JD, Crawford JR. 2005. The short-form version of the Depression Anxiety Stress Scales (DASS-21): construct validity and normative data in a large non-clinical sample. Br J Clin Psychol. 44(2):227–239. doi:10.1348/014466505X29657

Hertenstein E, Feige B, Gmeiner T, Kienzler C, Spiegelhalder K, Johann A, Baglioni C, Palagini L, Rücker G, Riemann D. 2019. Insomnia as a predictor of mental disorders: a systematic review and meta-analysis. Sleep Med Rev. 43(96–105). doi:10.1016/j.smrv.2018.10.006

Hidalgo MP, Caumo W, Posser M, Coccaro SB, Camozzato AL, Chaves MLF. 2009. Relationship between depressive mood and chronotype in healthy subjects. Psychiatry Clin Neurosci. 63(3):283–290. doi:10.1111/j.1440-1819.2009.01965.x

Hu Y, Shmygelska A, Tran D, Eriksson N, Tung JY, Hinds DA. 2016. GWAS of 89,283 individuals identifies genetic variants associated with self-reporting of being a morning person. Nat Commun. 7(1):1–9. doi:10.1038/ncomms10448

Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. 2005. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. Arch Gen Psychiatry. 62(6):593–602. doi:10.1001/archpsyc.62.6.593

Kivelä L, Papadopoulos MR, Antypa N. 2018. Chronotype and psychiatric disorders. Curr Sleep Med Rep. 4(2):94–103. doi:10.1007/s40675-018-0113-8

Knutson KL, von Schantz M. 2018. Associations between chronotype, morbidity and mortality in the UK Biobank cohort. Chronobiol Int. 35(8):1045–1053. doi:10.1080/07420528.2018.1454458

Konjarski M, Murray G, Lee VV, Jackson ML. 2018. Reciprocal relationships between daily sleep and mood: a systematic review of naturalistic prospective studies. Sleep Med Rev. 42:47–58. doi:10.1016/j.smrv.2018.05.005

Konttinen H, Kronholm E, Partonen T, Kanerva N, Männistö S, Haukkala A. 2014. Morningness–eveningness, depressive symptoms, and emotional eating: a population-based study. Chronobiol Int. 31(4):554–563. doi:10.3109/07420528.2013.877922

Lane JM, Vlasac I, Anderson SG, Kyle SD, Dixon WG, Bechtold DA, Saxena R, Little MA, Luik A, Loudon A 2016. Genome-wide association analysis identifies novel loci for chronotype in 100,420 individuals from the UK biobank. Nat Commun. 7(1). doi:10.1038/ncomms10889

Lester D. 2015. Morningness–eveningness, current depression, and past suicidality. Psychol Rep. 116(2):331–336. doi:10.2466/16.02.PR0.116k18w5

Lien M, Bredeli E, Sivertsen B, Kallestad H, Pallesen S, Smith ORF, Vedaa Ø, Ritterband LM, Thorndike FP, Vedaa Ø. 2019. Short and long-term effects of unguided internet-based cognitive behavioral therapy for chronic insomnia in morning and evening persons: a post-hoc analysis. Chronobiol Int. 36(10):1384–1398. doi:10.1080/07420528.2019.1647435

Littlewood DL, Kyle S, Pratt D, Peters S, Gooding P. 2017. Examining the role of psychological factors in the relationship between sleep problems and suicide. Clin Psychol Rev. 54:1–16. doi:10.1016/j.cpr.2017.03.009

Littlewood DL, Kyle SD, Carter L-A, Peters S, Pratt D, Gooding P. 2019. Short sleep duration and poor sleep quality predict next-day suicidal ideation: an ecological

momentary assessment study. Psychol Med. 49(3):403. doi:10.1017/S0033291718001009
Loureiro F, Garcia-Marques T. 2015. Morning or evening person? Which type are you? Self-assessment of chronotype. Pers Individ Differ. 86:168–171. doi:10.1016/j.paid.2015.06.022
Lovibond PF, Lovibond SH. 1995. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the beck depression and anxiety inventories. Behav Res Ther. 33(3):335–343. doi:10.1016/0005-7967(94)00075-U
Manber R, Bernert RA, Suh S, Nowakowski S, Siebern AT, Ong JC. 2011. CBT for insomnia in patients with high and low depressive symptom severity: adherence and clinical outcomes. J Clin Sleep Med. 7(6):645–652. doi:10.5664/jcsm.1472
Matsumoto Y, Uchimura N, Ishida T, Toyomasu K, Morimatsu Y, Mori M, Kushino N, Hoshiko M, Ishitake T. 2016. Day workers suffering from a wider range of sleep problems are more likely to experience suicidality. Sleep Biol Rhythms. 14(4):369–376. doi:10.1007/s41105-016-0067-5
McDonald RP. 1999. Test theory: a unified treatment. London; Mahwah, N.J: L. Erlbaum Associates.
McGorry P, Trethowan J, Rickwood D. 2019. Creating headspace for integrated youth mental health care. World Psychiatry. 18(2):140–141. doi:10.1002/wps.20619
Merrow M, Spoelstra K, Roenneberg T. 2005. The circadian cycle: daily rhythms from behaviour to genes. EMBO Rep. 6(10):930–935. doi:10.1038/sj.embor.7400541
Miller MA, Rothenberger SD, Hasler BP, Donofry SD, Wong PM, Manuck SB, Roecklein KA. 2015. Chronotype predicts positive affect rhythms measured by ecological momentary assessment. Chronobiol Int. 32(3):376–384. doi:10.3109/07420528.2014.983602
Norbury R. 2019. Chronotype, depression and hippocampal volume: cross-sectional associations from the UK biobank. Chronobiol Int. 36(5):709–716. doi:10.1080/07420528.2019.1578229
O'Connor RC. 2011. Towards an integrated motivational–volitional model of suicidal behaviour. In: International handbook of suicide prevention. John Wiley & Sons, Ltd; p. 181–198. doi:10.1002/9781119998556.ch11
O'Connor RC, Kirtley OJ. 2018. The integrated motivational–volitional model of suicidal behaviour. Philos Trans R Soc B. 373(1754):20170268. doi:10.1098/rstb.2017.0268
Park H, Lee H-K, Lee K. 2018. Chronotype and suicide: the mediating effect of depressive symptoms. Psychiatry Res. 269:316–320. doi:10.1016/j.psychres.2018.08.046
Partonen T. 2015. Chronotype and health outcomes. Curr Sleep Med Rep. 1(4):205–211. doi:10.1007/s40675-015-0022-z
Portaluppi F, Smolensky MH, Touitou Y. 2010. Ethics and methods for biological rhythm research on animals and human beings. Chronobiol Int. 27:1911–1929. doi:10.3109/07420528.2010.516381
Preckel F, Fischbach A, Scherrer V, Brunner M, Ugen S, Lipnevich AA, Roberts RD. 2019. Circadian preference as a typology: latent-class analysis of adolescents' morningness/eveningness, relation with sleep behavior, and with academic outcomes. Learn Individ Differ. doi:10.1016/j.lindif.2019.03.007
Putilov AA. 2017. Owls, larks, swifts, woodcocks and they are not alone: a historical review of methodology for multidimensional self-assessment of individual differences in sleep-wake pattern. Chronobiol Int. 34(3):426–437. doi:10.1080/07420528.2017.1278704
Putilov AA, Donskaya OG, Verevkin EG. 2015. How many diurnal types are there? A search for two further "bird species". Pers Individ Differ. 72:12–17. doi:10.1016/j.paid.2014.08.003
Putilov AA, Marcoen N, Neu D, Pattyn N, Mairesse O. 2019. There is more to chronotypes than evening and morning types: results of a large-scale community survey provide evidence for high prevalence of two further types. Pers Individ Differ. 148:77–84. doi:10.1016/j.paid.2019.05.017
R Core Team. 2020. R: a language and environment for statistical computing. Vienna, Austria. https://www.R-project.org/
Randler C, Schredl M, Göritz AS. 2017. Chronotype, sleep behavior, and the Big Five personality factors. SAGE Open. 7(3):2158244017728321. doi:10.1177/2158244017728321
Relia S, Thompson NR, Mehra R, Moul D, Katzan I, Foldvary-Schaefer N, Walia HK. 2018. Depression score changes in response to sleep disordered breathing treatment with positive airway pressure in a large clinic-based cohort. Sleep Breath. 22(1):195–203. doi:10.1007/s11325-018-1626-6
Ribeiro JD, Pease JL, Gutierrez PM, Silva C, Bernert RA, Rudd MD, Joiner TE. 2012. Sleep problems outperform depression and hopelessness as cross-sectional and longitudinal predictors of suicidal ideation and behavior in young adults in the military. J Affect Disord. 136(3):743–750. doi:10.1016/j.jad.2011.09.049
Roenneberg T, Allebrandt K, Merrow M, Vetter C. 2012. Social jetlag and obesity. Curr Biol. 22(10):939–943. doi:10.1016/j.cub.2012.03.038
Roenneberg T, Kuehnle T, Pramstaller PP, Ricken J, Havel M, Guth A, Merrow M. 2004. A marker for the end of adolescence. Curr Biol. 14(24):R1038–R1039. doi:10.1016/j.cub.2004.11.039
Roenneberg T, Wirz-Justice A, Merrow M. 2003. Life between clocks: daily temporal patterns of human chronotypes. J Biol Rhythms. 18(1):80–90. doi:10.1177/0748730402239679
Rosseel Y. 2012. lavaan: an R package for structural equation modeling. J Stat Softw. 48(2):1–36. doi:10.18637/jss.v048.i02
RStudio Team. 2020 Rstudio: integrated development environment for R. Boston, MA. http://www.rstudio.com/
Rumble ME, Dickson D, McCall WV, Krystal AD, Case D, Rosenquist PB, Benca RM. 2018. The relationship of person-specific eveningness chronotype, greater seasonality, and less rhythmicity to suicidal behavior: a literature review. J Affect Disord. 227:721–730. doi:10.1016/j.jad.2017.11.078
Selvi Y, Aydin A, Atli A, Boysan M, Selvi F, Besiroglu L. 2011. Chronotype differences in suicidal behavior and impulsivity among suicide attempters. Chronobiol Int. 28(2):170–175. doi:10.3109/07420528.2010.535938
Selvi Y, Aydin A, Boysan M, Atli A, Agargun MY, Besiroglu L. 2010. Associations between chronotype, sleep quality, suicidality, and depressive symptoms in patients with major depression and healthy controls. Chronobiol Int. 27(9–10):1813–1828. doi:10.3109/07420528.2010.516380
Selvi Y, Aydin A, Gulec M, Boysan M, Besiroglu L, Ozdemir PG, Kilic S. 2012. Comparison of dream anxiety and subjective sleep quality between chronotypes. Sleep Biol Rhythms. 10(1):14–22. doi:10.1111/j.1479-8425.2011.00511.x
Shanahan L, Copeland WE, Angold A, Bondy CL, Costello EJ. 2014. Sleep problems predict and are predicted by generalized anxiety/depression and oppositional defiant disorder.

J Am Acad Child Adolesc Psychiatry. 53(5):550–558. doi:10.1016/j.jaac.2013.12.029

Sheaves B, Porcheret K, Tsanas A, Espie CA, Foster RG, Freeman D, Goodwin GM, Wulff K, Goodwin GM. 2016. Insomnia, nightmares, and chronotype as markers of risk for severe mental illness: results from a student population. Sleep. 39(1):173–181. doi:10.5665/sleep.5342

Shrout PE, Bolger N. 2002. Mediation in experimental and non-experimental studies: new procedures and recommendations. Psychol Methods. 7(4):422. doi:10.1037/1082-989X.7.4.422

Simor P, Zavecz Z, Pálosi V, Török C, Köteles F. 2015. The influence of sleep complaints on the association between chronotype and negative emotionality in young adults. Chronobiol Int. 32(1):1–10. doi:10.3109/07420528.2014.935786

Takahashi M, Iwasaki K, Sasaki T, Kubo T, Mori I, Otsuka Y. 2011. Worktime control-dependent reductions in fatigue, sleep problems, and depression. Appl Ergon. 42 (2):244–250. doi:10.1016/j.apergo.2010.06.006

Tan MN, Mevsim V, Cifci MP, Sayan H, Ercan AE, Ergin OF, Ensari S, Ensari S. 2020. Who is happier among preclinical medical students: the impact of chronotype preference. Chronobiol Int. 37 (8):1–10. doi:10.1080/07420528.2020.1761373

Taylor BJ, Hasler BP. 2018. Chronotype and mental health: recent advances. Curr Psychiatry Rep. 20(8):59. doi:10.1007/s11920-018-0925-8

Toomey R, Panizzon MS, Kremen WS, Franz CE, Lyons MJ. 2015. A twin-study of genetic contributions to morningness–eveningness and depression. Chronobiol Int. 32 (3):303–309. doi:10.3109/07420528.2014.971366

Trauer JM, Qian MY, Doyle JS, Rajaratnam SMW, Cunnington D. 2015. Cognitive behavioral therapy for chronic insomnia. Ann Intern Med. 163(3):191–204. doi:10.7326/M14-2841

Trockel M, Karlin BE, Taylor CB, Brown GK, Manber R. 2015. Effects of cognitive behavioral therapy for insomnia on suicidal ideation in veterans. Sleep. 38(2):259–265. doi:10.5665/sleep.4410

Tubbs AS, Perlis ML, Grandner MA. 2019. Surviving the long night: the potential of sleep health for suicide prevention. Sleep Med Rev. 44:83–84. doi:10.1016/j.smrv.2019.01.001

Van Den Berg JF, Kivelä L, Antypa N. 2018. Chronotype and depressive symptoms in students: an investigation of possible mechanisms. Chronobiol Int. 35(9):1248–1261. doi:10.1080/07420528.2018.1470531

van der Zweerde T, Bisdounis L, Kyle SD, Lancee J, van Straten A. 2019. Cognitive behavioral therapy for insomnia: a meta-analysis of long-term effects in controlled studies. Sleep Med Rev. 48:101208. doi:10.1016/j.smrv.2019.08.002

van Spijker BAJ, Batterham PJ, Calear AL, Farrer L, Christensen H, Reynolds J, Kerkhof AJ. 2014. The suicidal ideation attributes scale (SIDAS): community-based validation study of a new scale for the measurement of suicidal ideation. Suicide Life-Threat Behav. 44(4):408–419. doi:10.1111/sltb.12084

Werner H, LeBourgeois MK, Geiger A, Jenni OG. 2009. Assessment of chronotype in four- to eleven-year-old children: reliability and validity of the Children's ChronoType Questionnaire (CCTQ). Chronobiol Int. 26(5):992–1014. doi:10.1080/07420520903044505

Williams JMG. 2014. Cry of pain: understanding suicide and the suicidal mind. London: Piatkus.

Winsper C, Tang NKY. 2014. Linkages between insomnia and suicidality: prospective associations, high-risk subgroups and possible psychological mechanisms. Int Rev Psychiatry. 26 (2):189–204. doi:10.3109/09540261.2014.881330

Wittmann M, Dinich J, Merrow M, Roenneberg T. 2006. Social jetlag: misalignment of biological and social time. Chronobiol Int. 23(1–2):497–509. doi:10.1080/07420520500545979

Wong ML, Lau KNT, Espie CA, Luik AI, Kyle SD, Lau EYY. 2017. Psychometric properties of the Sleep Condition Indicator and Insomnia Severity Index in the evaluation of insomnia disorder. Sleep Med. 33:76–81. doi:10.1016/j.sleep.2016.05.019

Wong PM, Hasler BP, Kamarck TW, Muldoon MF, Manuck SB. 2015. Social jetlag, chronotype, and cardiometabolic risk. J Clin Endocrinol Metab. 100(12):4612–4620. doi:10.1210/jc.2015-2923

You M, Laborde S, Dosseville F, Salinas A, Allen MS. 2020. Associations of chronotype, big five, and emotional competences with perceived stress in university students. Chronobiol Int. 37(7):1–9. doi:10.1080/07420528.2020.1752705

Young MW, Kay SA. 2001. Time zones: a comparative genetics of circadian clocks. Nat Rev Genet. 2(9):702–715. doi:10.1038/35088576