

Original Article

Cite this article: Kang S, Kim H, Yu H, Lee D, Lee HJ, Ha TH, Park J, Myung W, and Kang HS. (2024) The impact of morningness–eveningness on depression through a serial mediation model of resilience and anxiety. *Acta Neuropsychiatrica* 36:438–445. doi: 10.1017/neu.2024.23

Received: 21 February 2024
Revised: 16 May 2024
Accepted: 18 May 2024
First published online: 27 May 2024

Keywords:



Anxiety; depressive symptom; morningness–eveningness; mood disorder; resilience

Corresponding authors:

H. S. Kang; Email: hyoshin.kang@knu.ac.kr;
J. Park; Email: jkp@knu.ac.kr;
W. Myung; Email: wmyung@snu.ac.kr

Suhyeon Kang and Huiyeoung Kim contributed equally to this work as co-first authors.

The impact of morningness–eveningness on depression through a serial mediation model of resilience and anxiety

Suhyeon Kang¹, Huiyeoung Kim¹, Hyeona Yu², Daseul Lee², Hyuk Joon Lee², Tae Hyon Ha², Jungkyu Park¹, Woojae Myung^{2,3}  and Hyo Shin Kang¹ 

¹Department of Psychology, Kyungpook National University, Daegu, Republic of Korea; ²Department of Neuropsychiatry, Seoul National University Bundang Hospital, Seongnam, Republic of Korea and ³Department of Psychiatry, Seoul National University College of Medicine, Seoul, Republic of Korea

Abstract

Objective: Resilience has been recently considered one of the possible mechanisms for the association between morningness–eveningness and depression. Meanwhile, anxiety is closely associated with mood disorder, but its association with morningness–eveningness is unclear. Therefore, this study aimed to explore the mediating effects of resilience and anxiety on morningness–eveningness and depression as the possible mechanisms. **Methods:** This study included patient group and nonpatient group. Patient group consists of 743 patients with mood disorders [Major Depressive Disorder (MDD), 233; Bipolar Disorder I (BDI), 113; Bipolar Disorder II (BDII), 397] whereas nonpatient group consists of 818 individuals without mood disorder. The Composite Scale of Morningness, Connor–Davidson Resilience Scale, Self-Rating Depression Scale, and Beck Anxiety Inventory were used to evaluate morningness–eveningness, resilience, anxiety, and depression, respectively. **Results:** Our model provided a good fit for the data. The association between morningness–eveningness and depression symptoms was partially serially mediated by resilience and anxiety in both the patient and nonpatient groups. The patient group exhibited significantly stronger morningness–eveningness toward resilience and anxiety than the nonpatient group. In the indirect effect of morningness–eveningness on depression, group differences exist only through each mediation of resilience and anxiety, not through serial mediation. **Conclusion:** Our results expand on the mechanism underlying the association between morningness–eveningness and depression. They highlight the importance of morningness–eveningness modification to increase resilience and the need to consider anxiety jointly in this process.

Significant outcomes

- This study expanded underlying mechanisms between morningness–eveningness and depression with resilience and anxiety.
- Resilience and anxiety individually and sequentially mediate between morningness–eveningness and depression in both the patient of mood disorder and the general population.
- The patient group has stronger paths not only between morningness–eveningness and resilience but between morningness–eveningness and anxiety than the nonpatient group.

Limitations

- Demographic data of the general population were not collected except sex and age.
- BDI samples were less compared with those of MDD and BDII patients in patient group.

Introduction

Circadian rhythm refers to biological and behavioural human functions, including sleep–wake patterns, hormone secretion, body temperature moderation, and socialisation. These variances are influenced by morningness–eveningness preference, which can be classified into three typologies: morning, intermediate (or neither), and evening (Roenneberg *et al.*, 2003; Adan *et al.*, 2012). In the past 20 years, interests in the investigation of chronotypes have increased and many researchers have explored the effect of morningness–eveningness on mental health issues

© The Author(s), 2024. Published by Cambridge University Press on behalf of Scandinavian College of Neuropsychopharmacology. This is an Open Access article, distributed under the terms of the Creative Commons Attribution-NonCommercial licence (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original article is properly cited. The written permission of Cambridge University Press must be obtained prior to any commercial use.



(Natale *et al.*, 2008; Broms *et al.*, 2011; Lin & Gau, 2013), particularly depression (Fares *et al.*, 2015). Patients with any type of mood disorder tend to exhibit more delayed circadian rhythms, showing preference for eveningness, than nonpatients (Au & Reece, 2017; Meyrel *et al.*, 2022). Previous studies have demonstrated that patients with eveningness preferences tend to experience higher level of depression (Hasler *et al.*, 2010; Seo *et al.*, 2022), increased suicidality (Chan *et al.*, 2014), and more severe circadian rhythm disorders (Mondin *et al.*, 2017) compared with morningness preferences. These results were consistent even after controlling for sleep-related factors (Kitamura *et al.*, 2010; Chan *et al.*, 2014; Antypa *et al.*, 2016b).

Despite the association between morningness–eveningness and mood disorder, the underlying mechanisms for the association between them have not been fully established. Among the potential variables for the aforementioned association, resilience has recently gained increasing attention (Chung *et al.*, 2018). Resilience is a positive ability of an individual to effectively adapt to and overcome adversity (Fletcher & Sarkar, 2013). A higher level of this positive ability is associated with lesser depression symptoms (Wermelinger Ávila *et al.*, 2017) and lower suicidal risks (Sher, 2019). In terms of the mechanism variance, previous studies have demonstrated that eveningness is associated with lower resilience (Antúnez *et al.*, 2015; Lee *et al.*, 2016; Chung *et al.*, 2018) and even indirectly affects depression symptoms through the mediation (Palagini *et al.*, 2022) or moderation (Zhou *et al.*, 2021) of resilience.

Depression exhibited high comorbidity with anxiety, and mood disorder accompanied by anxiety symptoms often resulted in worse prognosis, longer recovery time, and greater risks of suicide when compared with mood disorder alone (Goldberg & Fawcett, 2012). Furthermore, anxiety symptoms, along with depression, have been shown to be lesser if resilience increases (Hjemdal *et al.*, 2011; Shin *et al.*, 2019). However, most previous studies that have identified the indirect effects of resilience on morningness–eveningness and depression did not consider anxiety severity (Zhou *et al.*, 2021; Palagini *et al.*, 2022). Therefore, further study on this matter is warranted.

Although the association between morningness–eveningness and resilience is generally consistent between prior studies, the association between the former and anxiety has not been firmly established. Existing evidence suggest that eveningness is associated with anxiety disorder (Lemoine *et al.*, 2013; Fares *et al.*, 2015). However, some studies have reported that eveningness and anxiety disorder do not have an association (Antypa *et al.*, 2016b; Danielsson *et al.*, 2019). Even in patients with bipolar disorder (BD) among mood disorder types, conflicting results of association of morningness–eveningness and anxiety exist. A previous study found that evening chronotypes were associated with higher levels of anxiety and lower levels of functioning (Melo *et al.*, 2019). Contrarily, another study showed that patients with BD and eveningness preference did not exhibit higher comorbidity rate of anxiety disorders (Romo-Nava *et al.*, 2020). Therefore, further investigation is warranted to better understand the association between morningness–eveningness and anxiety.

In this study, we investigated the roles of resilience and anxiety in the association between morningness–eveningness and depressive symptom. Previous studies have suggested that resilience may serve as a one possible protective mechanism factor and anxiety as an important factor in depression, although anxiety has uncertain relevance with morningness–eveningness. Understanding the association between morningness–eveningness

Table 1. Demographic characteristics of patient and nonpatient groups

	Patient (n = 743)	Nonpatient (n = 818)
	Mean (SD)	Mean (SD)
Age (years)	34.01 (12.54)	24.47 (6.29)
Sex (n, %)		
Female	519 (69.9)	759 (92.8)
Male	224 (30.1)	59 (7.2)
Clinical diagnosis (n, %)		
BDI	113 (15.2)	
BDII	397 (53.4)	
MDD	233 (31.4)	

BD I = Bipolar I Disorder; BD II = Bipolar II Disorder; MDD = Major Depressive Disorder.

and depression is imperative for the establishment of effective interventions related to morningness–eveningness in a mood disorder. However, no studies have examined the associations among morningness–eveningness, resilience, anxiety, and depression jointly. On the basis of past research, we hypothesised that eveningness would increase depression symptoms through the mediation of lower resilience and greater anxiety. Furthermore, we determined whether these associations are applicable to both patients with mood disorder and the general population.

Material and methods

Participants

This study included 743 patients with mood disorder (Major Depressive Disorder (MDD), 233 [31.4%]; Bipolar Disorder I (BDI), 113 [15.2%]; Bipolar Disorder II (BDII), 397 [53.4%]) who were recruited from the clinic of the Seoul National University Bundang Hospital and 818 nonpatients. Data collection was carried out from July 2013 to February 2021. The psychiatric diagnoses of all patients were confirmed by board-certified psychiatrists (THH and WM) through a structured diagnostic interview (Mini-International Neuropsychiatric Interview [MINI]) (Sheehan *et al.*, 1998) or a review of case records. Patient-related information including age, sex, education years, job, marital status, alcohol use, smoking habit, family psychiatric history, and hospitalisation history were collected. The nonpatients were recruited anonymously from an online survey. Some of them were excluded if they self-reported history of any psychiatric disorder and others were used as a comparison group. The requirement for informed consent was waived as data of the patients were collected through a medical chart review whereas those of the comparison group were obtained through an anonymous survey, not directly accessing their personal information. The study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital (B-2104-679-103). The descriptive statistics of the study sample are presented in Table 1.

Measures

Composite scale of morningness

The Composite Scale of Morningness (CS) is a 13-item self-report scale that assesses the morningness–eveningness preference of an individual (Smith *et al.*, 1989). Three questions are rated

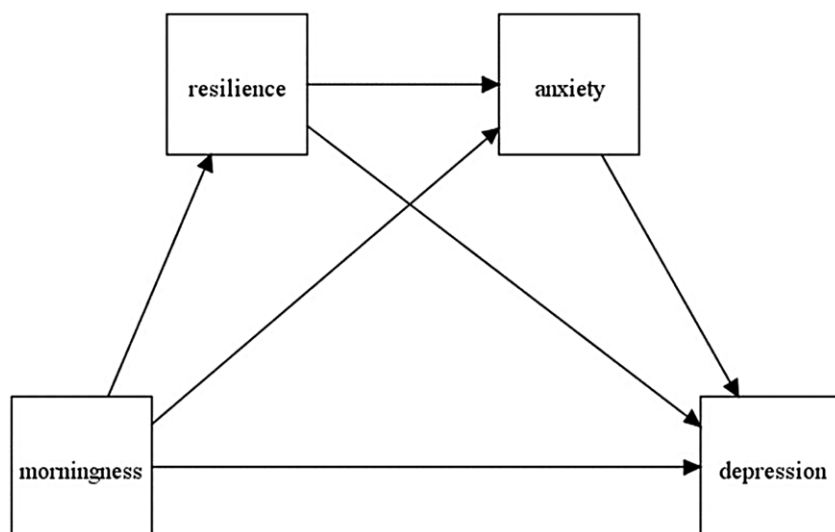


Figure 1. Hypothesised study model.

on a five-point Likert scale (1–5) and the remaining 10 questions on a four-point Likert scale (1–4). The total score of the items ranges from 13 to 55, with higher scores denoting greater morningness preference. The Korean version of the CS translated and validated by Kim (1998) exhibits psychometric reliability (Cronbach's $\alpha = .81$). The reliability of the CS in the present sample was adequate (McDonald's $\omega = .87$).

Self-rating depression scale

The Self-Rating Depression Scale (SDS) (Zung, 1965) consists of 20 items, where half questions of the scales are negative and leaving half is positive so needed reversed score. The items are rated on a four-point Likert scale (1–4). The total score of the items ranges from 20 to 80, with higher scores denoting more severe depression symptoms. The Korean version of the SDS exhibited reliable internal consistency (Lee & Song, 1991) (Cronbach's $\alpha = .80$). The reliability of the SDS in the present sample was adequate (McDonald's $\omega = .89$).

Beck anxiety inventory

The Beck Anxiety Inventory (BAI) is a 21-item self-report scale that evaluates the severity of anxiety symptoms (Beck *et al.*, 1988). Each item is rated on a four-point Likert scale (0–3). The total score of the items ranges from 0 to 63, with higher scores denoting higher severity of anxiety symptoms. The Korean version of the BAI exhibited good reliability (Cronbach's $\alpha = .90$) (Kim *et al.*, 2015). The reliability of the BAI in the present sample was excellent (McDonald's $\omega = 0.93$).

Connor–Davidson resilience scale

The Connor–Davidson Resilience Scale (CD-RISC) is a self-report scale developed by Connor and Davidson (2003) that measures an individual's ability to adapt to change and cope with adversity. It consists of 25 items rated on a five-point Likert scale ranging from 0 to 4. The total score of the items ranges from 0 to 100, with higher scores denoting stronger resilience. The Korean version of the CD-RISC exhibited excellent reliability (Baek *et al.*, 2010) (Cronbach's $\alpha = .93$). The reliability of the CD-RISC in the present sample was good (McDonald's $\omega = .93$).

Statistical analysis

Before the main analysis, we conducted a confirmatory factor analysis (CFA) to evaluate the construct validity of the measures. To achieve this, we developed a measurement model that includes four factors of interest: morningness, resilience, anxiety, and depression. We incorporated several fit indices, including the chi-squared statistic, CFI, TLI, RMSEA, and SRMR, to evaluate how well the four-factor model fits the data. When fitting the four-factor model, we generated item parcels due to the substantial number of items in each subscale. These parcels represent an aggregated indicator formed by combining two or more items using either the sum or average of individual items. To generate systematically balanced parcels for each factor, we used a factorial algorithm based on the magnitudes of the loadings, as suggested by Little *et al.* (2002).

We employed a path analysis model to simultaneously estimate all path coefficients using maximum likelihood estimation with robust standard errors. Our hypothesised model suggests that the relationship between morningness and depression is sequentially mediated by resilience and anxiety, as presented in Figure 1. The hypothesised model includes three indirect effects mediated by each mediator (morningness \rightarrow resilience \rightarrow depression; morningness \rightarrow anxiety \rightarrow depression) and the serial mediation that was mediated by both mediators (morningness \rightarrow resilience \rightarrow anxiety \rightarrow depression). These indirect effects were calculated by multiplying the coefficients along each path.

To test the indirect effects, we constructed the 95% confidence intervals (CIs) for the average indirect effect via Monte Carlo simulation procedure. This approach accurately reflects the asymmetric nature of the sampling distribution of an indirect effect by producing empirical sampling distributions of the path coefficients used to calculate the indirect effect (Preacher & Selig, 2012). Furthermore, we incorporated demographic variables, such as sex and age, in the model. We also conducted additional statistical tests to explore the differences in the estimated path coefficients as well as the indirect effects between the patient and nonpatient groups. We used Mplus version 8.6 (Muthén & Muthén, 2021) to conduct all the statistical analyses in our study.

Table 2. Means, standard deviations, correlations for all study variables

Variables	Means	SD	1	2	3
Patient					
1. Morningness	29.08	8.02			
2. Resilience	45.67	19.14	−.426**		
3. Anxiety	21.68	14.03	.330**	−.569**	
4. Depression	42.89	10.76	−.300**	.750**	−.329**
Non-patient					
1. Morningness	27.95	7.19			
2. Resilience	53.19	17.76	−0.307**		
3. Anxiety	15.96	9.95	0.216**	−0.641**	
4. Depression	39.40	9.49	−0.187**	0.718**	−0.418**

** $p < .01$.**Table 3.** Estimates, standard errors and 95% confidence intervals for path coefficients and indirect effects

	Patient				Nonpatient			
	Estimates	SE	95%CI Lower	Upper	Estimates	SE	95%CI Lower	Upper
Path coefficients								
M→R	0.731**	0.085	0.559	0.895	0.447**	0.086	0.274	0.613
M→A	−0.361**	0.067	−0.493	−0.228	−0.110**	0.050	−0.210	−0.013
R→A	−0.183**	0.027	−0.236	−0.130	−0.207**	0.019	−0.246	−0.171
R→D	−0.182**	0.013	−0.206	−0.157	−0.205**	0.013	−0.230	−0.179
A→D	0.459**	0.018	0.424	0.494	0.498**	0.024	0.451	0.547
Direct effect								
M→D	−0.189**	0.031	−0.251	−0.128	−0.151**	0.027	−0.204	−0.098
Indirect effects								
M→R→D	−0.133**	0.018	−0.168	−0.099	−0.091**	0.019	−0.130	−0.055
M→A→D	−0.166**	0.031	−0.227	−0.104	−0.055*	0.025	−0.106	−0.007
M→R→A→D	−0.062**	0.012	−0.088	−0.041	−0.046**	0.010	−0.067	−0.028
Total effect	−0.549**	0.047	−0.641	−0.457	−0.344**	0.045	−0.432	−0.254

M = Morningness; R = Resilience; A = Anxiety; D = Depression.

* $p < .05$.** $p < .01$.

Results

The means, standard deviations, and correlations of all study variables for each group are presented in Table 2. The CFA results indicate that the four-factor model exhibited a satisfactory fit to the data ($\chi^2 = 900.72$, $df = 113$, CFI = 0.96, TLI = 0.95, RMSEA = 0.06, SRMR = .04). In addition, all item parcels were significantly loaded onto their corresponding factors, which ranged from 0.594 to .910. The correlation coefficients among the four factors ranged from −0.667 to 0.810, indicating that the four-factor model fit the data well.

Coefficient estimates and their 95% CIs in the model for each group are presented in Table 3. As can be seen from the table, morningness is positively associated with resilience in both groups

(patient group: $\beta = 0.731$, $p < .001$; nonpatient group: $\beta = 0.447$, $p < .001$) after controlling for age and sex whereas it is negatively associated with anxiety also in both groups (patient group: $\beta = -0.361$, $p < .001$; nonpatient group: $\beta = -0.110$, $p = .032$). Furthermore, the effects of resilience on anxiety and depression are negative and significant in both groups. Table 3 also demonstrates that anxiety is positively associated with depression also in both groups (patient group: $\beta = 0.459$, $p < .001$; nonpatient group: $\beta = 0.498$, $p < .001$).

In the patient group, the indirect effect of morningness on depression through the mediation of resilience was negative and significant (*estimate* = −0.133, 95% CI [−0.168, −0.099]), similar to that through the mediation of anxiety (*estimate* = −0.166, 95% CI [−0.227, −0.104]). Furthermore, the findings indicate that the

Table 4. Difference in path coefficients, direct effect, and indirect effects between patient and nonpatient groups

	Estimates	SE	Diff (Patient-Nonpatient)	
			95%CI	
			Lower	Upper
Path coefficients				
M→R	0.285*	0.121	0.048	0.524
M→A	−0.251**	0.084	−0.415	−0.087
R→A	0.024	0.034	−0.043	0.089
R→D	0.023	0.018	−0.012	0.058
A→D	−0.038	0.030	−0.097	0.019
Direct effect				
M→D	−0.038	0.041	−0.119	0.044
Indirect effects				
M→R→D	−.078*	0.031	−0.138	−0.016
M→A→D	−.075*	0.036	−0.148	−0.005
M→R→A→D	−0.015	0.016	−0.047	0.014
Total effect	−0.206**	0.065	−0.335	−0.081

M = Morningness; R = Resilience; A = Anxiety; D = Depression.

* $p < .05$.

** $p < .01$.

hypothesised serial mediation was significant in the patient group ($estimate = -0.062$, 95% CI $[-0.088, -0.041]$), fully supporting our hypothesised associations.

Similarly, in the nonpatient group, both resilience and anxiety mediated the association between morningness and depression. Specifically, the indirect effect estimate of morningness on depression through the mediation of resilience was -0.091 (95% CI $[-0.130, -0.055]$), whereas that through the mediation of anxiety was -0.055 (95% CI $[-0.106, -0.007]$), both exhibiting significance. The serial indirect effect of morningness on depression through the mediation of both resilience and anxiety was negative and significant ($estimate = -0.046$, 95% CI $[-0.067, -0.028]$). Furthermore, the direct effect of morningness on depression was statistically significant for the patient group ($\beta = -0.189$, $p < .001$) and nonpatient group ($\beta = -0.151$, $p < .001$).

The differences in the estimated path coefficients and indirect effects between the groups are presented in Table 4. The results indicate that there were no significant differences in the path coefficients between the groups, except for the M→R and M→A paths. As shown in Table 4, the M→R path coefficient was significantly different between the groups ($\tau = 0.285$, $p = .019$); the difference in the M→A path coefficient was also significant ($\tau = -0.251$, $p = .003$). Table 4 also demonstrates that the difference in the indirect effect of morningness on depression through the mediation of resilience was statistically significant ($diff = -0.008$, 95% CI $[-0.138, -0.016]$) whereas that in the indirect effect through the mediation of anxiety was significantly different between the groups ($diff = -0.008$, 95% CI $[-0.148, -0.005]$).

Discussion

This study aimed to investigate the associations among morningness–eveningness, resilience, anxiety, and depression in patients with mood disorder and the general population. As expected, in

both groups, we found that morningness–eveningness was associated with depression. Furthermore, the results of the present study are consistent with the path hypotheses that resilience and anxiety individually and sequentially were mediators between morningness–eveningness and depression in both the patient and nonpatient groups. The results also indicate that the total effects of this model between the groups exhibited significant differences. Specifically, such differences appeared to have resulted from the paths between morningness–eveningness and resilience as well as between morningness–eveningness and anxiety.

The results of this study also indicate that each variable was significantly associated each other, which is consistent with the results of previous studies. Recent studies reported that morningness–eveningness was associated with depression (Müller *et al.*, 2016; Daghlis *et al.*, 2021; Seo *et al.*, 2022) and resilience (Antúñez *et al.*, 2015; Lee *et al.*, 2016; Chung *et al.*, 2018). Moreover, in previous studies, the association between resilience and depression has been consistently confirmed not only in mood disorders (Waugh & Koster, 2015; Masuyama *et al.*, 2022) but also in various mental disorders (Wingo *et al.*, 2010; Williams & Jahn, 2017). Despite the existence of associations between these three variables, there were few studies that examined the direction of the variables all at once by postulating a model (Tafoya *et al.*, 2019; Zhou *et al.*, 2021; Palagini *et al.*, 2022). In addition to resilience, we extend these associations by presenting a serial mediating effect of anxiety, which is strongly associated with depression symptoms, as seen in high comorbidities (Goldberg & Fawcett, 2012; Antypa *et al.*, 2016a).

Unlike the associations between other variables that are generally consistent, previous studies have yielded conflicting results regarding the association between morningness–eveningness and anxiety (Melo *et al.*, 2019; Romo-Nava *et al.*, 2020). In the present study, we found a significant association between morningness–eveningness and anxiety. Based on these results, we can deduce that aside from resilience, anxiety is also an important mechanism for the association between morningness–eveningness and depression in patients with mood disorders.

The association between morningness–eveningness and resilience can be interpreted from various theoretical perspectives. First, from a biological standpoint, various factors may be involved, including glucocorticoid hormones, sunlight exposure, rapid eye movement sleep, and neural plasticity (Lee *et al.*, 2016; Chung *et al.*, 2018). We particularly focused on glucocorticoid hormones and sunlight exposure as explications for this model. Glucocorticoid hormones are a major pathway for transmitting information within circadian rhythm (Androulakis, 2021), the phases of which are related to morningness–eveningness, both intrinsically and through its behavioural traits (Duffy *et al.*, 2001; Adan *et al.*, 2012). Additionally, because glucocorticoid hormones function as both a primary circadian signal and a major stress response indicator (Spencer *et al.*, 2018), they play a critical role in the fundamental processes of adaptation and resilience (Reul *et al.*, 2015). Furthermore, glucocorticoid hormone levels are linked to symptoms of anxiety and depressive disorders via the corticotropin-releasing hormone (Spijker & Van Rossum, 2012; Raglan *et al.*, 2017). Also, longer sunlight exposure in the daytime is associated with morningness preference (Lee *et al.*, 2016) and increased resilience (Killgore *et al.*, 2020). Exposure to natural light is the core zeitgeber of the circadian system as well as can affect depression and associated low anxiety (An *et al.*, 2016; Blume *et al.*, 2019).

Secondly, from a psychological perspective, vulnerabilities such as hopelessness could mediate this relationship. Hopelessness is

one of the main symptoms of depression and is defined as an emotional or cognitive condition characterised by negative anticipation about the future (Beck *et al.*, 1974). Some studies have suggested a relationship between anxiety and hopelessness (Miranda *et al.*, 2008; Alali, 2016), whereas depression has been shown to have a clear connection with hopelessness (Alloy *et al.*, 2012; Hamilton *et al.*, 2013). Furthermore, previous research has indicated that hopelessness acts as an underlying mechanism mediating between morningness–eveningness and depression (Antypa *et al.*, 2017; Üzer & Yüçens, 2020) and has also shown a significant association with resilience (Somasundaram & Devamani, 2016; Nieto *et al.*, 2023). Consequently, vulnerabilities such as hopelessness may impair an individual's psychological coping ability, which in turn influences their morningness–eveningness, depression, anxiety, and resilience. Therefore, we may be able to promote resilience by manipulating morningness–eveningness-related behaviours, which can help reduce anxiety and depression symptoms.

In this study, we only found significant difference in the pathways from morningness–eveningness to resilience and anxiety in the patient and nonpatient groups. Previous studies have demonstrated that high resilience provides protection against suicidal ideation in patients with depression (Min *et al.*, 2015) and is associated with good self-esteem and physical, mental, and general health (Feggi *et al.*, 2016). Therefore, stronger pathway of morningness–eveningness toward resilience in patients may indicate that not only the severity of depression is minimised (Wingo *et al.*, 2010) but also good overall health and protection against suicidal ideation is provided, by regulating morningness–eveningness preference to promote resilience in patients with depression. Conversely, anxiety was associated with worse prognosis, longer recovery time, and higher risks of suicide (Goldberg & Fawcett, 2012). Thus, a stronger pathway with morningness–eveningness toward anxiety in patients with mood disorders shows the increased risk of negative outcomes through comorbidity with anxiety. Therefore, the importance of morningness–eveningness and its underlying mechanism in mood disorders were explored, which also increases the need for morningness–eveningness modification intervention.

The present study has several limitations that need to be acknowledged. First, we did not collect demographic variables, except sex and age, in the general population; thus, we were unable to identify and control for additional possible between-group differences in such variables. Second, in our patient samples, the number of BDI patients was relatively small compared with those of MDD and BDII patients. Third, we individually assessed all the variables in this study using self-report scales. Fourth, we conducted a cross-sectional design that cannot provide temporal associations, but mediation analysis revealed partial instead of full causation (Sobel, 2008; Pearl, 2010).

Nevertheless, this study has the following strengths. First, most of the studies that investigated the effect of morningness–eveningness in patients with mood disorders did not consider the role of anxiety, but the present study included anxiety as a variable. Second, few studies have investigated the association between resilience and morningness–eveningness in patients with mood disorders and the general population. Third, this study included a large sample size. Fourth, we examined the path differences between the groups through two statistical steps.

In conclusion, the present study demonstrated that resilience and anxiety were significant mediators between morningness–eveningness and depression in the patient and nonpatient groups.

In particular, the effects of morningness–eveningness on resilience and anxiety were greater in the patient than in the nonpatient group. These results could improve the importance of morningness–eveningness preference in patients with mood disorder and the understanding of the possible mechanisms for the association between morningness–eveningness and depression. Modification of morningness–eveningness-related behaviours increases resilience, one of the possible mechanisms between morningness–eveningness and depression, and can ultimately improve the health of individuals, particularly those with mood disorder. In this modification process for promoting their health, it is necessary to also consider anxiety.

Acknowledgements. None.

Author contributions. WM, HSK and JP had full access to all of the data in this study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conceptualisation: Hyo Shin Kang, Jungkyu Park, Woojae Myung.

Data curation: Suhyeon Kang and Huiyeong Kim.

Funding acquisition: Woojae Myung.

Investigation: Suhyeon Kang, Huiyeong Kim, Hyeona Yu, Daseul Lee, Hyuk Joon Lee, Tae Hyon Ha, Jungkyu Park, Woojae Myung, Hyo Shin Kang.

Supervision: Hyo Shin Kang, Jungkyu Park, Woojae Myung.

Statistical analysis: Suhyeon Kang and Jungkyu Park.

Writing – original draft: Suhyeon Kang and Huiyeong Kim.

Writing – review & editing: All authors.

Financial support. This work was supported by a National Research Foundation (NRF) of Korea Grant, funded by the Korean government (NRF-2021R1A2C4001779; WM). This research was additionally supported by the Korea Medical Device Development Fund grant, funded by the Korean government (the Ministry of Science and ICT; the Ministry of Trade, Industry, and Energy; the Ministry of Health & Welfare; the Ministry of Food and Drug Safety) (Project Number NTIS 9991006915, KMDF_PR_20200901_0250). The funding body had no role in the study design, data collection, data analysis, data interpretation, or writing of this report. The corresponding authors had full access to all the data in this study and had final responsibility for the decision to submit for publication.

Competing interests. None.

Institutional review board statement. This study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of Seoul National Bundang Hospital (protocol code B-2205-756-111, approved May 2, 2022).

Informed consent statement. Patient consent was waived because data was gathered through a medical chart review. Comparison consent was also waived as the researchers did not have direct access to participant personal information and used anonymised survey data for analyses.

References

- Adan A, Archer SN, Hidalgo MP, Di Milia L, Natale V and Randler C (2012) Circadian typology: a comprehensive review. *Chronobiol Int* 29(9), 1153–1175.
- Alali T (2016) The relationship between anxiety, depression and hopelessness among nonclinical sample. *Eur Psychiatry* 33(S1), S156–S156.
- Alloy LB, Black SK, Young ME, Goldstein KE, Shapero BG, Stange JP, Boccia AS, Matt LM, Boland EM, Moore LC and Abramson LY (2012) Cognitive vulnerabilities and depression versus other psychopathology symptoms and diagnoses in early adolescence. *J Clin Child Adolesc Psychol* 41(5), 539–560.
- An M, Colarelli SM, O'Brien K and Boyajian ME (2016) Why we need more nature at work: effects of natural elements and sunlight on employee mental health and work attitudes. *PLOS ONE* 11(5), e0155614.

- Androulakis IP (2021) Circadian rhythms and the HPA axis: a systems view. *WIREs Mech Dis* 13(4), e1518.
- Antúnez JM, Navarro JF and Adan A (2015) Circadian typology is related to resilience and optimism in healthy adults. *Chronobiol Int* 32(4), 524–530.
- Antypa N, Souery D, Tomasini M, Albani D, Fusco F, Mendlewicz J and Serretti A (2016a) Clinical and genetic factors associated with suicide in mood disorder patients. *Eur Arch Psychiatry Clin Neurosci* 266(2), 181–193.
- Antypa N, Verkuil B, Molendijk M, Schoevers R, Penninx BW and Van Der Does W (2017) Associations between chronotypes and psychological vulnerability factors of depression. *Chronobiol Int* 34(8), 1125–1135.
- Antypa N, Vogelzangs N, Meesters Y, Schoevers R and Penninx BW (2016b) Chronotype associations with depression and anxiety disorders in a large cohort study. *Depress Anxiety* 33(1), 75–83.
- Au J and Reece J (2017) The relationship between chronotype and depressive symptoms: a meta-analysis. *J Affect Disord* 218, 93–104.
- Baek HS, Lee KU, Joo EJ, Lee MY and Choi KS (2010) Reliability and validity of the Korean version of the connor-davidson resilience scale. *Psychiatry Investig* 7(2), 109.
- Beck AT, Epstein N, Brown G and Steer RA (1988) An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol* 56(6), 893–897.
- Beck AT, Weissman A, Lester D and Trexler L (1974) The measurement of pessimism: the hopelessness scale. *J Consult Clin Psychol* 42(6), 861–865.
- Blume C, Garbaza C and Spitschan M (2019) Effects of light on human circadian rhythms, sleep and mood. *Somnologie* 23(3), 147–156.
- Broms U, Kaprio J, Hublin C, Partinen M, Madden PAF and Koskenvuo M (2011) Evening types are more often current smokers and nicotine-dependent—A study of finnish adult twins. *Addiction* 106(1), 170–177.
- Chan JWY, Lam SP, Li SX, Yu MWM, Chan NY, Zhang J and Wing YK (2014) Eveningness and insomnia: independent risk factors of nonremission in major depressive disorder. *Sleep* 37(5), 911–917.
- Chung JK, Choi KS, Kang HG, Jung HY and Joo EJ (2018) The relationship between morningness-eveningness and resilience in mood disorder patients. *Compr Psychiatry* 87, 72–78.
- Connor KM and Davidson JR (2003) Development of a new resilience scale: the connor-davidson resilience scale (CD-RISC). *Depress Anxiety* 18(2), 76–82.
- Daghlas I, Lane JM, Saxena R and Vetter C (2021) Genetically proxied diurnal preference, sleep timing, and risk of major depressive disorder. *JAMA Psychiatry* 78(8), 903–910.
- Danielsson K, Sakarya A and Jansson-Fröjmark M (2019) The reduced morningness-eveningness questionnaire: psychometric properties and related factors in a young Swedish population. *Chronobiol Int* 36(4), 530–540.
- Duffy JF, Rimmer DW and Czeisler CA (2001) Association of intrinsic circadian period with morningness-eveningness, usual wake time, and circadian phase. *Behav Neurosci* 115(4), 895–899.
- Fares S, Hermens DF, Naismith SL, White D, Hickie IB and Robillard R (2015) Clinical correlates of chronotypes in young persons with mental disorders. *Chronobiol Int* 32(9), 1183–1191.
- Feggi A, Gramaglia C, Guerriero C, Bert F, Siliquini ROBERTA and Zeppegno P (2016) Resilience, coping, personality traits, self-esteem and quality of life in mood disorders. *Eur Psychiatry* 33(S1), S518–S518.
- Fletcher D and Sarkar M (2013) Psychological resilience. *Eur Psychol* 18(1), 12–23.
- Goldberg D and Fawcett J (2012) The importance of anxiety in both major depression and bipolar disorder. *Depress Anxiety* 29(6), 471–478.
- Hamilton JL, Shapero BG, Stange JP, Hamlat EJ, Abramson LY and Alloy LB (2013) Emotional maltreatment, peer victimization, and depressive versus anxiety symptoms during adolescence: hopelessness as a mediator. *J Clin Child Adolesc Psychol* 42(3), 332–347.
- Hasler BP, Buysse DJ, Kupfer DJ and Germain A (2010) Phase relationships between core body temperature, melatonin, and sleep are associated with depression severity: further evidence for circadian misalignment in non-seasonal depression. *Psychiatry Res* 178(1), 205–207.
- Hjemdal O, Vogel PA, Solem S, Hagen K and Stiles TC (2011) The relationship between resilience and levels of anxiety, depression, and obsessive-compulsive symptoms in adolescents. *Clin Psychol Psychother* 18(4), 314–321.
- Killgore WD, Taylor EC, Cloonan SA and Dailey NS (2020) Psychological resilience during the COVID-19 lockdown. *Psychiatry Res* 291, 113216.
- Kim JH, Lee EH, Hwang ST and Hong SH (2015) Korean Version of the Beck Anxiety Inventory Guide. Daegu, Republic of Korea: Korea Psychology Corporation.
- Kim JK (1998) Circadian rhythm and psychological adjustment. *Korean J Health Psychol* 3(1), 129–140.
- Kitamura S, Hida A, Watanabe M, Enomoto M, Aritake-Okada S, Moriguchi Y, Kamei Y and Mishima K (2010) Evening preference is related to the incidence of depressive states independent of sleep-wake conditions. *Chronobiol Int* 27(9–10), 1797–1812.
- Lee SJ, Park CS, Kim BJ, Lee CS, Cha B, Lee YJ, Soh M, Park JA, Park SY and Song EH (2016) Association between morningness and resilience in Korean college students. *Chronobiol Int* 33(10), 1391–1399.
- Lee YH and Song JY (1991) A study of the reliability and the validity of the BDI, SDS, and MMPI-D scales. *Korean J Clin Psychol* 10, 98–113.
- Lemoine P, Zawieja P and Ohayon MM (2013) Associations between morningness/eveningness and psychopathology: an epidemiological survey in three in-patient psychiatric clinics. *J Psychiatry Res* 47(8), 1095–1098.
- Lin YH and Gau SSF (2013) Association between morningness-eveningness and the severity of compulsive internet use: the moderating role of gender and parenting style. *Sleep Med* 14(12), 1398–1404.
- Little TD, Cunningham WA, Shahar G and Widaman KF (2002) To parcel or not to parcel: exploring the question, weighing the merits. *Struct Equ Modeling* 9(2), 151–173.
- Masuyama A, Kubo T, Shinkawa H and Sugawara D (2022) The roles of trait and process resilience in relation of BIS/BAS and depressive symptoms among adolescents. *PeerJ* 10, e13687.
- Melo MC, Garcia RF, Araújo CFD, Luz JH, Bruin PFD and Bruin VMD (2019) Chronotype in bipolar disorder: an 18-month prospective study. *Braz J Psychiatry* 42(1), 68–71.
- Meyrel M, Scott J and Etain B (2022) Chronotypes and circadian rest-activity rhythms in bipolar disorders: a meta-analysis of self-and observer rating scales. *Bipolar Disord* 24(3), 286–297.
- Min JA, Lee CU and Chae JH (2015) Resilience moderates the risk of depression and anxiety symptoms on suicidal ideation in patients with depression and/or anxiety disorders. *Compr Psychiatry* 56, 103–111.
- Miranda R, Fontes M and Marroquín B (2008) Cognitive content-specificity in future expectancies: role of hopelessness and intolerance of uncertainty in depression and GAD symptoms. *Behav Res Ther* 46(10), 1151–1159.
- Mondin TC, de Azevedo Cardoso T, de Mattos Souza LD, Jansen K, da Silva Magalhães PV, Kapczinski F and da Silva RA (2017) Mood disorders and biological rhythms in young adults: a large population-based study. *J Psychiatr Res* 84, 98–104.
- Müller MJ, Olschinski C, Kundermann B and Cabanel N (2016) Patterns of self-reported depressive symptoms in relation to morningness-eveningness in inpatients with a depressive disorder. *Psychiatry Res* 239, 163–168.
- Muthén LK and Muthén BO (2021) Mplus Statistical Software (Version 8.6). Computer Software. Los Angeles, CA: Muthén & Muthén.
- Natale V, Ballardini D, Schumann R, Mencarelli C and Magelli V (2008) Morningness-eveningness preference and eating disorders. *Pers Individ Dif* 45(6), 549–553.
- Nieto M, Visier ME, Silvestre IN, Navarro B, Serrano JP and Martínez-Vizcaino V (2023) Relation between resilience and personality traits: the role of hopelessness and age. *Scand J Psychol* 64(1), 53–59.
- Palagini L, Miniati M, Marazziti D, Massa L, Grassi L and Geoffroy PA (2022) Circadian rhythm alterations may be related to impaired resilience, emotional dysregulation and to the severity of mood features in bipolar I and II disorders. *Clin Neuropsychiatry* 19(3), 174.
- Pearl J (2010) An introduction to causal inference. *Int J Biostat* 6(2), 1–62.
- Preacher KJ and Selig JP (2012) Advantages of Monte Carlo confidence intervals for indirect effects. *Commun Methods Meas* 6(2), 77–98.
- Raglan GB, Schmidt LA and Schulkin J (2017) The role of glucocorticoids and corticotropin-releasing hormone regulation on anxiety symptoms and response to treatment. *Endocr Connect* 6(2), R1–R7.

- Reul JM, Collins A, Saliba RS, Mifsud KR, Carter SD, Gutierrez-Mecinas M, Qian X and Linthorst AC (2015) Glucocorticoids, epigenetic control and stress resilience. *Neurobiol Stress* 1, 44–59.
- Roenneberg T, Daan S and Merrow M (2003) The art of entrainment. *J Biol Rhythms* 18(3), 183–194.
- Romo-Nava F, Blom TJ, Cuellar-Barboza AB, Winham SJ, Colby CL, Nunez NA, Biernacka JM, Frye MA and McElroy SL (2020) Evening chronotype as a discrete clinical subphenotype in bipolar disorder. *J Affect Disord* 266, 556–562.
- Seo JY, Yeom JW, Cho CH, Son S, Ahn YM, Kim SJ, Ha TH, Cha B, Moon E, Park DY, Baek JH, Kang HJ, An H and Lee HJ (2022) The relationship between morningness-eveningness and mood symptoms and quality of life in euthymic state of mood disorders: results from a prospective observational cohort study. *J Affect Disord* 316, 10–16.
- Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, Hergueta T, Baker R and Dunbar GC (1998) The mini-international neuropsychiatric interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry* 59(20), 22–33.
- Sher L (2019) Resilience as a focus of suicide research and prevention. *Acta Psychiatr Scand* 140(2), 169–180.
- Shin YC, Kim SM, Kim H, Min KJ, Yoo SK, Kim EJ and Jeon SW (2019) Resilience as a protective factor for depressive mood and anxiety among Korean employees. *Journal of Korean Medical Science* 34(27), e188.
- Smith CS, Reilly C and Midkiff K (1989) Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. *J Appl Psychol* 74(5), 728–738.
- Sobel ME (2008) Identification of causal parameters in randomized studies with mediating variables. *J Educ Behav Stat* 33(2), 230–251.
- Somasundaram RO and Devamani KA (2016) A comparative study on resilience, perceived social support and hopelessness among cancer patients treated with curative and palliative care. *Indian J Palliat Care* 22(2), 135.
- Spencer RL, Chun LE, Hartsock MJ and Woodruff ER (2018) Glucocorticoid hormones are both a major circadian signal and major stress signal: how this shared signal contributes to a dynamic relationship between the circadian and stress systems. *Frontiers Neuroendocrinol* 49, 52–71.
- Spijker AT and Van Rossum EFC (2012) Glucocorticoid sensitivity in mood disorders. *Neuroendocrinology* 95(3), 179–186.
- Tafoya SA, Aldrete-Cortez V, Ortiz S, Fouilloux C, Flores F and Monterrosas AM (2019) Resilience, sleep quality and morningness as mediators of vulnerability to depression in medical students with sleep pattern alterations. *Chronobiol Int* 36(3), 381–391.
- Üzer A and Yücens B (2020) Chronotype and depressive symptoms in healthy subjects: the mediating role of hopelessness and subjective sleep quality. *Chronobiol Int* 37(8), 1173–1180.
- Waugh CE and Koster EH (2015) A resilience framework for promoting stable remission from depression. *Clin Psychol Rev* 41, 49–60.
- Wermelinger Ávila MP, Lucchetti ALG and Lucchetti G (2017) Association between depression and resilience in older adults: a systematic review and meta-analysis. *Int J Geriatr Psychiatry* 32(3), 237–246.
- Williams MT and Jahn ME (2017) Obsessive-compulsive disorder in African American children and adolescents: risks, resiliency, and barriers to treatment. *Am J Orthopsychiatry* 87(3), 291–303.
- Wingo AP, Wrenn G, Pelletier T, Gutman AR, Bradley B and Ressler KJ (2010) Moderating effects of resilience on depression in individuals with a history of childhood abuse or trauma exposure. *J Affect Disord* 126(3), 411–414.
- Zhou J, Hsiao FC, Shi X, Yang J, Huang Y, Jiang Y, Zhang B and Ma N (2021) Chronotype and depressive symptoms: a moderated mediation model of sleep quality and resilience in the 1st-year college students. *J Clin Psychol* 77(1), 340–355.
- Zung WW (1965) A self-rating depression scale. *Arch Gen Psychiatry* 12(1), 63–70.