Original Research

The Relationship between Morning-Evening Types and Mental Health Using a Canonical Correlation Analysis

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Abstract

Background and Objective: The optimal method of predicting mental health is the investigation of individual differences, such as identification of morning-evening types. The present study examined the relationship between components of morning-evening types, using the four components of mental health, in a group of students.

Materials and Methods: The population of this descriptive cross-sectional study was all undergraduate students at the University of Bojnord, Bojnord, Iran. The participants (N = 341) were selected from this population via stratified random sampling, and they were evaluated using the Composite Scale of Morningness (CSM) and the General Health Questionnaire-28 (GHQ-28). To analyze the data, the Pearson correlation coefficient and canonical correlation analysis (CCA) were applied.

Results: The canonical redundancy analysis showed that the first canonical function was statistically significant ($R^2 = 0.205$, $P < 0.0001$). The canonical weights showed that the order of contribution of independent variables to the first variate was morning affect (-0.921) and activity planning (-0.162), and the order of contribution of dependent variables was anxiety/insomnia (0.488), severe depression (0.350), somatic symptoms (0.198), and social dysfunction (0.179).

Conclusion: This study showed the importance of morning-evening types as the predictor of mental health and its dimensions. Therefore, it is recommended that the morningness-eveningness preferences of people be considered in clinical interviews and diagnosis.

Keywords: Circadian rhythm; Mental health; Correlation study

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Introduction

Diurnal preferences are considered as an important dimension of human personality. Human and animals have sustainable cycles in many behavioral, physiological, and metabolic traits, which are controlled by the "circadian clock" (1). Circadian type is associated with natural body rhythms and is known as morningness-eveningness preferences (2). Morningness-eveningness can be viewed as a continuum along two extremes: the morning lark and the evening owl (3). The morning lark (type M) wakes up at dawn, at around sunrise, has no problems with early getting up, soon achieves the highest mental and physical activity, and goes to bed in the evening. In contrast, evening owls (type E) are awake during the night and do most of their activities late at night. They prefer to rest or sleep at dawn, and if they remain awake during the day, they will have problems (4). However, most people (60-70 percent) have an intermediate chronotype; in other words, they fall between these two extremes (3).

Studies of the types of circadian cycles have shown that an individual's chronotype has an important relationship with their susceptibility to mental health issues (5-8). Previous studies have shown that the eveningness type in particular may be associated with numerous health problems, and a high incidence of psychological and psychosomatic distress, while a circadian preference towards morningness appears to protect individuals from these health-related problems, and they tend to lead a healthier life (9, 10).

According to the National FINRISK Study

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(2007), sleep problems, depression, cardiovascular diseases (CVDs), type II diabetes, and respiratory disorders are associated with eveningness types (10). Eveningness types also experience insomnia symptoms and nightmares more often than do morningness types (11). Furthermore, eveningness has been associated with a higher risk of depression, especially major depression, and individuals with this type take more antidepressant medications than do morningness types (10, 12-14). Diaz-Morales found that people with the evening type reported more symptoms of depression, sleep problems, and poor health (15). Addiction and mood disorders are also associated with extreme eveningness (16), and vulnerability to bipolar disorder (17). More somatic complaints, anxiety, fatigue, and shorter duration of menstruation are also indicated to have association with evening type in female adolescents. However, it was shown that eveningness is not related to back pain or menstrual regularity (18). Moreover, since the social and cultural realms of society are organized around solar light-dark cycles and daytime work, it is thus reasonable to expect that poor adaptation by evening types leads to risky behaviors, conflicts over daily routines, less responsibility for household tasks, problematic school functioning, and a variable selection of deviant friends (19).

Therefore, the present study investigated the multiple relationships between the components of morning-evening types (morning affect and activity planning) and the four components of mental health (somatic symptoms, anxiety/insomnia, social dysfunction, and severe depression) using canonical correlation analysis (CCA). Previous studies of morning-evening types and mental health have not simultaneously analyzed relationships on the component level of the two constructs; therefore, the current study has novel findings, particularly with regard to the Iranian population.

Materials and Methods

Sample: The population of this descriptive, cross-sectional study consisted of all undergraduate students enrolled at the University of Bojnord, Iran, (n = 2723), between May and June 2016-2017 academic year. In accordance with Krejcie and Morgan table (20), 341 undergraduate students were selected using a stratified random sampling method, but due to the non-cooperation of a number of participants, as well as issues arising from the completion of questionnaires, only 300 questionnaires were collected (a response rate of 88%). Finally, after removing the univariate and multivariate outliers by z-values and Mahalanobis distance, 273 questionnaires were included in the final analysis. It should be noted that the power of the sample size was calculated by G power software, which indicated sample size of 189 (21).

Measures and procedure: 1) The Composite Scale of Morningness (CSM): Smith et al. designed a 13-item scale in an attempt to respond to poorly reported psychometric properties, or their absence (22), which appears to be associated with the previously published morningness questionnaires, for example, Horne and Ostberg (23) and Torsvall and Akerstedt (24). The items are scored from 1 to 4 or 5, depending on the number of response alternatives. To calculate total score, scores of all questions are summed (13: extreme eveningness and 55: extreme morningness). This scale has been used in a variety of different countries, and shows acceptable psychometric properties and convergent validity (25, 26).

There are two components of morningness-eveningness in the Persian version of the CSM. The first consists of items corresponding to eveningness, and is called “activity planning” (items 1, 2, 7, 8, 9, 10, and 13). The second component is labeled “morning affect” (items 3, 4, 5, 6, 11, and 12), and includes questions relating to tiredness, alertness, recovered senses in the morning, and a general morningness preference (27).

The internal reliability coefficient (α Cronbach) for the CSM was calculated as 0.79 in Rahimi-Pordanjani and Mohammadzadeh-Ebrahimi (28) study, and construct validity was calculated using the conformity factor analytic. The results indicated a reasonable fit, with normed χ^2 measure [χ^2/degree of freedom (df)] = 3.65, normed fit index = 0.85, incremental fit index = 0.87, comparative fit index = 0.93, root-mean-square error of approximation = 0.075, Tucker-Lewis index = 0.87, goodness of fit index = 0.90, and adjusted goodness of fit index = 0.86 (27).

2) The General Health Questionnaire-28 (GHQ-28): The GHQ-28 was developed by Goldberg and Hillier (1979) for the screening of somatic symptoms, anxiety/insomnia, social dysfunction, and severe depression (29). Answer of each question is scored as 0-3. A total possible score ranged from 0–84. This questionnaire was translated into Persian, and its validity and reliability were approved in an independent study (28).

Table 1. Means, standard deviations and correlation coefficients between variables

		Mean	SD	1	2	3	4	5	6	7	8
1	Activity planning	17.45	4.20	-							
2	Morning affect	16.23	3.53	0.42**	-						
3	Total M/E	33.67	6.52	0.87**	0.81**	-					
4	Somatic symptoms	6.16	3.76	-0.09	-0.20**	-0.17**	-				
5	Anxiety/insomnia	7.09	4.56	-0.19**	-0.21**	-0.23**	0.60**	-			
6	Social dysfunction	7.61	2.85	-0.08	-0.17**	-0.14*	0.50**	0.47**	-		
7	Severe depression	4.89	4.79	-0.15*	-0.22**	-0.15*	0.57**	0.56**	0.50**	-	
8	Total GHQ	25.18	12.78	-0.13*	-0.24**	-0.21**	0.79**	0.84**	0.71**	0.81*	-

** Correlation is significant at the .01 level (1-tailed); * Correlation is significant at the .05 level (1-tailed).
M/E: morningness/eveningness; SD: Standard deviation; GHQ: General Health Questionnaire

In the current research, internal reliability coefficients (Cronbach α) for the questionnaire and its components (somatic symptoms, anxiety/insomnia, social dysfunction, and severe depression) were calculated 0.92, 0.79, 0.78, 0.71, and 0.89, respectively.

The study was approved by the Ethical Review Committee of the University of Bojnord. Furthermore, participation was anonymous and voluntary, and written informed consent was obtained before administering questionnaires. Moreover, consent form was obtained from all study participants.

The scores were presented as mean, standard deviation (SD), Pearson's correlation coefficient, and CCA. All analyses were performed using SPSS software (version 22, IBM Corporation, Armonk, NY, USA).

CCA is the most common method of multivariate analysis that aims to determine the linear relationship between the multidimensional variables. In other words, CCA examines the correlation between linear combinations of variables belonging to one set and linear combinations of variables belonging to the other sets.

Results

The study participants were undergraduates aged 18-26 years (Mean = 20.17, SD = 1.44) that were 130 (47.6%) women and 143 (52.4%) men. A total of 106 participants (38.8%) were studying in human sciences, 90 (33.0%) in engineering, 30 (11.0%) in basic sciences, and 47 (17.2%) in arts.

Descriptive statistics: The descriptive findings, consisting of the mean, SD, and internal correlation of the morningness-eveningness types, mental health, and its components are presented in table 1.

As shown in table 1, the correlation coefficients between morningness/eveningness total score and somatic symptoms (-0.17, $P < 0.006$), anxiety/insomnia (-0.23, $P < 0.001$), social dysfunction (-0.14, $P < 0.016$), severe depression (-0.15, $P < 0.013$), and total GHQ-28 score (-0.21, $P < 0.001$) were significant; students with higher scores on the CSM (morningness preference) had lower GHQ-28 scores (better mental health). The present study considered morningness-eveningness as a continuum, with decreasing scores reflecting a greater eveningness preference and increasing scores reflecting a greater morningness preference. In addition, decreasing GHQ-28 scores reflected better mental health and increasing GHQ-28 scores reflected vise-versa.

Canonical correlation analysis (CCA): CCA was used to assess the relationship between the components of morning-evening types and the four components of mental health. In order to evaluate the full canonical model and formally assess the importance of the canonical correlation, the root statistics (Wilks' Lambda, Pillai's Trace, Hotelling's Trace, and Roy's Greatest Root) comparing the within and between variability were initially obtained.

These statistics tested the null hypothesis that stated that there is no correlation between morning-evening types and mental health variables. The results are presented in table 2.

Table 2. Multivariate statistics and F approximations

	Value	Exact F	Hypothesis DF	Error DF	P-value
Pillai's Trace	0.093	3.285	8	536	0.001
Hotelling's Trace	0.098	3.289	8	532	0.001
Wilk's Lambda	0.779	3.287	8	534	0.001
Roy's Largest Root	0.065	-	-	-	-

DF: Degree of freedom

Table 3. Eigenvalues and canonical correlations

Root No.	Eigenvalue	Pct.	Cum. Pct.	Canonical correlation.	Squared correlation	F Hypothe-sis	P-value
1	0.070	71.23	71.23	0.453	0.205	3.287	0.001
2	0.028	28.76	100	0.166	0.027	2.542	0.057

Table 2 shows that the four root statistics were highly significant at 5% probability level, indicating a significant correlation between morningness-eveningness and mental health. The most common statistical test used was Wilks's lambda (λ), which is useful in identifying an inverse effect size or an amount of variance that is not shared between the variable sets. The eigenvalues and canonical correlations are also shown (Table 3).

As table 3 shows, as there were two dependent variables, two canonical functions were derived (roots 1 and 2). One canonical function was statistically significant (dimension reduction analysis), with the first function having a squared canonical correlation of 0.205 ($P < 0.001$) and the second having a squared canonical correlation of 0.027 ($P < 0.057$). Squared canonical correlation represents the proportion of variance shared by the two variable sets. These are interpreted in a similar manner to the squared multiple correlations obtained in regression analysis. In addition, the standardized canonical coefficients for variables (canonical weights) and canonical structure correlations (canonical loadings) are presented (Table 4).

Standardized canonical function coefficients are the standardized coefficients that are used in linear equations to combine the independent and dependent variables into two respective canonical variates (synthetic). The weights are directly analogous to beta weights in regression (30). Variables with relatively large weights contribute more to the shared variance of the two variable sets. Based on the size of the weights, the order of contribution of independent variables to the first variate was morning affect (-0.921), and activity planning (-0.162), and the order of the contribution of dependent variables to the first variate was anxiety/insomnia (0.488), severe depression (0.350), somatic symptoms (0.198), and social dysfunction (0.179).

The canonical structure correlation is the bivariate correlation between an observed variable and a synthetic variable (30). Canonical structure correlations can be interpreted as factor-loading in assessing the relative contribution of each variable to each canonical function (31). Only structure coefficients greater than 45 are interpreted (30).

Table 4 shows that the relevant, independent variables were primarily morning affect (-0.98), followed by activity planning (-0.54), both of which made secondary contributions to the synthetic independent variable. The loadings for the dependent variables showed that anxiety/insomnia was strongly associated with their first canonical variate, with a correlation of 0.89. The least influential was social dysfunction, with a first canonical variate of 0.67. As the structure coefficient for independent variables was negative, it was reversely related to all of the dependent variables.

Discussion

The present study analyzed the links between the components of morning-evening types and the four components of mental health. The results of the CCA indicated that morning-evening types have a significant correlation with mental health ($R = 0.453$, $R2 = 205$). As the structure coefficient for morning-evening types was negative, it was reversely related to all of the components of mental health; students with a morningness preference (morning affect) had better mental health, and vice versa, students with an eveningness preference (activity planning) had worse mental health.

Table 4. Standardized canonical correlation coefficients and canonical structure correlations

		Standardized canonical correlation coefficients	Canonical structure correlations
Independent	Activity planning	-0.162	-0.546
	Morning affect	-0.921	-0.988
Dependent	Somatic symptoms	0.198	0.776
	Anxiety/insomnia	0.488	0.890
	Social dysfunction	0.179	0.675
	Severe depression	0.350	0.826

These results are consistent with previous findings (5-8, 10, 11, 13, 32), and revealed that among components of morning-evening types, morning affect, as compared to activity planning, caused a greater contribution to the explanation of shared variance. The four components of mental health made relative contributions to the explanation of shared variance in the following order: anxiety/insomnia, severe depression, somatic symptoms, and social dysfunction.

In order to explain these findings, we can state that since anxiety and cognitive problems are among the most frequent problems of chronic insomniacs (32), and evening types are more prone to wider circadian misalignment of biological rhythms and accumulation of sleep deprivation during the working day, due to their innate need to sleep more than morning types (10), therefore there is a relationship between evening types and anxiety disorders (32). The authors also suggested that, as self-reported positive affect is different between morning and evening types in terms of phase and amplitude, this can be considered that evening circadian type increases risk of mood disorders (33).

However, the mechanisms linking morning-evening types and depressive symptoms are not yet clear (13); although it is possible that sleep problems, which are common among evening types, also relate to a heightened risk of depression in such types compared to morning types, as sleep problems and depressive symptoms often co-exist (10). Moreover, morning affect is likely facilitated by a greater cortisol awakening response, that is blunted both in evening types (34) and in some depressed people (35), showing that this mechanism may be considered as a basis for a link be-tween evening types and depressiveness (13).

Furthermore, eveningness individuals are more prone to use alcohol, smoke, cannabis, and have a less healthy dietary intake than morning types; this leads to more CVDs and a higher incidence of type 2 diabetes, as well as respiratory disorders (10). The results also supported the belief that eveningness is associated with increased social problems. Since the social and cultural realms of society are organized around solar light-dark cycles, daytime work and educational activities are given priority. It is thus reasonable to expect that interactional transaction within social environments, such as family and educational settings, would show differences associated with morning-evening types (19).

In general, our research suggests that evening type is associated with psychological symptoms (36). The present study has some limitations. First, the use of self-report questionnaires can be associated with problems; as results may be influenced by response bias and incorrect answers. Hence, a combination of self-report scales and objective evaluations (e.g., interviews) would be proper. Second, the results of this study are limited to the university students, and participants of a limited age range. Therefore they are not necessarily applicable to all organizations with different features. Thus, further studies among different populations such as workers and shift workers are recommended. Third, since an evening orientation has been reported in many previous studies of young adults (aged approximately 20 years) (37), future studies should perform long-term investigations to find out more about circadian type and mental health, as chronotype will tend to change again as adolescents enter young adulthood. Finally, the current results should be carefully interpreted; this study did not assess casual relationships between morningness-eveningness and mental health.

Conclusion

In conclusion, the present study provides important evidence in support of the association between morning-evening types specially morning affect and mental health in students. Therefore, neurologists, clinical psychologists and counselors, and therapists should emphasize the chronotype preferences of people in clinical interviews and in making a diagnosis. In addition, university officials should account for the chronotype preferences of students in the micro and macro plans of the university. Moreover, the results of the current study can be used to predict mental health in work shifts and consultation in professionals such as doctors on emergency shifts, nurses, pilots and flight attendants, military forces, and the attendant security staff of office buildings.

Conflict of Interests

Authors have no conflict of interests.

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