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Original Research

The Impacts of Chronotype on Sleep Quality, Eating Attitudes, and Cardiovascular Risk in Patients with Bipolar Disorder

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ABSTRACT

Objective: The study aimed to investigate the relationship between chronotype and sleep quality, eating attitudes and cardiovascular disease (CVD) risk in bipolar disorder (BD).

Methods: The study included data on sociodemographic and clinical variables, anthropometric measurements, and blood biochemical tests of 78 individuals in the euthymic period diagnosed with BD. Morningness-Eveningness Questionnaire (MEQ), Pittsburgh Sleep Quality Index (PSQI), and Eating Attitudes Test-40 (EAT-40) were administered to the participants. The internet-based Systematic Coronary Risk Evaluation-2 (SCORE-2) calculator was used as a cardiovascular risk assessment tool, and the presence of metabolic syndrome (MetS) was assessed.

Results: Participants were divided into three chronotype groups: morning (n=25, 32.1%), intermediate (n=26, 33.3%) and evening type (n=27, 34.6%). The evening chronotype had significantly higher systolic blood pressure levels compared to the morning chronotype (p=0.050). Lower HDL (High-Density Lipoprotein) levels were observed in the evening chronotype group, while there was no significant difference in other biochemical parameters. 89% of the evening group had poor sleep quality. Two thirds of individuals in the evening group had MetS. After adjusting for confounding factors, it was observed that evening-type individuals had higher SCORE-2 scores compared to the non-evening-type group.

Conclusion: In conclusion, late chronotype in BD is associated with poorer clinical prognosis and sleep quality, unhealthier dietary habits and higher risk of CVD. The development of chronobiological treatment interventions targeting circadian regulation may be beneficial for evening chronotype diagnosed with BP.

Keywords: Bipolar Disorder, Cardiovascular Risk, Chronotype, Eating Attitudes, Metabolic Syndrome, Sleep Quality

INTRODUCTION

The emphasis on circadian and chronobiological mechanisms in the etiopathogenetic of various psychopathologies, especially bipolar disorder (BD) is noteworthy [1, 2].

Studies have shown that, in the general population, a late chronotype is associated with poorer sleep quality, cigarette/alcohol/caffeine dependence, unhealthy eating habits a sedentary lifestyle and an increased risk of cardiometabolic disease [3-5]. Disturbances in sleep and biological rhythms, especially in people who are vulnerable, can lead to mood swings and depressive symptoms, which are more common in people with an evening chronotype [6].In patients with BD, the evening chronotype is more prevalent compared to the healthy population, and it is thought that a late chronotype is associated with poorer disease outcomes and reduced functional levels [7, 8]. The nature of BD, medication treatments and many co-morbid conditions can cause disruptions in circadian rhythms, which can lead to a variety of sleep disturbances [6]. Poor sleep quality has been shown to have a negative impact on the treatment process and is a poor prognostic factor for patients diagnosed with BD, as well as being associated with reduced functionality and quality of life [9]. Additionally, sleep disorders are associated with increase increase the risk of cardiovascular and metabolic disease [10].
The circadian system regulates many aspects of eating behavior, including the rhythm of hunger, timing of meals, and food preferences [11]. Disruptions in the sleep-wake cycle can lead to metabolic dysfunctions such as a decrease in the appetite-regulating anorexigenic hormone "leptin," resulting in overeating behaviour and ultimately obesity [12]. It has been shown that individuals with poor sleep quality and a late chronotype tend to have poor dietary habits [3, 13].

Main Points

- BD patients with an evening chronotype have poorer sleep quality and worse eating habits.
- BD patients with an evening chronotype have higher blood pressure values and a greater frequency of metabolic syndrome, while their HDL levels are lower.
- CVD risk is higher in BD patients with an evening chronotype compared to the non-evening chronotype group.
- Evening chronotype appears to be associated with a higher cardiovascular risk in patients diagnosed with BD.

Co-diagnosis of eating disorders with various psychiatric diagnoses is commonly encountered. Patients with comorbid eating disorders and BD are at increased risk of obesity, cardiovascular diseases (CVD), type 2 diabetes mellitus (DM), hyperlipidemia, and cerebrovascular disease increases [14]. Studies investigating the relationship between unhealthy eating attitudes and chronotype in BD patients are scarce.

In patients diagnosed with BD, CVD are among the leading medical conditions that shorten life expectancy. Patients have approximately twice the risk of CVD and metabolic syndrome (MetS) compared to the general population [15]. Various factors have been identified as potential contributors to the relationship between BD and increased risk of CVD. Sedentary lifestyle, endocrine disorders, dysregulations in the sympathetic nervous system, stress burden, disorders in the hypothalamic-pituitary-adrenal (HPA) axis, side effects of medications, reduced access to general health services, high rates of tobacco use, and unhealthy eating habits are among them [15-18].

It has been suggested that the chronotype, particularly the evening chronotype, is one factor associated with an increased risk of CVD [19]. It is thought that evening chronotypes may develop a set of behavioural and physiological risk factors due to chronic misalignment between internal physiological timing and the timing of external work and social activities, making them particularly vulnerable to CVD [20].

The high frequency of CVD risk factors and MetS observed in these patients imposes an additional medical burden, complicates the treatment process, reduces overall physical well-being and functionality, worsens quality of life, diminishes self-esteem, and negatively impacts psychological well-being, thereby adversely affecting the course of BD [21]. Investigating chronobiological mechanisms that may contribute to the increased risk of CVD in BD and better understanding factors that could serve as potential targets for treatments and interventions will contribute to preventing metabolic and cardiovascular problems that shorten lifespan in these patients. Exploring chronobiological mechanisms that may contribute to increased CVD risk in BD and better understanding of factors that could serve as potential targets for treatments and interventions will contribute to the prevention of metabolic and cardiovascular problems that shorten lifespan in these patients.

The aim of this study is to explore the direct and indirect effects of chronotypes, sleep quality, and dietary habits on CVD risk in euthymic patients diagnosed with BD.

MATERIALS AND METHODS

Study Design and Participants

This study was designed as a cross-sectional study and was conducted on 78 volunteer patients attending the outpatient psychiatric clinic who were in regular treatment and diagnosed with BD according to DSM-5 criteria. Inclusion criteria for the study were being between 18 and 65 years of age, being able to communicate verbally on the scales used, being in euthymic phase for at least 8 weeks. Exclusion criteria for the study were being in an acute mood episode, having a comorbid neurological or neurodevelopmental disorder, having a history of alcohol or substance use disorder within the previous six months, having language and communication problems, lack of education to understand the tests, and pregnancy. Ethical approval for the study was obtained from Mersin University Clinical Research Ethics Committee on 3 November 2021 with protocol number 2021/685. Our research was conducted in accordance with the Helsinki Declaration of 1964. All participants provided written informed consent.

Assesments of Socio-Demographic and Clinical Parameters

- A socio-demographic and clinical data form was used to collect descriptive information and clinical characteristics related to BD. Participants' exercise habits were assessed using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [22] and their dietary attitudes were assessed using questions prepared by the clinician.
- Pittsburgh Sleep Quality Index (PUQI) is a tool that includes seven subscales used to evaluate sleep quality [23]. A total score of 5 or higher indicates poor sleep quality. The Turkish validity and reliability study of the scale was conducted by Ağargün et al. [24]
- Morningness-Eveningness Questionnaire (MEQ) is developed by Horne and Ostberg [25] and includes questions about sleep-wake patterns and the timing of their physical and psychological performances. The validity and reliability study of the scale in Turkey was conducted by Ağargün and colleagues [26].
- Eating Attitudes Test-40 (EAT-40) developed to assess disturbances in eating behaviour [27]. The Turkish validity and reliability study was conducted by Savaşır et al. [28]. Individuals with a score 30 or above are classified as having " predisposition to eating disorder".

Assesments of Anthropometric, Vital, Biochemical Parameters

- Participants' weight, height, waist-to-height ratio, BMI, and blood pressure values were measured and recorded. Those with a BMI value of 30 and above were considered obese.
- Fasting blood glucose, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride and total cholesterol levels in mg/dL obtained from routine biochemical tests performed after a 12-hour fast within the previous 3 months were retrospectively recorded.

Assesment of Metabolic Syndrome and Cardiovascular Risk

- The study used both a web-based risk calculator and the presence of metabolic syndrome (MetS) to determine participants' risk of CVD.
- SCORE-2 (Systematic Coronary Risk Evaluation-2) Calculation Tool is an internet-based tool, which calculates the risk of fatal CVD within 10 years, was first developed in 2007. It takes into account gender, smoking status, age, blood pressure, and total cholesterol levels [29].
- Metabolic Syndrome (MetS) is considered a significant predictor of CVD. In our study, the presence of MetS was assesed according to the diagnostic criteria of the National Cholesterol Education Program, Adult Treatment Panel III .

Statistical Analysis

Statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were summarized as counts, percentages, means, standard deviations, medians and minimum-maximum values. Chi-square tests were used to determine differences in frequencies between categorical groups. For dependent variables with a normal distribution, Student's t-tests and ANOVA tests were used for analyses between two independent groups. Tukey's test was used for post hoc analyses. For continuous variables with non-normal distribution, Mann-Whitney U test and Kruskal-Wallis test were used for comparisons between two groups. The Spearman correlation test was used for correlation analysis. The ANCOVA test was used to determine the factors

predicting the CVD risk score. A significance level of $p<0.05$ was considered statistically significant.

RESULTS

A total of 78 patients were included in the study. The mean age of the participants was 41.06 ± 12.07 years. According to their scores on MEQ, the participants were categorized into three chronotype groups: morning type (n=25, 32.1%), intermediate type (n=26, 33.3%), and evening type (n=27, 34.6%). The sociodemographic and clinical characteristics of the participants according to their chronotypes are summarized in Table 1.

There were no significant differences between groups for height, weight, waist circumference, waist to height ratio, BMI. Mean systolic blood pressure was significantly higher in the evening group than in the morning group ($\chi2=5.699$; $p=0.050$). Mean diastolic blood pressure was also higher in the evening group compared to the other groups, but this difference was not statistically significant ($\chi2=5.927$; $p=0.052$). The frequency of MetS was observed to be lowest in the morning group, followed by the intermediate type, and highest in the evening group; the differences between all groups were found to be statistically significant ($\chi2=9.816$, $p=0.007$). Anthropometric measurements and blood biochemical tests were separately analyzed for men and women; no significant differences were observed between chronotype groups. Anthropometric measurements, blood biochemical parameters and numerical characteristics related to metabolic and CVD risk of the participants are shown in Table 2.

The frequency of paying attention to the food satiation was significantly lower in evening chronotypes compared to morning chronotypes ($\chi2=10.219$; $p=0.003$). No significant differences were observed between chronotype groups in terms of main mail and snack consumption, preferred food characteristics, EAT-40 scores, and predisposition to eating disorders. The frequency of having good sleep quality was significantly higher in intermediate chronotypes (42.3%, n=11) than in the morning chronotypes (84%, n=21) and evening chronotypes ($\chi2=27.983$; $p<0.001$). Poor sleep quality was observed in the majority of evening types (88.9%, n=24). A significant increase in the PSQI total score was observed from morning individuals to evening types (higher scores indicate poorer sleep quality) ($\chi2=21.328$; $p<0.001$). Among the PSQI subscales, scores of evening chronotype were significantly higher than the morning chronotype group for subjective sleep quality, sleep latency, sleep medication, and daytime sleep dysfunction subscales (p values: 0.016; <0.001; 0.002; 0.004). No significant differences were observed between groups in terms of other dimensions of PSQI such as sleep duration, habitual sleep efficiency, and sleep disturbance scores. Participants' eating habits, EAT-40 scores, PSQI and subscale scores are shown in Table 3.

Table 1. Mean values (± SD) and percentages (%) of sociodemographic and clinical data according to the chronotypes

	Total n=78 (100%)	**Chronotype**			
		Morning n=25 (100%)	**Intermediate n=26 (100%)**	**Evening n=27 (100%)**	***p***
Age, year	41,06 ± 12,07	42,68 ± 12,519	42,81 ± 12,303	37,89 ± 11,175	0,242
Male, %	50	40	42,3	66,7	0,990
Marital status, %					
Single	39.7	28	30,8	59,3	0,059
Married	44,9	48	50	37	
Divorced	15,4	24	19,2	3,7	
Smoking rates, %	42,3	32	34,6	59,3	0,860
Exercise habits[1], %					
Sedentary	60,3	60	50	70,4	0,626
Moderately active	16,7	16	19,2	14,8	
Active	23,1	24	30,8	14,8	

[1:] Classified according to the GLTEQ.

MEQ: Morningness-Eveningness Questionnaire, SD: Standard Deviation

Table 2. Anthropometric measurements, blood biochemical tests and CVD risk for chronotypes presented as mean ± SD, percentage (%) or median (range) values

	Total n=78 (100%)	**Chronotype**			
		Morning n=25 (100%)	**Intermediate n=26 (100%)**	**Evening n=27 (100%)**	***p***
Height (cm)	167,7 ± 8,1	166,4 ± 7,7	167 ± 8,2	169,8 ±8,3	0,272
Weight (kg)	85,3 ± 14	81,5 ± 13,1	87,2 ± 17	87,1 ± 11,1	0,247
Waist circumference (cm)	106,1 ± 14	103,3 ± 12,6	108,5 ± 18	106,4 ± 10,6	0,453
Waist-to-height ratio	0,63 (0,46-0,93)	0,63 (0,47-0,75)	0,64 (0,46-0,93)	0,62 (0,49-0,79)	0,683
BMI (kg/m^2)	30,5 ± 5,5	29,4 ± 4,2	31,6 ± 7,5	30,3 ± 4,2	0,415
Obesity, %	57,7	52	53,8	66,7	0,814
Blood pressure (mmHg) Systolic Diastolic	 125 (100-180) 80 (60-100)	 117 (100-150) 79 (60-90)	 125 (100-150) 80 (67-100)	 130 (110-180) 85 (60-100)	 **0,050** 0,052
Fasting blood sugar (mg/dL)	102,2 ± 26,4	102,9 ± 28	104,9 ± 33,9	98,9 ± 14,6	0,811
HDL (mg/dL)	49,5 ± 11,7	50,7 ± 13,2	51,2 ± 11,7	45,9 ± 9,7	0,149
LDL (mg/dL)	112,5 ± 41,5	113,7 ± 44,4	99,6 ± 40,9	107,8 ± 40,2	0,760
Triglycerides (mg/dL)	167,6 ± 100,1	157,8 ± 85,3	146,2 ± 69,1	197,1 ± 130	0,320
Total cholesterol (mg/dL)	195,8 ± 52,2	197,9 ± 52,7	197,8 ± 50	197,7 ± 57,7	0,962
CVD risk score[1]	2,5 (0,3-16)	2,1 (0,4-8,2)	2,45 (0,3-16)	3,6 (0,7-15,4)	0,289
MetS presence, %	42,3	20	42,3	63	**0,007**

BMI: Body Mass Index, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, MetS: Metabolic Syndrome.

[1]: Estimated CVD risk (according to SCORE-2).

Table 3. Mean ± SD, percentage (%) or median (range) values of participants' eating attitudes and sleep quality-related data according to chronotypes

	Total n=78 (100%)	**Chronotype**			
		Morning n=25 (100%)	**Intermediate n=26 (100%)**	**Evening n=27 (100%)**	***p***
Regular main meal consumption, %	80,8	88	80,8	74,1	0,445
Regular snack consumption%	55,1	64	65,4	37	0,065
Characteristics of preferred foods, % Easily prepared Healthy cooking method Low in fat content Low-calorie Satiation of food Delicious meal Balanced content meal Vegetarian/vegan/gluten-free foods Free from additives Economical foods	 65,4 59 52,6 42,3 87,2 92,3 74,4 5,1 61,5 70,5	 76 72 68 56 100 100 84 8 80 72	 61,5 57,7 53,8 38,5 92,3 92,3 73,1 0 53,8 69,2	 59,3 48,1 37 33,3 70,4 85,2 66,7 7,4 51,9 70,4	 0,394 0,215 0,081 0,227 **0,003** 0,157 0,354 0,459 0,07 0,977
EAT-40	15,5(2-46)	14 (5-43)	14 (3-39)	19 (2-46)	0,736

Predisposition to eating disorders, % (30≤EAT-40)	20,5	24	15,4	22,2	0,713
PSQI score					
Subjective sleep quality	1 (0-3)	1 (0-3)	1 (0-3)	1 (0-2)	**0,016**
Sleep latency	1 (0-3)	1 (0-2)	1 (0-3)	2 (0-3)	**<0,001**
Sleep duration	0 (0-3)	0 (0-1)	0 (0-3)	0 (0-3)	0,931
Habitual sleep efficiency	0 (0-3)	0 (0-3)	0 (0-3)	0 (0-3)	0,434
Sleep disturbances	1 (0-3)	1 (0-2)	1 (0-2)	1 (0-3)	0,552
Sleep medication	0 (0-3)	0 (0-3)	0 (0-3)	3 (0-3)	**0,002**
Daytime sleep dysfunction	0,5 (0-3)	0 (0-2)	1 (0-3)	1 (0-3)	**0,004**
Total	5 (2-46)	3 (5-43)	5 (3-39)	8 (2-46)	**<0,001**
Sleep Quality, %					
High (PSQI<5)	44,9	84	42,3	11,1	**<0,001**
Poor (PSQI≥5)	55,1	16	57,7	88,9	

PSQI: Pittsburgh Sleep Quality Index, EAT-40: Eating Attitudes Test-40

Table 4. Mean ± SD, percentage (%) or median (range) values of data for non-evening and evening chronotypes

	Chronotype		
	Non-evening n=51 (100%)	**Evening n=27 (100%)**	**p**
Male, %	41.2	67.7	**0.032**
Smoking, %	33.3	59.3	**0.027**
Blood Pressure (mmHg)			
Systolic	120 (100-150)	130 (110-180)	**0.005**
Diastolic	80 (60-100)	85 (60-100)	**0.042**
HDL (mg/dL)	53.6 ± 12.3	45.9 ± 9.7	**0.050**
MetS presence, %	31.4	63	**0.007**
Regular main meal consumption, %	64.7	37	**0.019**
Preference for low-fat foods, %	60.8	37	**0.046**
Preference for satisfying foods, %	96.1	70.4	**0.001**
PSQI score			
Subjective sleep quality	1 (0-3)	1 (0-2)	**0.003**
Sleep latency	1 (0-3)	2 (0-3)	**<0.001**
Sleep medication	0 (0-3)	3 (0-3)	**0.002**
Daytime sleep dysfunction	0 (0-3)	1 (0-3)	**0.005**
Total	4 (0-17)	8 (1-15)	**<0.001**
Sleep Quality			**<0.001**
High (PSQI<5)	62.7	11.1	
Poor (PSQI≥5)	37.3	88.9	

Table 5. The effect of evening or non-evening group on cardiovascular disease risk score (when age variable is controlled)

	Chronotype	
	Non-evening	**Evening**
CVD risk score		
x̄	3,34	4,48
SD	3,21	3,89
CVD risk score [adj]		
x̄	3,04	5,04
SE	0,39	0,54

The common variable in the model is accepted as age = 41.06.
CVD risk score was calculated using the SCORE-2 prediction algorithm.
CVD risk score [adj:] Age-adjusted CVD risk score was calculated using the SCORE-2 prediction algorithm.
x̄: Mean, SD: Standard deviation, SE: Standard Error

After dividing the participants into two categories as evening-type and non-evening-type, analyses were repeated. According to the analysis, evening-types comprised 34.6% (n=27) of the total group, while non-evening-types comprised 65.4% (n=51). The variables that revealed significant differences between the non-evening and evening groups are shown in Table 4.

In the analysis of covariance performed by controlling for age, one of the variables used to calculate the CVD risk score. It was observed that being in the evening group had a significant effect on the CVD risk score, the mean CVD risk score was higher in the evening group independent of the age variable: F (1,75) = 8.812; p=0.004; r: 0.11 (Table 5).

DISCUSSION

The current study investigated the clinical characteristics according to chronotype in patients diagnosed with BD, as well as exercise habits, sleep quality and dietary attitudes, and their effects on CVD risk.

In this study, consistent with the literature [30], the frequency of smoking in the BD group was observed to be higher in the evening chronotype, similar to that in the general population [3, 5]. The increased incidence of impulsivity and risk-taking behaviour with in BD patients who have evening chronotype may be the cause of various addictions, particularly tobacco [31]. Approximately 60% of participants were sedentary, but no significant difference in levels of physical inactivity was observed between the chronotype groups in our research.

Approximately 21% of participants were observed to have a predisposition to eating disorders, with no difference observed between the chronotype groups in terms of eating disorders. However, consistent with the literature, evening types were observed to have irregular snacking habits, to consume more fatty foods and to pay less attention to eating a satisfying diet [8, 13].

In our study, individuals' height, weight, waist circumference, waist-to-height ratio and BMI did not differ according to chronotype. Some studies in the literature associate eveningness with overweight and obesity [32]. There are also studies in the literature that found no differences in waist circumference, BMI and obesity prevalence between chronotype groups [3, 8, 30]. In our study, an increase in both systolic and diastolic blood pressure was observed with chronotype. According to a clinical study by Godin et al, while no difference in systolic blood pressure was found between chronotype groups, it was observed that patients with diastolic blood pressure above 70 mmHg were clustered in the evening chronotype [30].

In a study of patients with BD by Romo-Nava et al, the frequency of hypertension was 18%, which was significantly higher than in the non-evening group. In our study, the frequency of meeting the diagnostic criteria for HT on repeated measurements was found to be twice as high in the evening types (41%) as compared to the non-evening types (20%) [8]. Although no significant differences were observed in the other biochemical parameters, it was detecte that HDL levels were higher in the group of non-evening types. According to a meta-analysis of 27 community-based studies, a late chronotype was associated with a higher BMI, higher levels of LDL and total cholesterol, and lower levels of HDL [33]. In a study of patients diagnosed with BD by Godin et al, no differences in LDL levels were observed between the chronotype groups. However, low HDL levels and hypertriglyceridemia were more common in the evening type group [30]. Factors such as higher prevalence of smoking, physical inactivity, preference for high-calorie and irregular diet, more frequent occurrence of depressive symptoms and stress burden, and increased frequency of smoking in patients with evening-type BD may predispose them to higher blood pressure, obesity, and low HDL levels. Further research is needed to investigate the relationship between biochemical parameters and chronotype in patients with BD in larger studies. According to our findings, almost 9 out of 10 evening types reported poor sleep quality. This rate was 2.5 to 3 times higher

than in the non-evening group. Previous studies have also associated the evening chronotype with poorer sleep quality [30]. Previous studies have shown that short sleep duration and sleep disorders are associated with dyslipidemia, obesity, coronary heart disease, and myocardial infarction. [34, 35].

On the basis of this study, a remarkable relationship was observed between eveningness and CVD risk score. In addition, about two-thirds of patients in the evening-type group had MetS, which was significantly higher compared to other chronotype groups. Studies examining CVD risk scores by chronotype in patients with BD using comprehensive parameters are inadequate. In their study of 752 BD patients, Godin et al. found that the plasma atherogenic index was higher in the evening-type group [30]. Previous studies have used different methods to calculate CVD risk scores using different parameters, making it difficult to compare results between studies. However, both the results of our study and publications in the literature suggest an association between eveningness and increased CVD risk score in people diagnosed with BD. There are several hypotheses regarding the relationship between evening chronotype, poor sleep quality and cardiometabolic risk. For example, increased appetite hormones caused by circadian misalignment are thought to be associated with increased CVD risk [12]. It is also known that circadian disruption may contribute to impaired glucose tolerance and reduced insulin sensitivity [36]. Furthermore, it should be remembered that poor sleep quality and insufficient sleep have negative effects on metabolism and may contribute to increased blood pressure, impaired insulin metabolism and increased CVD risk through their association with stress and their effects on dopaminergic pathways. Other behavioural factors, such as lower levels of physical activity, smoking or alcohol consumption, and unhealthy dietary habits in evening types, may also contribute to the association between chronotype and cardiometabolic disease. These observations are not specific to BD and are applicable to the general population. The circadian system, which plays a role in regulating the HPA axis, leptin/ghrelin hormone balance, and components of immune and oxidative stress, and abnormalities in this system have been proposed as factors triggering metabolic problems in patients diagnosed with BD [37]. Moreover, BD is considered to be a multisystemic inflammatory disorder that disrupts hormonal, metabolic and circadian homeostasis [17, 38]. In addition, genome-wide association studies, including meta-GWAS, have found that genes encoding key components associated with circadian alignment or circadian signalling pathways overlap with genetic traits observed in mood disorders and cardiometabolic diseases [33]. It is thought that the disrupted circadian system in patients with BD controls the expression of numerous genes regulated by both central and peripheral clocks that play a role in cortisol secretion, glucose homeostasis, blood pressure or lipid regulation [39]. Furthermore, the use of atypical antipsychotics and the prevalence of polypharmacy in patients with BD may induce both sedation and weight gain, which may explain the relationship between chronotype and cardiometabolic parameters.

In this study, a comprehensive dataset was created to investigate the relationship between chronotype and CVD risk in patients with BD. The data include a variety of potentially influential factors such as clinical data, exercise habits, eating attitudes and sleep quality. Studies focusing on CVD, one of the leading causes of death in BD patients, are limited. To our knowledge, our study is the first in the literature to examine all these areas together.

The limitations of our study include its cross-sectional design, which restricts the ability to establish cause-effect relationships, and the absence of a separate analysis for patients taking psychotropic drugs, who are at higher risk of metabolic disease, or a study on the side effects of these drugs. Additionally, our study is limited by the fact that we did not inquire about participants' eating habits and did not calculate their calorie intake.

Further comprehensive studies are needed to more clearly delineate the relationship between sleep, chronotype characteristics and CVD in people diagnosed with BD, and to clarify the direction of the underlying causality. These studies should consider various confounding factors, such as demographic differences, details of exercise habits, concomitant depressive symptoms, metabolic and circadian effects of treatments, differences in social rhythm and lifestyle, and genetic factors, compared with healthy controls.

CONCLUSION

Based on the current study, individuals with an evening chronotype had poorer sleep quality, unhealthier eating habits, high risk of CVD, and higher prevalence of MetS. For patients diagnosed with BD, there is agreement that chronobiological treatments and interventions designed to align with endogenous circadian and social rhythms could help improve affective

symptoms and sleep quality. This may have implications for both the clinical course of BD and the prevention of associated cardiometabolic diseases. Further research into chronotype could provide valuable insights into the identification and treatment of those at higher risk from both a psychological and cardiometabolic perspective.

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