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SHORT REPORT

Prevalence and Correlates of Diurnal Mood Variation in Chinese Adolescents with Major Depressive Disorder and Anxiety Symptoms: A Cross-Sectional Study

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Purpose: Diurnal mood variation is one of the prominent symptoms in depression. However, little is known about this phenomenon. This study examined diurnal variation in adolescents with comorbid depression and anxiety symptoms, and assessed the incidence, correlates, and related factors.

Patients and Methods: The study comprised a sample of 557 outpatients who were adolescents suffering from anxiety and depression. Symptom severity was assessed using the Zung Self-Rating Depression Scale, Anxiety Scale, and 24-item Hamilton Rating Scale for Depression.

Results: Majority of the participants (69.83%) reported diurnal mood variation throughout the day. Higher score on the Zung Self-Rating Depression Scale, specifically somatic, cognitive impairment, retardation, sleep disturbance, and feelings of despair, were noted in individuals with diurnal variation compared to those without. Additionally, there was a significant correlation between feelings of despair and diurnal mood variation, which was able to predict diurnal variation in adolescent aged 10 to 13 years or those whose depressive symptoms were mild.

Conclusion: Diurnal mood variation is common in adolescents with major depressive disorder and anxiety. The pattern is associated with more severe depressive symptoms. Feelings of despair are a potential associated factor for diurnal changes in mood, although the discriminatory capacity of this variable is limited.

Keywords: diurnal variation, major depressive disorder, anxiety symptoms, adolescent

Introduction

Depression is a prevalent issue in adolescence. Various physical, psychological, and social characteristic changes of this developmental period can make adolescents more vulnerable to depression compared with adults.[1] In recent years, the prevalence of self-reported depressive symptoms has been high in outpatient clinical settings,[2] with an upsurge in depressive symptoms among adolescents.[3] This trend has been further exacerbated by the impact of the Covid-19 pandemic on adolescent symptomatology.[4,5]

Diurnal mood variation, which refers to the fluctuation of mood throughout the day, is one of the defining features of depression.[6,7] Such recurrent mood instability is a consistent and independent predictor of suicidal ideation[8,9] and may contribute to premature mortality. A study focused on diurnal variation suggested that the pattern of mood change throughout the day could be understood from the perspective of circadian function, which may have implications for the phenomenology and pathogenesis of depression.[10] While diurnal mood variation has been well studied in adults, studies show that only 20–30% of depressed adult patients exhibit such symptoms.[11] In contrast, relatively little research has

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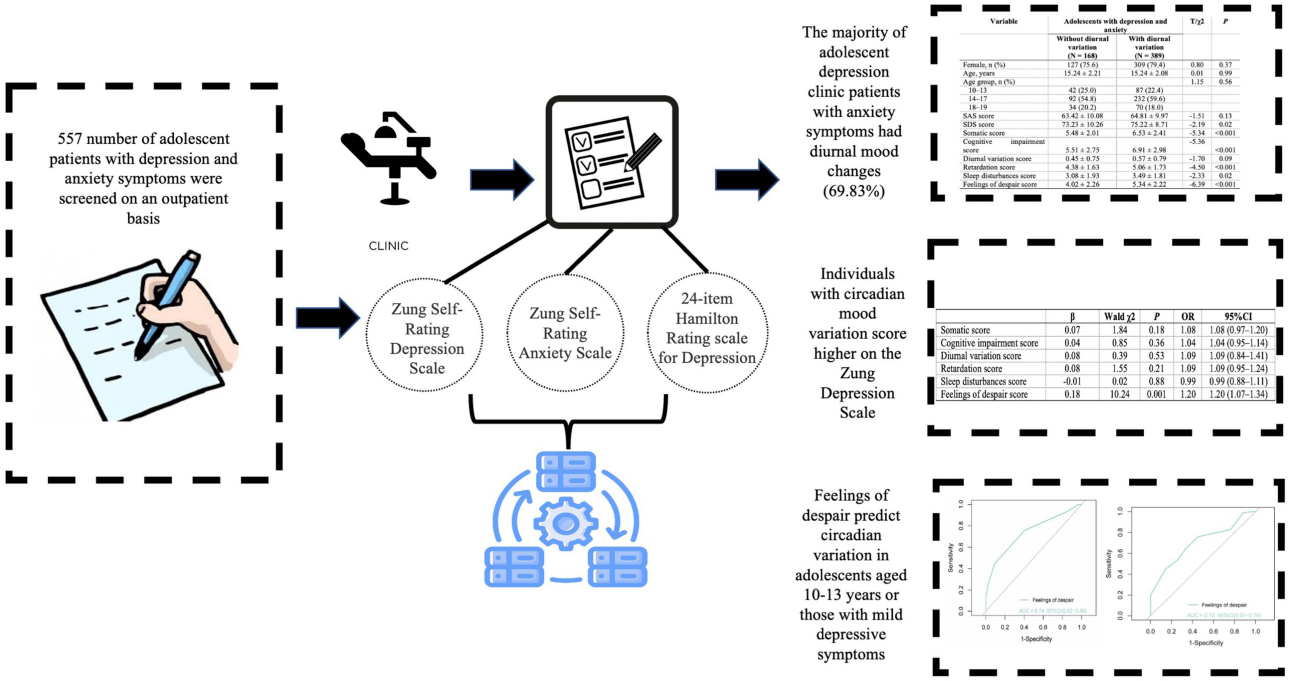
Graphical Abstract



focused on this phenomenon in adolescents, despite the distinct developmental and environmental factors that may influence mood regulation during this period. Research on adolescents with small sample sizes suggest that greater mood variability is correlated with comorbid depressive and externalizing disorders, such as conduct and substance use disorders.[12] Despite this findings, limited attention has been devoted to the specific exploration of diurnal mood variations among adolescent patients.

In the present study, the association between diurnal variation and other core symptoms of depression disorder was examined as well as the associated factors associated with diurnal variation in adolescents displaying depression comorbid anxiety symptoms.

Materials and Methods

The present study was reviewed and approved by the Shanghai Pudong New Areas Mental Health Ethics Committee and complied with the Helsinki Declaration of 1975, revised in 2013. Recruitment of participants took place between March 2021 and June 2023 from the outpatient clinical Mental Health Center of Tongji University Psychological Assessment Research Center at Shanghai. Written informed consents were obtained from participants or their guardians. The diagnostic criteria for the subjects were based on the DSM-5. Eligible participants met the following stringent inclusion criteria: (1) age between 10 and 19 years; (2) Zung Self-Rating Depression Scale (SDS) score ≥ 53; (3) Zung Self-Rating Anxiety Scale (SAS) score ≥ 50; (4) 24-item Hamilton Rating scale for Depression (HAMD-24) score ≥ 8; (5) no previous history of other mental disorders.

Participant underwent interviews conducted by psychiatrists at the health center. The severity of anxiety symptom was assessed using the SAS scales. Depression severity was specifically evaluated using the SDS, with SDS scores ≤ 50 classified as mild depression, scores between 51 and 58 considered as moderate depression, and scores > 58 classified as severe depression. The evaluation of depressive symptoms was conducted using the formally translated and standardized Chinese version of HADM-24.[13] Item 18 of the Chinese version of the HAMD-24, which assesses day-night changes (if

symptoms worsen in the morning or evening, and scores based on the degree of change), was included in the grouping criteria for identifying participants with significant diurnal mood variation. The collected data from the questionnaires were compiled and stored without differentiating between specific diurnal variation patterns (eg, morning-worse vs evening-worse). Therefore, we did not further analyze the data based on these patterns, which may introduce potential confounders and limit the diversity of the sample.

The statistical analyses were performed utilizing the SPSS software. (version 27; IBM Corp., Armonk, NY, USA). Chi-square tests were applied to categorical variables, while ANOVA was used for continuous variables to assess differences between groups. In order to examine factor associated with diurnal mood variation in adolescent patients with depression and comorbid anxiety symptoms, a univariate analysis was first applied and conducted to identify significant variables between diurnal mood variation and non-diurnal mood variation patients. Subsequently, logistic regression was performed using the Backward: Wald method, which sequentially removes non-significant variables to refine the model, focusing on variables that demonstrated statistical significance. The discriminatory capacity of the model was evaluated using the area under the receiver operating characteristics (AUCROC), with an AUC value between 0.7 and 0.8 considered generally acceptable for model performance.[14] The p values were set to be two-tailed with a significance level of α=0.05.

Results

Clinical characteristics of diurnal versus non-diurnal mood variation in adolescents with depression and comorbid anxiety symptoms: In the study population, the percentage of comorbid depression and anxiety symptoms exhibiting diurnal variation in adolescents stood at 69.83% (389 out of 557). As delineated in Table 1, significant differences were found between the depressed adolescents who experienced diurnal variation and those who did not, specifically in relation to certain factors measured by the HAMD scale. More precisely, the adolescents who experienced diurnal variation exhibited higher SDS scores, including somatic symptoms, cognitive impairment, retardation, sleep disturbance, and feelings of despair ($*P < 0.05$).

Factors associated with variation in adolescents with depression and comorbid anxiety symptoms: The subsequent focus centered on identifying the associated factors related to diurnal variation in adolescents with symptoms of

Table 1 HAMD Scale Scores According to the Presence or Absence of Diurnal Variation in Adolescents with Depression and Anxiety

Variable	Adolescents with Depression and Anxiety		T/χ2	*P*
	Without Diurnal Variation (N = 168)	With Diurnal Variation (N = 389)		
Female, n (%)	127 (75.6)	309 (79.4)	0.80	0.37
Age, years	15.24 ± 2.21	15.24 ± 2.08	0.01	0.99
Age group, n (%)			1.15	0.56
10–13	42 (25.0)	87 (22.4)		
14–17	92 (54.8)	232 (59.6)		
18–19	34 (20.2)	70 (18.0)		
SAS score	63.42 ± 10.08	64.81 ± 9.97	−1.51	0.13
SDS score	73.23 ± 10.26	75.22 ± 8.71	−2.19	0.02
Somatic score	5.48 ± 2.01	6.53 ± 2.41	−5.34	<0.001
Cognitive impairment score	5.51 ± 2.75	6.91 ± 2.98	−5.36	<0.001
Diurnal variation score	0.45 ± 0.75	0.57 ± 0.79	−1.70	0.09
Retardation score	4.38 ± 1.63	5.06 ± 1.73	−4.50	<0.001
Sleep disturbances score	3.08 ± 1.93	3.49 ± 1.81	−2.33	0.02
Feelings of despair score	4.02 ± 2.26	5.34 ± 2.22	−6.39	<0.001

Abbreviations: SAS, Zung Self-Rating Anxiety Scale; SDS, Zung Self-Rating Depression Scale.

Table 2 Factors Associated with Diurnal Variation in Adolescents with Depression and Anxiety

	β	Wald χ2	*P*	OR	95% CI
Somatic score	0.07	1.84	0.18	1.08	1.08 (0.97–1.20)
Cognitive impairment score	0.04	0.85	0.36	1.04	1.04 (0.95–1.14)
Diurnal variation score	0.08	0.39	0.53	1.09	1.09 (0.84–1.41)
Retardation score	0.08	1.55	0.21	1.09	1.09 (0.95–1.24)
Sleep disturbances score	−0.01	0.02	0.88	0.99	0.99 (0.88–1.11)
Feelings of despair score	0.18	10.24	0.001	1.20	1.20 (1.07–1.34)

depression and anxiety, as displayed in Table 2. According to the statistical analysis, only feelings of despair were deemed a significant related factor for diurnal variation in the study population (β = 0.18, $^{**}P = 0.001$, OR = 1.20, 95% CI = 1.07–1.34). Furthermore, the feelings of despair score had an AUC value of 0.66 in distinguishing adolescents who showed depression and anxiety symptoms with diurnal variation from those without diurnal variation (Figure 1A).

Subgroup analysis – We then focused on the discriminatory capacity of potential associated factors for diurnal mood variation in adolescent patients, considering sex, age, and depression severity. The adolescent patients were classified based on gender, age group, and SDS score. A binary sex categorization was applied, based on physical and physiological attributes assigned at birth. The AUCROC values for feelings of despair in different groups were as follows: 0.67 for males (Figure 1B), 0.64 for females (Figure 1C), 0.70 for adolescents aged 10 to 13 years (Figure 1D), 0.67 for those aged 14 to 17 years (Figure 1E), and 0.58 for those aged 18 to 19 years (Figure 1F). Regarding depression severity, the AUC-ROC values were 0.74 for mild SDS severity (Figure 1G), 0.63 for moderate SDS severity (Figure 1H), and 0.64 for severe SDS severity (Figure 1I). Among these, we found that adolescents aged 10 to 13 years ($^{*}P < 0.05$, 95% CI = 0.61–0.79) or those diagnosed with mild depression severity based on the SDS questionnaire ($^{*}P < 0.05$, 95% CI = 0.62–0.86) exhibited higher AUC values to distinguish diurnal mood variation from those without.

Discussion

This is the first report to investigate the prevalence of diurnal variation and related factors in a large sample of adolescents exhibiting symptoms of depression and anxiety. The primary findings of this study can be summarized as follows: (1) diurnal variation is prevalent among adolescents struggling with depression and anxiety symptoms; (2) adolescents experiencing diurnal variation report more pronounced depressive symptoms; (3) feelings of despair have moderate discriminatory potential in predicting diurnal variation among individuals aged 10 to 13 or with mild depressive symptoms.

In this study, 69.83% of the adolescent participants with comorbid depression and anxiety reported instances of diurnal variation. This finding contrasts with prior research involving adults, where diurnal mood variation was identified in only 20% to 30% of depressed adult patients.[11,15] The findings imply that the diurnal mood variation is more prevalent among contemporary adolescents. This phenomenon may be attributed to maladjustment in daily routines, particularly represented by a delayed onset-wakeup time, a pattern more pronounced in young subjects during Covid-19 lockdown period.[16,17] Changes in sleep schedules, as well as alterations in the quantity and quality of nighttime sleep, have been found to be associated with elevated rates of emotional symptoms and supports an important role in adolescent brain function and behavior.[18,19] Considering documented disparities in depressive symptomatology between adolescents and adults in previous studies,[20] the findings might contribute to the understanding of these variations and highlight a noteworthy symptom among depressed adolescents during Covid-19 pandemic.

Measures of mood variability are often deliberated concerning their connection to the severity of depression, and divergent viewpoints exist regarding this association. In the study, adolescent patients with diurnal variation reported significantly more severe depressive symptoms, including heightened somatic complaints, cognitive impairment, retardation, sleep disturbance, and a sense of despair. Research involving adults has also shown similar findings, indicating that

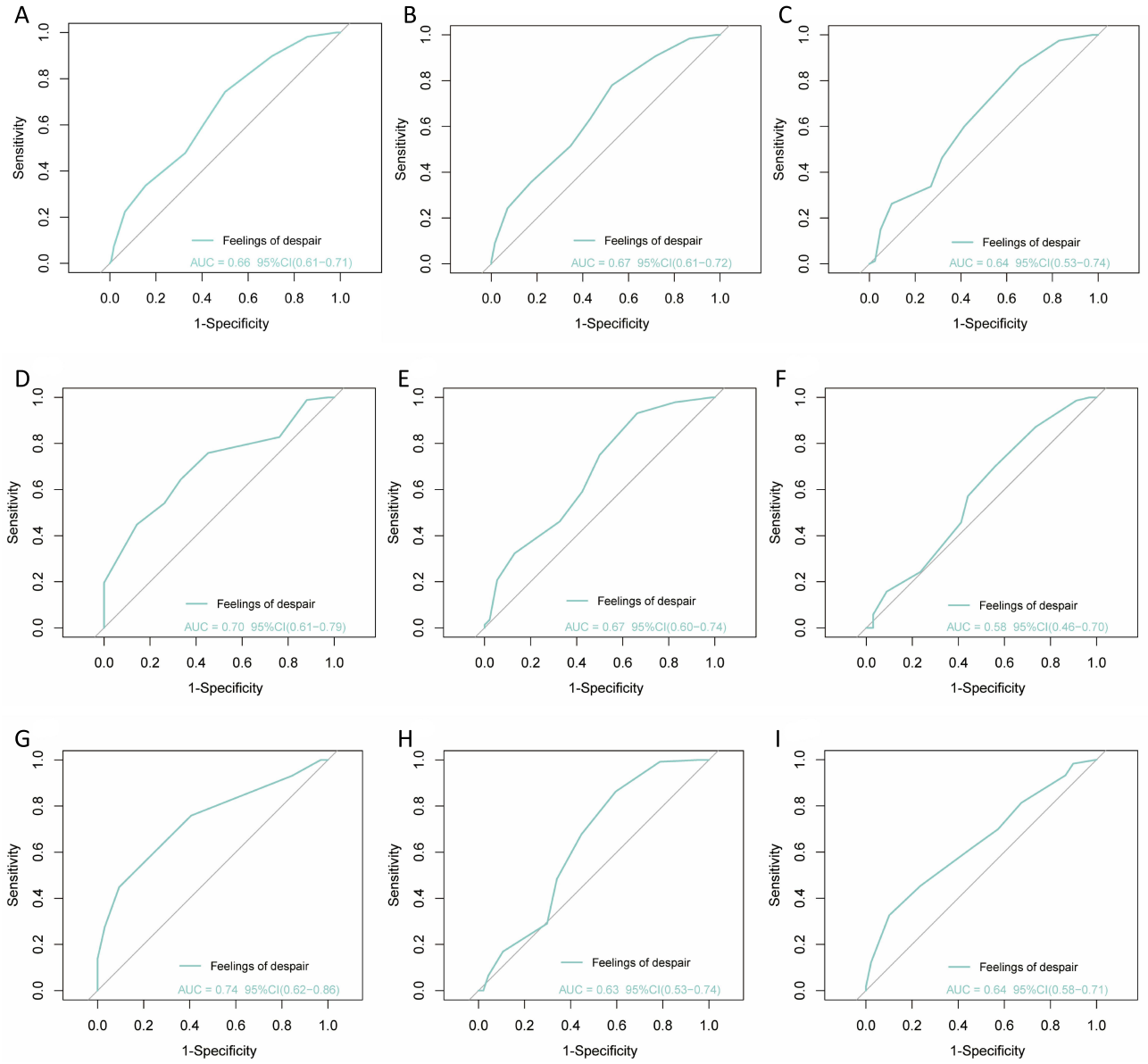


Figure 1 The discriminatory capacity of feelings of despair for distinguishing individuals with versus without diurnal variation among adolescents with depression and anxiety, grouped by sex, age, and depression severity. (**A**) Discriminatory capacity of feelings of despair for distinguishing diurnal mood variation in general with AUC equal to 0.66, (**B** and **C**), Discriminatory capacity of feelings of despair for distinguishing diurnal mood variation by sex: in female (**B**) with AUC equal to 0.67 and in male (**C**) with AUC equal to 0.64. (**D–F**) Discriminatory capacity of feelings of despair for distinguishing diurnal mood variation by age: 0–13 years old (**D**) with AUC was 0.70, 14–17 years old (**E**) with AUC was 0.67, 18–19 years old (**F**) with AUC was 0.58. Discriminatory capacity of feelings of despair for distinguishing diurnal mood variation by SDS severity score: reflecting mild (**G**) with AUC was 0.74, moderate (**H**) with AUC was 0.63, severe (**I**) with AUC curve was 0.64. All p values are <0.05.
Abbreviation: AUC, area under the curve.

diurnal mood variation is linked to a higher risk of severe depression and may potentially predict how individuals respond to treatment.[15,21] However, contrasting findings emerged in older psychiatric literature, where mood variability failed to correlate with increasing depression severity,[22] and the return of diurnal mood variation symptom has been construed as a sign of symptomatic improvement.[23] Given the inconsistencies among these findings and the emerging body of evidence supporting the potential of treatments targeting circadian rhythms for patients with diurnal variation,[15,21] additional investigation of this relationship is warranted.

In this study, only one clinical characteristic—feelings of despair—merits consideration as an associated factor for diurnal variation, holding the capacity to distinguish diurnal variation in adolescent patients. The subgroup analysis revealed that feelings of despair may help differentiate between adolescents aged 10 to 13 who experience diurnal

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variation and those who do not. Furthermore, this association was greater in cases of mild depression severity. The term "feelings of despair" is applied in the context of depression as a synonym of helplessness and hopelessness. A recent study has reported its utility as a scale for evaluate suicide risk and associated with more severe problems on several dimensions related to suicide risk.[24,25] Nevertheless, there exists a conspicuous paucity of extensive scientific literature concerning the examination of feelings of despair within the context of depression. Subsequent research is needed to elucidate the discriminatory capacity of "feelings of despair" in the context of diurnal variation in depression.

Several limitations in the study warrant acknowledgment. First, the study did not differentiate adolescents into morning-worse and evening-worse diurnal patterns of mood, which could introduce confounding factors. Second, other variables that may influence diurnal mood variation, such as sleep pattern, external stressors (eg, academic pressures, family issues), and difficulties in adapting to social or interpersonal relationships, were not considered, and their absence in the analysis may limit the generalizability of the findings. Finally, the representativeness of the sample is limited as participants in this study were all Han Chinese adolescents. This limitation arose from the location where the sample was collected. Future studies may consider multi-site research with larger and more diverse populations to enhance the generalizability of this findings. Including participants from different geographical regions and with varied demographic characteristic, such as ethnicity and socioeconomic status, will not only help enhance the generalizability of the findings but also control for potential confounders. Additionally, future research should consider differentiating diurnal mood pattern to better understand the nuanced effects of diurnal variation on adolescent mood disorders.

Conclusion

The study illustrated that diurnal mood variation is highly prevalent among adolescents with major depressive disorder and comorbid anxiety symptoms, compared with previous data from adult patients. Furthermore, diurnal changes were correlated with more severe symptoms of depression and anxiety. The data indicated that feelings of despair might act as an associated factor for diurnal variation in certain conditions. The findings may serve as a foundation for additional studies on the relationship between diurnal mood changes in adolescents with comorbid depression and anxiety. Replicated research and further studies with appropriate refinements are needed to confirm the current findings and look for potential therapeutic target.

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Disclosure

The authors report no conflicts of interest in this work.

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