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Unraveling the interplay: Exploring the relationship between children's obesity, sleep disorders, depressive symptoms, and age dynamics

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Abstract

Objective: This study explores the relationships between sleep disorders, depressive symptoms, and obesity among children of different ages.

Material and methods: The data for this study were collected from 163 Turkish children aged 7 to 10 and 11 to 15 years (mean age=9.4, SD=1.9) who were attending well-child visits. Parents completed an online questionnaire on sociodemographic data, while children completed the Children Depression Inventory and The Children's Sleep Habits Questionnaire.

Results: The regression model for the 7-10 years group included sleep resistance, sleep onset delay, nighttime awakenings, and daytime sleepiness, and explained 33.8% of the variance in Children Depression Inventory scores (R^2=0.338, F=9.779, p<0.001). For the 11-15 age group, the regression model included obesity status, Children's Sleep Habits Questionnaire scores, sleep onset delay, sleep-related anxiety, and sleep-disordered breathing, and explained 80.3% of the variance in Children Depression Inventory scores (R^2=0.803, F=28.489, p<0.001).

Conclusion: Overall, the results of this study emphasize the significance of addressing sleep disorders, obesity, and depressive symptoms in children, particularly in adolescents, to promote better mental health outcomes.

Keywords: adolescent, children, depressive, sleep, obesity

Introduction

Sleep disorders and obesity are two prominent public health concerns with significant impacts on the well-being of children and adolescents worldwide [1]. Over the past years, the prevalence of both conditions has been steadily rising, posing potential adverse effects on physical and mental health, academic performance, and overall quality of life among this vulnerable population. As these issues continue to grow, there is a pressing need to comprehend the intricate relationship between sleep patterns and weight-related factors to develop effective preventive measures and interventions.

Psychological and sentimental problems are becoming increasingly prevalent, disabling, and recurrent in the younger population [2]. While depression is more prevalent among adolescents, unaddressed psychological problems in children and adolescents can lead to poor academic performance, impaired social functioning, and substance abuse [3,4]. Furthermore, depression may persist into adulthood, increasing the risk of suicide, which ranks as the second most avoidable cause of mortality among young individuals [5].

A meta-analysis involving 143 603 children found strong evidence indicating that obese female children have a substantially greater likelihood of being at risk of experiencing depression in contrast to their normal-weight counterparts, and this risk endures into adulthood. As such, healthcare providers should take into account the potential for depression symptoms when screening obese female children [5].

Despite the evident significance of addressing sleep and weight-related issues, our understanding of the underlying mechanisms and mediators linking these conditions remains limited. Thus, unraveling the complex interplay between sleep, obesity, and mental health is imperative for the development of comprehensive interventions targeting these intertwined

problems. This study seeks to investigate the potential mediating role of depressive symptoms in the association between sleep disorders and obesity among children and adolescents. By elucidating the mechanisms through which these factors interact, we aim to contribute valuable insights to inform public health strategies and support the design of tailored interventions for this vulnerable population.

Material and methods

This study aimed to include both obese and normal-weight children who were seeking routine health check-ups. To be eligible for the study, children needed to be between the ages of 6 and 18 years and have no known medical or psychiatric conditions that could affect their sleep or weight. To assess depressive symptoms, we planned to use the Beck Depression Scale, which has been validated for use in children of this age group. Therefore, we included children aged 6 years and above in our study. Other inclusion criteria were the completion of an online questionnaire that we provided, being obese or normal-weight based on body mass index (BMI) measurements, and having no known chronic medical or psychiatric conditions that could affect sleep or weight. Children who met these criteria were recruited from the pediatric outpatient clinic at Başkent University between March 1, 2023, and July 1, 2023. Parents of eligible children were provided with detailed information about the study and asked to provide written informed consent before their child's participation. Ethical approval for the study was obtained from the institutional review board at Başkent University (project number: KA 23/206) before its commencement.

We determined that a sample size of 156 participants would be sufficient for conducting one sample proportion testing, with a power of 90% and a type I error of 0.05, assuming an effect size of 0.10. To obtain the maximum sample size, we chose a probability of success of 0.50. All statistical tests were interpreted using a significance level of 0.05. We performed statistical analyses using SPSS v25.0 software (SPSS Inc., IBM, USA).

All parent-child pairs completed an online questionnaire, which encompassed parent sociodemographic factors, children's weight and height measurements, as well as scales such as the Children's Depression Inventory and The Children's Sleep Habits Questionnaire.

Measures

Obesity or normal weight

This study utilized the BMI (Body Mass Index) percentile to categorize the children as either obese or non-obese. The participants' BMI was calculated by dividing their weight in kilograms by the square of their height in meters. The children's height and weight were measured to compute their body mass index (BMI), which was determined using BMI percentile charts developed based on the reference values for Turkish children [6]. The study included children who were of normal weight (between the 5th and 85th percentile) and those who were obese (above the 95th percentile).

Children's depression inventory

We used the Children's Depression Inventory (CDI), developed by Kovacs (1985), to assess the levels of depression in the children [7]. The scale comprises 27 items, with scores ranging from 0 to 54. Higher scores on the CDI indicate a greater degree of depression [8]. In our study, Cronbach's alpha coefficient for the scale was 0.89.

The children's sleep habits questionnaire

We used the Children's Sleep Habits Questionnaire (CSHQ) to assess the sleep patterns of the children in our study. The CSHQ was originally developed by Owens et al. (2000) to investigate sleep issues in preschool and school-aged children, with the aim of identifying high-risk situations for sleep problems rather than diagnosing sleep disorders [9]. The scale was adapted to Turkish in 2010 by Fis et al., who conducted a validity and reliability study (Cronbach's alpha value = 0.78) [10]. Parents retrospectively completed the scale by evaluating their child's sleep habits over the previous week. The scale consists of eight subscales, including bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep-disordered breathing, and daytime sleepiness. Based on the scores obtained from the Sleep Habits Questionnaire, we divided the children into two groups: Sleep Group I (≤ 41 points) and Sleep Group II (> 41 points). This study's results showed that 64.6% (n=62) of the children were classified as belonging to Sleep Group II. In our study, Cronbach's alpha coefficient for the scale was 0.75.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Qualitative data were summarized using numbers and percentages, while quantitative data were described using mean and standard deviation. The normality of distribution was assessed using the Kolmogorov-Smirnov test. To compare the two continuous groups, the Mann-Whitney U test was employed. For categorical variables, the Pearson chi-square test, continuity correction chi-square test, and Fisher's exact test were performed. Multiple linear regression analysis was conducted to examine the factors influencing children's BECK depression across different age groups. The level of statistical significance was set at $p<0.05$ for all analyses.

Results

A total of 497 children were initially assessed in the pediatric clinic. Since the Children's Depression Inventory was only validated for children aged 7 and above, 290 children under the age of 7 were excluded from the study. This resulted in a final sample of 207 children who were included in the subsequent analysis. Among them, 35 children were categorized as underweight (BMI percentile < 5%), and 9 children declined to participate in the survey.

Additionally, the study involved 163 parents, comprising both parents of normal-weight and obese children. Of the included children, 55.8% (n=91) were obese, while 44.2% (n=72) were of normal weight. The gender distribution among obese and normal-weight children was found to be similar (p=0.145). Notably, there were no children aged 15 or above among the applicants. Consequently, the children were divided into two age groups: 7-10 years and 11-15 years. When these age groups were analyzed separately, it was observed that the proportion of girls was 65% in the normal-weight group, whereas it was only 30% in the obese group (p=0.016).

Regarding the sociodemographic characteristics of the parents, the majority (89.5%) were married, with mothers having an average age of 40.5±4.3 and fathers having an average age of 45.4±4.8. Additionally, a significant number (74.3%) of parents reported having a monthly income of at least three times the minimum wage. Moreover, 76% of mothers and 75% of fathers had attained at least a bachelor's degree.

Table 1 Comparison of Sociodemographic Characteristics, Depressive Symptoms, and Sleep Habits Between Obese and Normal Weight Children Across Different Age Groups.

	7-10 years (n=122)			11-15 years(n=41)		
	Normal (n=59)	Obese (n=63)	p	Normal (n=13)	Obese (n=28)	p-values
Parenteral Characteristic						
Marital status n (%)*						
Married	53 (90)	55 (87)	0.878[b]	11 (85)	25 (89)	0.645[c]
Divorced	6 (10)	8 (13)		2 (15)	3 (11)	
Income level n (%)*						
<Minimal wage	3 (5)	-		-	-	0.987[b]
Minimal wage -3x	15 (25)	25 (40)	0.064[a]	6 (46)	13 (46)	
>Minimal wage 3x	41 (70)	38 (60)		7 (54)	15 (54)	
Educational level n (%)*						
Mother						
High school and below	15 (25)	8 (13)	0.118[b]	5 (39)	11 (39)	1.000[b]
License and graduate	44 (75)	55 (87)		8 (61)	17 (61)	
Father						
High school and below	16 (27)	9 (14)	0.126[b]	7 (54)	9 (32)	0.326[b]
License and graduate	43 (73)	54 (86)		6 (46)	19 (68)	
Employment status n (%)*						
Mother						
Not working	16 (27)	15 (24)	0.833[b]	5 (39)	11 (39)	1.000[b]
Working	43 (73)	48 (76)		8 (61)	17 (61)	
Father						
Not working	3 (5%)	3 (5%)	1.000[c]	-	-	
Working	56 (95%)	60 (95%)		13 (100)	28 (100)	-
Age of the parents (M±SD)						
Mother	39.44±6.07	38.86±4.16	-	41.38±5.08	42.54±5.17	-
Fathers	41.37±6.42	41.89±3.98	-	48.54±3.91	44.96±4.75	-
BMI	17.84 ±2.26	21.35±4.18	-	18.02±1.97	21.02±5.51	-
Children's Variables						
Gender n (%)*						
Female	39 (66)	28 (44)	**0.016**[a]	6 (46)	15 (54)	0.915[b]
Male	20 (34)	35 (56)		7 (54)	13 (46)	
Scores of the Children on the Scale (M±SD)						
CDI Score	6.42±3.61	8.76±7.67	0.611[U]	8.92±8.11	13.14±9.37	0.112[U]
CSHQ Total and Subscales Score						
Total	47.86±6.09	47.76±4.92	0.813[U]	47.69±5.17	48.82±5.04	0.692[U]
Bedtime resistance	9.54±1.50	9.87±1.56	0.259[U]	9.23±1.59	9.57±1.62	0.653[U]
Sleep onset delay	1.94±0.22	1.92±0.27	0.527[U]	1.69±0.48	1.75±0.44	0.702[U]
Sleep duration	6.57±0.83	6.53±0.88	0.703[U]	6.53±0.88	6.36±1.22	0.615[U]
Sleep anxiety	7.17±2.66	6.41±2.19	0.171[U]	4.92±1.98	5.61±1.93	0.102[U]
Night waking	4.03±1.26	3.88±1.15	0.547[U]	3.77±0.93	4.21±0.96	0.165[U]
Parasomnias	7.98±0.97	8.27±1.31	0.374[U]	9.92±2.18	8.32±1.81	0.015[U]
Sleep-disordered breathing	3.29±0.79	3.29±0.68	0.637[U]	3.31±1.11	3.25±0.80	0.828[U]
Daytime sleepiness	11.08±2.70	11.16±2.31	0.963[U]	10.92±2.81	12.53±2.32	0.092[U]

n: number, a: Pearson X^2 test, b: Continuity correction X^2 test, c: Fisher's exact test, U: Mann-Whitney U test.
*: column percentage, $p<0.05$ is statistically significant. CSHQ: The Children's Sleep Habits Questionnaire,
CDI: The Children's Depression Inventory.

Table 1 presents the sociodemographic data, gender distribution, CDI, and CSQI scores of both obese and normal-weight children aged 7-10 years and 11-15 years. Sociodemographic information, depressive scores, and total sleep scores of parents were found to be similar between obese and normal-weight children in both age groups ($p>0.05$). Analyzing the data separately for each age group, it was determined that 51.6% of the overall sample population was classified as obese, and this percentage increased to 68.2% among the 11-15 age group. Although obese children in both age groups scored higher on the Child Depression Inventory (CDI) and Children's Sleep Habits Questionnaire (CSHQ), no statistically significant difference was observed between the depressive symptoms of obese and normal-weight children within each age group ($p>0.05$; Table 1).

Regression models for both age groups revealed no multicollinearity issues based on the VIF values and no autocorrelation according to Durbin Watson d statistics. The regression equations estimating depressive symptom levels for ages 7-10 years and 11-15 years, respectively, were as follows:

- CDI = 2.515 - 0.939x1 + 1.705x2 - 4.601x3 + 1.544x4 + 2.523x5 + 1.413x6
- CDI = -15.377 + 4.470x1 + 1.155x2 - 12.462x3 - 1.404x4 - 2.186x5

The regression model for factors affecting the CDI in 7-10-year-olds was significant ($F=9.779$, $p<0.001$). The regression coefficients for total sleep, bedtime resistance, sleep onset delay, night waking, parasomnias, and daytime sleepiness were significant, explaining 33.8% of the variance in depressive symptom levels. Specifically, a 1-point increase in night waking

Table 2 Multiple linear regression

(CDI 7-10 years)	*b*	*S(b)*	*VIF*	*t*	*p*
CSHQ Total (X_1)	-0.939	0.262	9.525	-3.590	<0.001
Sleep onset delay (X_2)	1.705	0.479	2.483	3.563	0.001
Bedtime resistance (X_3)	-4.601	2.057	1.203	-2.237	0.027
Night waking (X_4)	1.544	0.624	2.586	2.477	0.015
Parasomnia (X_5)	2.523	0.594	2.201	4.246	<0.001
Daytime sleepiness (X_6)	1.413	0.318	2.912	4.443	<0.001
R^2=0.338 (F=9.779 p<0.001) d=0.617					
(CDI 11-15 years)	*b*	*S(b)*	*VIF*	*t*	*p*
Obese-normal (X_1)	4.470	1.480	1.040	3.020	0.005
CSHQ (X_2)	1.155	0.194	2.039	5.966	<0.001
Bedtime resistance (X_3 (X_4)	-12.462	1.650	1.172	-7.552	<0.001
Sleep anxiety (X_4)	-1.404	0.435	1.535	-3.229	0.003
Sleep-ordered breathing (X_5)	-2.186	0.956	1.566	-2.287	0.028
R^2=0.803 (F=28.489 p<0.001) d=1.149					

VIF: Variance Inflation Factor

was associated with a 1.544 increase in the CDI score. Similarly, the regression model for factors affecting the CDI in 11-15-year-olds was also significant (F=28.489, p<0.001). Regression coefficients for obesity status, total sleep, sleep onset delay, sleep anxiety, and sleep-disordered breathing were significant, explaining 80.3% of the variance in depressive symptom levels. Depressive scores were 4.47 points higher in obese versus normal-weight children.

Moderate correlations were observed between BECK depression and sleep scales in 7-10-year-olds (r=0.384) and 11-15-year-olds (r=0.512) (p<0.001).

Discussion

It is important to identify depressive symptoms in children and recognize associated factors. This study shows that in particular, in the adolescent age group, depressive symptoms are associated with sleep habits, bedtime resistance, sleep anxiety, breathing difficulties during sleep, and obesity. In the 7-10 years group, although sleep habits were associated with depressive symptoms, obesity was not found to be related.

The present study sheds light on the significant link between disrupted sleep habits and depression among adolescents, without any notable disparities between genders. A study conducted by Goldstone and colleagues, involving a substantial national sample of more than 11,000 participants aged 9-10 years in the United States [11], further supports these findings. The researchers utilized parent reports to assess sleep disturbance and sleep duration, while mental health was evaluated using the Child Behavior Checklist. The outcomes of their investigation revealed that higher levels of sleep disturbance and shorter sleep duration were correlated with an increase in mental health symptoms, and notably, sleep disturbance emerged as a predictor of future mental health issues, especially depression. These compelling findings underscore the potential of leveraging proper sleep patterns as a preventive measure against depression during early adolescence. An intriguing aspect noted in their study, which contrasts with our own, was the significant interaction between sleep disturbance and gender. This interaction indicated that the association between sleep disturbance and depression was more pronounced among girls compared to boys. Such nuanced gender differences emphasize the need for tailored approaches when addressing sleep-related interventions for adolescents.

There is a relationship between depressive symptoms and sleep disturbances in children [12]. Many studies have shown that sleep problems can contribute to the onset of depression or increase the severity of existing depression. Additionally, depression itself can lead to sleep problems. Sleep problems can lead to the emergence of depressive symptoms in children. For example, symptoms such as insomnia, fatigue, and difficulty concentrating can affect a child's social and school life and lead to depressive symptoms. The disturbances in the circadian rhythm of sleep and wakefulness were related to depression in adolescents [13]. On the other hand, depression can cause sleep problems [14]. Depressive symptoms in children can reduce sleep quality and lead to difficulty falling and staying asleep. Therefore, if both sleep problems and depressive symptoms are present in children, it is important to consider that these two conditions are related. Treating sleep problems can also help with treating depression, and similarly, treating depression can improve sleep problems.

The current study found obese children scored higher in depression in both the 7-10 and 11-15 age groups, but the link between obesity and depression was only significant among adolescents. In contrast to our findings, Moreno et al. (2021) discovered that later sleep midpoints were linked to greater BMI increases during summer [15]. Additionally, another study found that obesity was linked to increased sleep difficulties and lower Pediatric Quality of Life scores [16]. While children with more depressive symptoms had more sleep difficulties, this was not linked to the degree of obesity. As a result, it was concluded that obese children and adolescents require support to improve their sleep quality, quality of life, and depressive symptoms.

Our study demonstrated that disturbed sleep habits varied according to age groups, with adolescents having higher scores in the parasomnia subgroup. This finding is consistent with a study by Lewien et al. (2020) who also found that sleep habit disorders differed according to age groups [17]. However, unlike their study, we did not observe a difference in disturbed sleep habits based on the socioeconomic status of the parents. This discrepancy may be due to the relatively small sample size of our study or the homogeneity of our sample. Our findings highlight the importance of evaluating sleep habits and addressing sleep disturbances in children and adolescents, particularly those with depressive symptoms. Further research with larger and more diverse samples is needed to confirm and expand upon our findings.

Conclusion

Preventive measures are vital for children's health. Assessing sleep habits in obese or visibly depressed children can help implement preventive measures. We thought this study contributed to scientific understanding. However, our study has limitations. Firstly, wider research covering the 11-18 age range is needed due to hormonal changes and weight gain during adolescence. Secondly, participant selection should consider social status and other influencing factors. Additionally, the small sample size limits generalizability and statistical power. The study relied on the CDI scale without a psychiatric diagnosis. Nonetheless, this research is valuable, showing that obesity and sleep habits predict depressive symptoms in adolescents with affluent parents.

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