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Estimation of Alexithymia by Body Fat Ratio in Adolescents with Overweight and Obesity

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ABSTRACT

Introduction: This study investigated the association between adiposity and alexithymia risk among adolescents with overweight (OW) and obesity (OB).

Methods: In this cross-sectional study, adolescents who are OW or obese completed a sociodemographic questionnaire and the Toronto Alexithymia Scale (TAS). Anthropometric measurements-including weight, height, waist, and hip circumference-were collected, and body fat percentage was determined via bioelectrical impedance analysis. Participants were categorized into two groups based on the presence or absence of alexithymia, and statistical comparisons were conducted using appropriate parametric and non-parametric tests. Receiver operating characteristic (ROC) analysis was performed to evaluate the predictive value of adiposity indices.

Results: The study included 105 adolescents (69 females, 36 males). Alexithymia was present in 49.5% of participants, with a significantly higher prevalence among females (77%). Total TAS scores were positively correlated with body fat percentage and waist-to-height ratio (WHtR). A body fat percentage above 35.5% and WHtR over 0.61 showed moderate diagnostic performance, with respective sensitivities of 71.15% and 75%, and specificities of 54.72% and 65.51%. The area under the ROC curve was 0.632 [95% confidence interval (CI): 0.533-0.724] for body fat and 0.622 (95% CI: 0.522-0.715) for WHtR.

Conclusion: Among adolescents with OW or OB, those with a body fat percentage over 35.5% or a WHtR above 0.61-particularly females-may have an increased risk of alexithymia. These findings underscore the need for integrating emotional and metabolic assessments in the clinical care of this population.

Keywords: Adolescents, obesity, body fat mass, alexithymia

Introduction

The excessive accumulation of body fat is linked to an increased risk of cardiometabolic diseases as well as a higher likelihood of developing psychiatric issues. Studies show that individuals with overweight (OW) and obesity (OB) have a higher incidence of mental disorders, including reduced cognitive function, impaired mental and intellectual function, anxiety, and depression (1). Structural and functional brain changes in individuals with these disorders have been identified through neuroimaging studies (2). The commonly used tool for diagnosing and monitoring OB and predicting related health complications is the body mass index (BMI). However, using BMI as an indicator of OB is flawed due to its inability to consider variations in body composition or the distribution of body fat. In recent years, it has been shown that anthropometric measurements like waist circumference (WC), waist-to-height ratio (WHtR), and waist-to-hip ratio (WHR) are more effective than BMI in predicting metabolic and cardiovascular complications associated with OB (3). Furthermore, it has been proven through various studies that the distribution and amount of body fat are the primary factors that link OB to complications. Moreover, this phenomenon has led to a new definition of "normal weight OB," which refers to cases with normal BMI and body fat ratio above 30 percent (4).

Alexithymia is a psychiatric disorder with an increasing prevalence among individuals with OB (5). The term "alexithymia" originates from Greek and signifies the inability to express emotions verbally. It is defined by a limited imagination, a lack of emotional expression, and a cognitive approach that emphasizes the outer environment.The etiological factors include genetic, physiological, and psychosocial influences. Additionally, neurochemical and neuroanatomical elements play a role (6).

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The correlation between alexithymia as a psychological construct and OB has been investigated for over two decades. In individuals with OB, alexithymic behavior is likely to manifest more frequently as a coping strategy for stressors (7).

On the other hand, it is essential to note that alexithymia may contribute to OB (5). Negative emotions experienced by alexithymic individuals can increase overeating as a somatic response (8). Adolescents exhibiting alexithymia tend to engage in more episodes of uncontrolled eating and eating when not hungry. Difficulties in expressing emotions, especially during stressful times, can increase overeating episodes (9). Cognitive deficits in distinguishing bodily sensations (such as hunger or fullness) from emotions may explain this relationship. Alexithymia not only predisposes individuals to weight gain but also maintains OB and predicts treatment inefficiency and termination (10). These data emphasize the importance of identifying the link between OB and alexithymia due to their causal ambiguity. Although many studies indicate a higher occurrence of alexithymia in individuals with OB, no research has explored its correlation with body fat mass (BFM). This study aimed to determine whether alexithymia in adolescents with OW and OB is related to BFM.

Methods

Participants and Study Design

This is a cross-sectional study of adolescents followed for the diagnosis of exogenous OB and OW at University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital's pediatric endocrinology clinic. Exogenous OB was defined as OB that is not connected to any genetic causes and it is not associated with endocrine or metabolic conditions. Participants with conditions other than OB or its related comorbidities, as well as those with mental or neurological disorders and eating disorders, were excluded from the study. The study was reviewed by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital (approval no: 2011-KAEK-25 2023/02-14, date: 22.02.2023) and was conducted in accordance with the principles outlined in the Declaration of Helsinki. Both verbal and written informed consent was collected from all participants and their parents.

Sociodemographic Data Collection

Information was collected through a questionnaire that included age, gender, birth week, delivery mode, birth weight, school success, parents' ages and education levels, and family income. The school success of the adolescents was assessed based on their self-description and categorized into three levels: low, medium, or high. Families self-reported their economic status and categorized it as low, medium, or high. Parents' educational levels were categorized as follows: uneducated (cannot read or write), elementary school, middle school, high school, and university.

Anthropometric Measurements

The measurements were performed between 8:00 and 9:00 a.m. after an overnight fast of at least 8 hours and with an empty bladder.

Body Weight, Body Height, and Body Mass Index

Body weight and height were measured in underwear and no shoes. A stadiometer, which was calibrated daily, was employed to determine the height of all patients, while body weight was measured using a scale (Seca 703, with an accuracy of 100 g, SecaGmBH&Co Kg, Hamburg, Germany). Height was measured with a precision of 0.1 cm. Weight was recorded with an accuracy of 0.1 kg. The BMI was calculated using the formula: weight (kg)/height $(m)^2$. Additionally, the BMI z-score was determined using the World Health Organization reference with the AnthroPlus calculator [version 1.0.4, World Health Organization (WHO)] (11). A BMI between the 85^{th} and 95^{th} percentile was categorized as OW, a BMI above the 95^{th} percentile was classified as having OB, with a BMI of 35 or greater defined as severe OB (12).

Waist and Hip Circumferences

(WC, in cm) and hip circumference (HC, in cm) were assessed with an inelastic tape, which has an accuracy of 0.1 cm. The WC was taken at the midpoint between the lower rib and the top of the iliac crest during expiration, while the HC was taken at the maximum protuberance of the buttocks. An average of two measurements for each parameter was recorded. The WHR was computed as WC divided by HC, and the WHtR was determined by dividing WC by the measured height in centimeters.

Measurement of Body Fat Mass

BFM was assessed using a bioelectrical impedance analysis (BIA) method with a TANITA BC418-MA electronic scale. TANITA BC 418-MA is an electrode system with 8 contact points, that can evaluate body composition segmentally without the use of gel electrodes. To assess fluid balance, females were evaluated between 6 and 10 days after their menstrual cycle. The subjects verbally confirmed their adherence to these criteria before participating. Subject details, including gender, height, and age, were entered manually, and a standard adjustment of 0.5 kg for the weight of clothing was applied to all participants.

The Assessment of Alexithymia

The Turkish version of the 3-factor structure of the Toronto Alexithymia Scale (TAS-20) was used to assess alexithymia. The scale, which is based on Likert-type self-reporting, contains 20 sentences and includes 3 subfactors (difficulty identifying emotions, difficulty describing emotions, and externally oriented thinking). The Cronbach's alpha value of the scale is 0.85 for all items; αdif =0.83 and αddf =0.75 for the 3 subscales indicate good internal consistency of these subscales. Meanwhile, αeot =0.60 indicates borderline consistency. The lowest score is 20, the highest score is 100, and higher scores indicate greater impairment/difficulty. The cut-off values of the scores are determined

as follows: alexithymia (score ≥61), possible alexithymia (score between 52 and 60), and absence of alexithymia (score ≤51) (13). Two groups were created for statistical comparison: participants were divided into those with alexithymia and those without alexithymia based on a cut-off value of 61. Consequently, borderline patients were analyzed in the non-alexithymia group. Since the participants in the study filled out the data completely, no additional editing was required in terms of missing data.

Variables in the Laboratory

The participants' most recent laboratory values recorded in the hospital system were used, including alanine transaminase, fasting plasma glucose, fasting serum insulin, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides, and total cholesterol. The insulin resistance index was calculated using the homeostatic model assessment-insulin resistance (HOMA-IR) formula: (fasting plasma glucose × fasting serum insulin)/22.5.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 21 (IBM, Chicago, USA). The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Mean differences between two independent groups (alexithymia vs. non-alexithymia) were evaluated using the Student's t-test for normally distributed variables and the Mann-Whitney U test when parametric assumptions were not met. The chi-square test was used to compare categorical variables. Correlation analyses were conducted using the Pearson correlation coefficient (r), with an r-value above 0.300 considered meaningful regardless of statistical significance. Receiver operating characteristic (ROC) analysis was performed using MedCalc version 16.8 (MedCalc Software, Ostend, Belgium) to assess the diagnostic performance of body composition parameters in predicting alexithymia. A two-tailed p-value of <0.05 was considered statistically significant.

Results

We analyzed data from 105 adolescents, consisting of 69 girls and 36 boys, with a mean age of 14.84 years and a BMI of 32.24±5.17. The study found that 52 people, who is 49.5% of the population, had alexithymia based on TAS scores. Participants were divided into two groups: those with and without alexithymia. There was no significant difference in the pubertal stage between the groups (p=0.87). The alexithymia group had a higher proportion of females (77%, p=0.01). Table 1 compares the demographic characteristics of subjects with alexithymia and those without.

Table 1. Comparison of demographics of adolescents with OW and OB between those with and without alexithymia

		Subjects with alexithymia n=52	Subjects without alexithymia n=53	p
Age (years)		14.57±1.84	15.11±1.80	0.12#
Gender*				
Male		12 (23)	24 (45)	**0.01α**
Female		40 (77)	29 (55)	
Birth weight (gr)		3.330±668.30	3.210±624.35	0.407#
Delivery mode*	NVD	29 (56)	21 (40)	
	C/S	23 (44)	32 (60)	0.070α
Birth week*	<37th GW	9 (17)	12 (23)	
	≥37th GW	43 (83)	41 (77)	0.330α
Mother's age (year)		41.56±4.88	41.83±5.21	0.783¶
Mother's education*	Uneducated	2 (4)	4 (7)	
	Elementary school	25 (48)	23 (43)	
	Secondary school	14 (27)	12 (23)	
	High school	6 (11)	6 (11)	0.830α
	University	5 (10)	6 (16)	
Father's age (year)		44.10±4.91	46.04±4.99	0.058#
Father's education*	Uneducated	2 (4)	2 (4)	
	Elementary school	19 (37)	22 (41)	
	Secondary school	14 (27)	13 (25)	
	High school	8 (15)	9 (17)	0.546α
	University	9 (17)	7 (13)	
Socio-economic status*	Low	1 (2)	1 (2)	
	Medium	34 (65)	38 (72)	0.778α
	Good	17 (33)	14 (26)	
School success*	Low	1 (2)	1 (2)	
	Medium	28 (54)	28 (53)	0.994α
	Good	23 (44)	24 (45)	

OW: Overweight, OB: Obesity, GW: Gestational week, NVD: Normal vaginal delivery, C/S: Cesarean section. Values are reported as mean ± standard deviation. *n (%), #Mann-Whitney U test, ¶Student's t-test, αChi-square test

Anthropometric Measurements

Anthropometric measurements did not significantly differ between participants with and without alexithymia, except for their WHtR (Table 2, part 1).

Body Composition by BIA

The groups had similar total BFT (p=0.13) and trunk fat mass (kg) (p=0.10), but significantly different percentages of body fat and trunk fat (p=0.01 and p=0.02, respectively) (Table 2, part 2).

Comparison of Laboratory Values Between the Groups

There was no significant statistical difference in the laboratory measurements across the groups (Table 3).

More than half of the 52 participants with alexithymia were found to have severe OB. However, no correlation was discovered between the severity of OB and TAS scores (67.61±5.67) (p=0.29).

Table 2. Comparison of anthropometrics and BIA results between OW and OB subjects with and without alexithymia

	Subjects with alexithymia n=52	Subjects without alexithymia n=53	Between-group difference (95% CI), p-value/χ^2, p-value
Part 1, anthropometrics			
Weight, kg	87.40±19.52	87.99±17.16	0.78#
Height, cm	163.95±7.71	165.47±8.13	0.32¶
BMI, kg/m^2	35.52±5.48	31.96±4.88	0.58¶
BMI z-score	2.72±0.74	2.58±0.80	0.34¶
Waist circumference, cm	106.55±14.02	103.23±14.60	0.20#
WHtR	0.65±0.07	0.62±0.08	**0.04¶**
Hip circumference, cm	116.32±11.12	115.36±10.27	0.64¶
WHR	0.91±0.07	0.89±0.08	0.15¶
Part 2, body composition by BIA			
Trunk fat mass, kg	15.13±5.17	13.54±4.53	0.10#
Trunk fat mass, %	33.80±7.21	30.48±7.49	**0.02¶**
Total body fat, kg	34.97±12.64	31.40±11.16	0.13#
Total body fat, %	39.08±7.51	35.31±7.63	**0.01¶**
Part 3, TAS-20 measures, mean (SD)			
Subscale 1	24.75±4.13 24 (22-28)	14.89±4.46 15 (12-18.5)	**<0.001¶**
Subscale 2	16.81±2.53 16 (15-18.75)	12.11±2.93 12 (10.5-14.5)	**<0.001#**
Subscale 3	25.96±3.38 26 (24.2-28)	23.02±4.19 22 (21-26)	**<0.001#**
Total score	67.52±5.46 63 (60-70.75)	50.04±8.31 51 (47-57)	**<0.001#**

OW: Overweight, OB: Obesity, SD: Standard deviation, BMI: Body mass index, WHtR: Waist-height ratio, WHR: Waist-to-hip ratio, BIA: Bioelectrical impedance analysis, CI: Confidence Interval, TAS-20: Toronto Alexithymia Scale, Subscale 1: Difficulty identifying feelings, Subscale 2: Difficulty describing feelings, Subscale 3: External-oriented thinking.
Values are reported as mean ± SD or median (25th and 75th percentiles). Significant contrasts are marked in bold.
#Mann-Whitney U test, ¶Student's t-test, "Chi-square test

Table 3. Comparison of laboratory results between the groups

Values	Subjects with alexithymia n=52	Subjects without alexithymia n=53	p#
ALT (U/L)	24.77±19.43	21.53±11.20	0.90
HDL-C (mg/dL)	47.76±11.13	48.92±11.16	0.69
LDL-C (mg/dL)	89.57±26.95	93.51±27.66	0.24
TG (mg/dL)	99.65±48.69	102.83±44.650	0.47
TC (mg/dL)	156.02±38.59	162.92±31.44	0.31
HOMA-IR	4.66±2.69	4.04±2.42	0.28

Values are reported as mean ± standard deviation, #Mann-Whitney U test.
ALT: Alanine transaminase, HDL-C: High-density lipoprotein cholesterol, LDL-C: Low-density lipoprotein cholesterol, TG: Triglyceride, TC: Total cholesterol, HOMA-IR: Homeostatic model assessment for insulin resistance

The number of participants with OW, OB, and severe OB among female participants was 5, 11, and 24, respectively. Among male participants, the count was 4, for each category. In the OB classification, with a mean age of 15.08±1.70, the severe OB group was found to be statistically significantly older (p=0.03). It is worth noting that a significant majority of female participants fell into the severe OB category, constituting 62% of them (p=0.01).

Table 4 presents the comparison of anthropometric and body fat measurements in the alexithymic group. No significant difference between genders was noted.

The correlation analysis revealed a positive correlation between total alexithymia score and body fat percentage and waist-height ratio.

The correlation coefficients were 0.21 (p=0.03) and 0.24 (p=0.01), respectively, as depicted in Figures 1a, b.

A ROC analysis was carried out on the participants to identify the total body fat (%) cut-off value that could potentially predict the presence of alexithymia. The Area Under the Curve (AUC) has been calculated to be 0.632 with a 95% confidence interval (CI) of 0.533-0.724. The sensitivity and specificity diagnostic accuracies are 71.15% and 54.72%, respectively (Figure 2a).

A second ROC analysis was performed to assess the impact of the WHtR. It has been determined that a WHtR of greater than 0.61 is the cut-off value for identifying alexithymia. The AUC was 0.622 (with a 95% CI of 0.522-0.715), and the diagnostic accuracy was 75%. The sensitivity and specificity were both 65.51% and the results are shown in Figure 2b.

Table 4. Anthropometric measurements and body fat values of the alexithymic group by gender

	Females (n=40)	Males (n=12)	p
Trunk fat mass, kg	15.32±5.10	14.49±5.58	0.52#
Trunk fat mass, %	24.05±7.26	33.13±7.13	0.70¶
Total body fat, kg	34.89±12.22	35.25±14.52	0.99#
Total body fat, %	38.99±6.27	39.40±11.31	0.24#
Waist circumference, cm	91.33±7.51	103.13±12.58	0.74¶
WHtR	0.65±0.07	0.65±0.06	0.84¶
Hip circumference, cm	116.08±10.09	117.12±14.56	0.78¶
WHR	0.91±0.08	0.92±0.03	0.80¶

Values are reported as mean ± SD, SD: Standard deviation, WHtR: Waist-height ratio, WHR: Waist-to-hip ratio. #Mann-Whitney U test, ¶Student's t-test

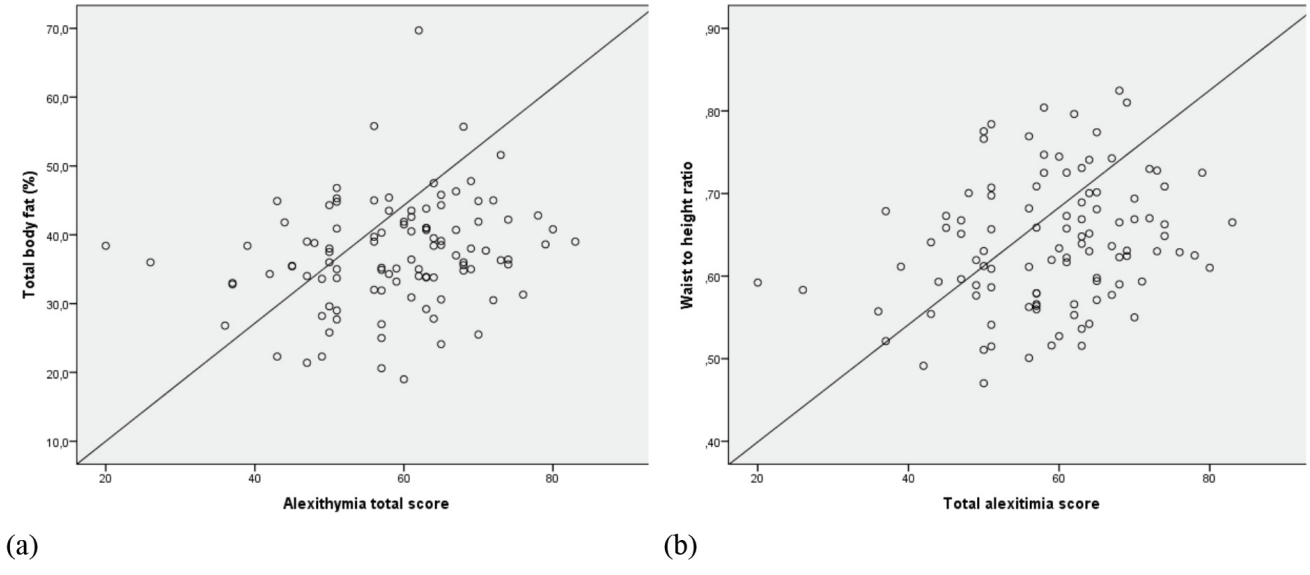

Figure 1. (a) the correlation between study population's total body fat (%) and TAS (b) the correlation between study population's waist-to-height ratio and TAS

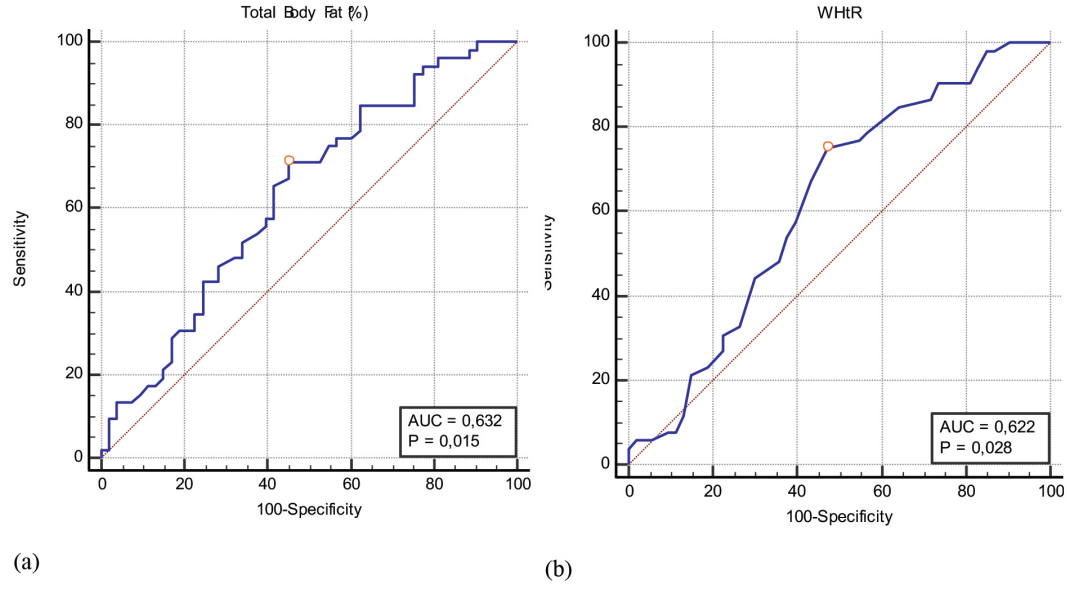

Figure 2. Receiver operating characteristic (ROC) curve of the predictive model of (a) total body fat percentage based on TAS scores (b) waist-to-height ratio based on TAS scores
TAS: Toronto Alexithymia Scale

Discussion

The findings revealed that having a BFT of more than 35.5% could suggest the existence of alexithymia. Notably, 45.2% of adolescents with OW or OB in the present study exhibited alexithymia, a rate higher than previously reported in similar populations (14). Initially, we considered that this might stem from a greater proportion of participants being obese or severely obese, unlike earlier studies where most were OW (15). However, alexithymia scores did not demonstrate a progressive increase across OB severity categories. This indicates that among adolescents whose BMI exceeds 25, the presence of alexithymia is more closely associated with body fat percentage than with BMI alone.

These results support growing concerns that BMI is insufficient as a standalone indicator of OB-related complications. Given that BMI values in children and adolescents vary by age and sex, BMI percentile values are used for classification (16). International references include the WHO (2007) and IOTF (2000; updated 2012) growth standards (17,18). However, several studies have highlighted limitations in OB classification based solely on BMI, leading to the adoption of complementary measures such as WC, WHR, and WHtR (19-21). Among these, WHtR has been shown to be a less age-dependent reliable indicator of central adiposity and metabolic risk.

In our study, both body fat percentage and trunk fat percentage were significantly higher in adolescents with alexithymia, while WHtR emerged as a more effective anthropometric predictor than other indices.

Prior studies have linked elevated visceral fat to psychiatric symptoms such as anxiety and depression (22,23), possibly via increased cytokine production (24) and chronic activation of the hypothalamic-pituitary-adrenal axis (25). Some literature suggests a potential association between visceral fat and alexithymia, though the relationship remains complex and causality is yet to be clearly established (26). Alexithymia may, in turn, exacerbate OB-related mental health vulnerabilities by impairing body perception and emotion regulation (5,10).

Incorporating WHtR into clinical screening for alexithymia in OW/obese adolescents may offer practical benefits, particularly in endocrinology clinics where psychiatric assessments are not routinely conducted. Identifying alexithymia through anthropometric indicators could facilitate earlier psychological referral and intervention.

Gender also emerged as a significant factor in alexithymia prevalence, with a higher proportion of female adolescents affected-contrary to general population trends that associate alexithymia more frequently with males (27). Previous findings in adolescents have been inconsistent, with some studies reporting higher rates among females (28) and others showing no gender difference. One study specifically reported a higher prevalence of alexithymic traits in girls with abdominal OB (29), aligning with our findings of a female predominance in the severely obese subgroup.

Additionally, research from Türkiye supports the notion that alexithymia in adolescents is associated with various psychopathological indicators. Studies have shown that alexithymia is linked to high levels of anxiety and is mediated by thought-action fusion (30). It increases the risk of being subjected to peer bullying when combined with behavioral problems (31). It may serve as a risk factor for somatization (32). Moreover, problematic social media use is positively correlated with alexithymia in this age group (33), and adolescents with conversion disorder in the form of psychogenic seizures show elevated alexithymia and lower self-esteem levels (34). These findings collectively underscore the critical role of alexithymia as a comorbid vulnerability in adolescent mental health, particularly in populations with OB.

Despite exploring a range of laboratory parameters, including HOMA-IR, serum lipid profiles, and transaminases, our study did not

detect significant associations with alexithymia. This suggests that alexithymia may precede metabolic dysfunctions or represent a parallel psychosomatic process rather than a downstream effect.

Study Limitations

The results should be interpreted in the context of several limitations. The fact that the study was conducted on patients who applied to the hospital limits the generalizability of the results to the broader society. However, considering that patients with OB who apply to the hospital may be more likely to need help than those who do not, it is important to allocate resources accordingly. This hypothesis is further supported by the lower number of patients with OW in the study. Yet we believe that our study will enhance the subject matter and open new avenues for future research by introducing a unique perspective to the existing literature. It's crucial to recognize the limitations of the study's design. While it provides valuable statistical data, it doesn't allow us to establish causality with certainty. A prospective design would have offered even more insightful information. Another limitation is the lack of clinical assessment for alexithymia, as it was solely measured through a self-report scale, which could have potentially induced bias in the results. However, the TAS-20 scale is the most widely used and dependable tool for identifying and defining alexithymia (13).

Conclusion

The current study highlights that body fat percentage may be a valuable tool for identifying alexithymia in adolescents with OW and OB. Moreover, being female and having a higher WHtR may also play an instrumental role in this connection.

Ethics

Ethics Committee Approval: The study was reviewed by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, Bursa Yüksek İhtisas Training and Research Hospital (approval no: 2011-KAEK-25 2023/02-14, date: 22.02.2023) and was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Informed Consent: Both verbal and written informed consent was collected from all participants and their parents.

Footnotes

Authorship Contributions: Concept - N.K.; Design - N.K.; Data Collection or Processing - M.E.U., Ö.K.; Analysis or Interpretation – N.K., H.Ş., Ö.K.; Literature Search - N.K., H.Ş.; Writing – N.K., H.Ş., M.E.U.

Conflict of Interest: No conflict of interest was declared by the authors.

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