Obese adolescents have reduced mentalizing ability

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Abstract

**Purpose:** Obesity affects both mental health and the quality of life, and it also causes diseases associated with increased mortality. The aetiology of obesity is thought to be multifactorial with biological, psychological and social elements. The psychological realm includes the capacity to be aware of one’s own and others’ mental states, that is mentalizing. We hypothesized that poor mentalizing might contribute to the development and/or persistence of obesity among adolescents. The present study aims to investigate the components of the mentalization model to better identify the psychological status of obese adolescents.

**Methods:** This study was carried out on 100 adolescent girls aged 15 to 19 years who were either obese (N=50, Mean age=17.04, Mean BMI=30.24) or normal weight (N=50, Mean age=16.94, Mean BMI=20.95). All completed the reflective functioning questionnaire (RFQ), reading the mind in the eyes test (RMET), difficulties in emotional regulation scale (DERS), and Toronto alexithymia scale (TAS).

**Results:** Multivariate analysis of variance, univariate analysis of variance, and independent t-test were used. Lower certainty and higher uncertainty on the RFQ were confirmed in the OB group indicating reduced mentalizing ability. Misperception and misinterpretation of emotional states conveyed in the eyes in the RMET were consistent the RFQ results. Alexithymia, including difficulty recognizing, expressing and reflecting on emotions, was also found and this also fits with poor mentalizing capacity. The OB group had difficulty in all components of DERS, apart from the “Strategies” subscale.

**Conclusion:** Mentalization or reflective function is significantly poorer in obese, compared to normal weight adolescents. Poor mentalizing could be a cause of obesity, a factor leading to its
persistence, or a consequence of obesity. Further research is required to differentiate these possibilities.

**Level of evidence** Level III: case-control analytic study.

**Keywords**: Obesity, Mentalization, Reflective functioning, Adolescents

1. **Introduction**

   According to the World Health Organization (WHO), while less than 1% of children and adolescents aged 5 to 19 worldwide were obese in 1975, the figure increased to 6% in girls and 8% in boys in 2016 [1]. Obesity in Iran is even more prevalent, and in 2016 its prevalence in Iranian girls and boys aged 5 to 19 years was reported to be 8.7% and 10.8% in 2016, respectively [2], while in 1980, Iranian girls aged 2-4 years had the lowest prevalence of obesity in the Middle East, 1.66%. [3].

   Considering that adolescence is a period with a high level of vulnerability to the onset of various mental health problems [4], including eating disorders (EDs) [5], and the fact that adolescents face multiple tasks such as identity development, independence from attachment figures, intimate relationships, and moderation of sexual impulses [4, 6-7], obesity during this period can lead to many psychological difficulties including low self-esteem, negative body image, experience of peer labeling, depression and anxiety, ED, attention deficit hyperactivity disorder, Internet addiction, social isolation, cognitive difficulties, and in some cases, suicidal preoccupation [8-13].

   Approximately, 80% of obese adolescents will become obese adults [14], which increases the risk of developing physical ailments such as diabetes [15], heart problems, cancer [16-17],
hypertension, and hyperlipidemia, respiratory difficulties, fatty liver disease [18], sleep problems [19-20], chronic pain [21] and chronic fatigue syndrome in adolescence [22].

Obesity is often associated with eating disorders, especially Binge Eating Disorder (BED) [23-24]. ED Symptoms, such as unhealthy weight control behaviors including self-induced vomiting, misuse of laxatives, restriction of food intake, and fasting, are more common among obese people than in the general population [9, 25]. These behaviors are common among adolescent [26] and can lead to restrictive food intake disorder and BED [24, 27]. Many authors have considered unhealthy eating behavior as an attempt to regulate negative emotions and have confirmed the association between unhealthy eating behaviors and emotional dysregulation [28-32]. People with emotional dysregulation appear to use eating behaviors to compensate for their inability to employ effective situational processing strategies or to deter and avoid negative emotions [33]. Thus, it is not the level or frequency of negative emotions, but the emotional dysregulation and responsiveness of the individual that may lead to the formation of external and emotional eating behaviors [34]. There is, indeed, qualitative and quantitative evidence that emotional dysregulation is associated with the development of disordered eating [35-36].

Although many studies have emphasized the role of emotional dysregulation in obesity [29-32, 37], there is no comprehensive and clear picture of how this might develop. Some obesity prevention programs have failed to prevent future obesity in participants, despite improving their ability to regulate their emotions [e.g., 38]. Therefore, it can be concluded that it would be simplistic to merely focus on eliminating emotional dysregulation to prevent obesity. However, investigating emotional dysregulation in obesity seems likely to be useful given that it appears to have a role in EDs, and that some types of EDs, principally Binge Eating Disorder, are associated with obesity.
Mentalization, as an affect-focus theoretical model, which is thought to be relevant in the development and persistence of EDs and has been found to be useful in treatment [e.g., 39-40], refers to a person's capacity to perceive and interpret the behaviors of themselves and others based on mental states that underlie these behaviors [39, 41]. Mentalization enables people not only to respond effectively to social stress stimuli, but also to achieve a better understanding of their own emotions, thoughts, and needs, and to achieve effective self-regulation as a whole [42]. By integrating knowledge from different areas such as evolutionary psychology, attachment, theory of mind, and neuroscience, mentalization provides a new model for understanding behaviors in general and psychological difficulties in particular [39]. The importance of mentalization in achieving self-regulation, emotional regulation, impulse control, and agency [43] is exemplified in disorders associated with impaired mentalization, such as antisocial and borderline personality disorders, depression, EDs, substance abuse, and other conditions associated with poor impulse control such as food addiction and gambling [41, 44-45]. The ability to self-regulate is dependent on the healthy development of mentalization [46] (or reflective function in an operational sense). A large amount of evidence indicates the existence of an inverse relationship between the activity of neural infrastructures of the attachment system, emotional regulation, and the activity of the arousal system [e.g., 41]. Attachment and mentalization are thought to be related in that poor mentalizing may be associated with disturbed attachment patterns [47-48]. Moreover, mentalization is thought to be impaired under the influence of emotional arousal [41]. Although reflective function (RF), a highly complex mental process, is acquired after the ability to regulate emotions, these two abilities are considered to be evolutionarily interrelated [49]. Moreover, the ability to reflect on mental states enables one to communicate with their emotions in new ways [50].
In addition to predicting the development of ED symptoms [42, 51], degree of mentalization has been associated with the formation of physical complaints and somatization [48, 52, 53] that have been identified as potential core predictors of obesity [54-56]. Numerous studies have confirmed the existence of insecure attachment and impaired RF in people with EDs [50, 57-58]. The prevalence of insecure attachment among obese patients is also reported to be higher than the general population [59-60]. However, few studies have focused on the RF of obese patients. It was suggested in one study [56] that obese patients appeared to have difficulty in reflecting on their conditions or identifying the obesity-induced impacts on their personal and social adjustment, and it was hypothesized that the capacity of obese individuals to self-monitor might be impaired owing to low reflective function [56]. Impaired mothers’ RF was also predictive of children's obesity [61-62]. In one study [63] overweight women both with and without BED showed reduced reflective function, while other studies have studied RF in obesity associated with EDs, and the study of RF among the non-Eating Disordered obese population is a neglected area of research.

Various instruments are used to measure mentalization and this is a reflection of the complexity and breadth of the concept. It is important to have the least overlap between the instruments, and simultaneously, ensure maximum coverage of mentalization dimensions. Scales used to assess the RF of patients with EDs in a research project conducted at the Institute for Eating Disorders at the University Hospital Oslo in Norway [39], were also used to evaluated the RF of obese patients in the present study. The aim of this study was to investigate mentalization in obesity in order to increase understanding of the association between the two and develop hypotheses about the direction of causation of abnormal findings in obese adolescents.

The reflective function questionnaire, the RFQ, [64] provides scores to assess the degree of mentalization (hyper-mentalizing and hypo-mentalizing) with two subscales, i.e., Certainty
(RFQc) and Uncertainty (RFQu). The certainty subscale is related to secure attachment and shows a person's level of confidence in mentalizing (shows the extent to which an individual is certain about mental states). However, a high score can be illustrative of unrealistic and non-evidence-based amounts of confidence about mental states. Uncertainty reflects an individual's inability to consider mental-state patterns which are complex and internal (uncertainty about mental states), taking precedence over certainty in predicting pathologies [64-65]. EDs were associated with lower certainty scores and higher uncertainty scores, and this difference increase in participants who also self-harmed [65]. Accordingly, in the present study, the OB group is expected to show lower certainty and higher uncertainty scores than the NW group. Considering the negative correlation between certainty and alexithymia and the positive correlation between uncertainty and alexithymia [66-67], the OB group is expected to show higher levels of alexithymia compared to the NW group. Another reason for this expectation is that obese people show more tendency towards external signals (food appearance) compared to internal ones (being hungry) [68], indicating a lack of self-reflection on their emotions. A range of studies have confirmed the presence of alexithymia among obese patients [e.g., 69], although there is substantial variation in which alexithymia subscales are affected in obesity. Patients with EDs show limited ability to identify and process facial emotions [70] and experience difficulty showing empathy which requires understanding the emotional state in others [71]. There are similarities between the cognitive dysfunction in EDs and obesity [72]. Hence, we expect the obese participants to demonstrate poor performance in demonstrating theory of mind. DERS, as one of the main instruments in the evaluating emotion regulation, part of this broad concept, has previously been used in obese groups, with various explanations being proposed for the differences in its subscales [e.g., 32]. However, the overall difficulty in emotion regulation is expected to be higher in the
obese group than the normal weight group. The present study, the first to aim at investigating the mentalization among obese people, expects them to have more difficulty than controls in components of mentalizing.

2. Materials and Methods

2.1. Participant & Procedure

This was a causal-comparative study. Among all girl's secondary high school in Tehran, 10 high schools were selected by the use of Convenience Sampling. Eligibility criteria included girls aged 15-19 years of age, providing written consent from one of their parents and themselves, BMI percentile according to growth reference data approved by WHO [73] 25th-75th BMI values for the Normal Weight (NW) group and BMI values >95th percentile for the Obese (OB) group [74-75].

Table 1 Characteristics of NW and OB groups

| Variables  | Normal weight | Obese          |
|------------|---------------|----------------|
|            | Total (n=50)  | Total (n=50)   |
|            | Mean          | Mean           |
|            | SD            | SD             |
| Age (months) | 203.38        | 204.46         |
|            | 13.63         | 13.51          |
| Weight (Kg)  | 57.29         | 81.98          |
|            | 6.50          | 9.64           |
| BMI (kg/m²) | 20.95         | 30.24          |
|            | 1.23          | 2.35           |
In order to determine the number of participants a power calculation was performed (G*Power ver. 3.0.10) (considering type I error=0.05, having two groups, effect size $f^2=0.20$, test power= 0.80, and 12 dependent variables for multivariate analysis of variance), the sample size was estimated to be a total of 98 people which is greater than usually recommended (30) for this type of study [76]. After obtaining the necessary permits from the Ministry of education in Iran, Tehran, due to the limitations caused by the COVID-19 pandemic, the sampling was conducted online. Participants were asked to express their consent and that of their parents to participate in the study, and report their exact date of birth, weight, and height, and then complete the questionnaires. Out of 184 participants in the study, after applying the exclusion criteria, including incomplete questionnaires, or absence of an accurate report of the month and year of birth or weight and height, and using words such as "Do Not know" or "Approximately", 50 people were placed in the OB group (mean BMI=30.24; mean age=17.04 years) and 50 people in the NW group.

![BMI distributions of NW and OB groups](image-url)
(mean BMI=20.95; mean age=16.94 years). Ethical approval was obtained from the Ethics Committee of Shahid Beheshti University (ID IR.SBU.REC.1399.022.)

2.2 Definitions and Measures

Obesity was defined using gender specific percentile charts [73]. Utilizing the BMI formula (Kg/m2) and matching the number with the WHO table [73], the weight range of each person was identified and individuals were placed in NW (25th<BMI<75th percentile) and OB groups (>95th percentile) [74-75]. By choosing the second half of adolescence (15-19), an attempt was made to limit the range of the various psychological characteristics observed across the whole of adolescence [77].

**Reflective Function:** The Reflective functioning questionnaire (RFQ) is an 8-item questionnaire that measures mentalization using two subscales of certainty and uncertainty, based on a 7-point Likert (1 = Strongly disagree; 7 = Strongly agree) and reports scores between 0 and 3 [65]. Certainty refers to the construction of complex mental patterns from the minds of oneself and others and one's high confidence in what one knows (Strong disagreement = hyper-mentalizing or high certainty). A person's confidence is measured by how strongly one opposes propositions (agreement to any degree or a neutral response reflects more genuine mentalizing). Little agreement with propositions indicates hyper-mentalization and more frequent agreement with genuine mentalization means being aware that one hundred percent clarity of mind is impossible (acknowledging the opaqueness of mental states). Uncertainty indicates the difficulty of considering the inner world and is assessed by the degree to which one agrees with the propositions. A very high score indicates a lack of awareness of internal mental state (hypo-
mentalizing) and a low score indicates a proper mentalization. Each subscale is scored in 7 propositions and has no scoring in 4 propositions (4 to 7 in certainty; 1 to 4 in uncertainty), which indicates that each subscale has three scoring levels. Cronbach's alpha, internal consistency, and retest reliability of uncertainty and certainty is equal to 0.77, 0.75, 0.36, 0.35, and $r=0.88$, $r=0.81$, respectively [67]. In the Persian version of the questionnaire Cronbach's alpha for RFQc and RFQu respectively was 0.88 and 0.66 [78]. In the present study, Cronbach's alpha for certainty and uncertainty was 0.661 and 0.668, respectively. (It should be noted that RFQ-8 was the only standardized questionnaire to measure reflective function in Iran at the time of this study).

**Alexithymia:** The Toronto Alexithymia Scale (TAS) is a 20-item self-assessment scale that measures 3 subscales based on a five-point Likert (1 = Strongly disagree; 5 = Strongly agree). Difficulty identifying feelings (DIF) evaluates the ability to identify emotions and distinguish them from bodily senses. Difficulty describing feelings (DDF) examines the ability to express feelings in words. Externally oriented thinking (EOT) examines one's reflection on emotional experiences. This scale is scored as follows: scores $>60$, $<52$, and 52-60 indicate alexithymia, no alexithymia, and mild alexithymia or possible alexithymia. In the Persian version of the questionnaire Cronbach's alpha for overall alexithymia, DIF, DDF and EOT was reported 0.85 ,0.82, 0.75 and 0.72 respectively which shows a high internal consistency [79]. In the present study, Cronbach's alpha for DIF, DDF, and EOT, overall alexithymia was 0.795, 0.725, 0.616, and 0.823, respectively.

**Reading the Mind in the Eyes Test:** RMET is a psychological criterion of theory of mind that includes 36 images of people's eyes and eyebrows in different emotional states. The respondent must choose the option that best describes the mental state of the person in the picture. The possible score range is 0 to 36, with scores $<22$, 22-30, and $>30$ indicating low, moderate, and
high ability in theory of mind. In the Persian version of this questionnaire Cronbach's alpha was reported 0.72 [80], and Cronbach's alpha in the present study was 0.641.

**Difficulties in emotional regulation scale:** DERS is a 36-item instrument that assesses impairment in emotional regulation based on a five-point Likert (1 = Almost never; 5 = Almost always) with 6 subscales. Non-acceptance of negative emotions or (non-acceptance); tendency to a secondary response or lack of response to distress, difficulties engaging in goal-directed behaviors (goals); difficulty concentrating and completing a task when experiencing negative emotions, difficulty controlling impulsive behaviors (impulse); difficulty controlling behavior when experiencing negative emotions, lack of emotional awareness (awareness); ability to pay attention and recognize emotions, lack of emotional clarity (clarity); awareness and clarity of emotions, limited access to effective emotion regulation strategies (strategies); reflect the belief that there are few measures to emotional regulation when experiencing distress. A high score indicates more difficulty in emotion regulation. In the Persian version of this questionnaire Cronbach's alpha for non-acceptance 0.73-0.88, goals 0.72-0.89, impulse 0.75-0.90, strategies 0.76-0.85, awareness 0.72-0.86, clarity 0.77-0.90 and for overall difficulty in total emotion regulation was reported 0.79-0.92 [81]. In the present study, Cronbach's alpha was obtained 0.848, 0.515, 0.527, 0.699, 0.860, 0.836, and 0.914 for non-acceptance, goals, impulse, strategies, awareness, clarity, and overall difficulty in total emotion regulation, respectively.

**Data Analysis**

Data analysis was carried out using MANOVA, ANOVA, and independent samples t-test in SPSS ver. 21. Initially, the independent samples t-test was used to ensure the homogeneity between the two groups in terms of age (P = 0.692 and t = 0.398). Afterwards, the Kolmogorov-Smirnov test was used to check the normality of the variables (P> 0.05) and Levene's test was used...
to check the homogeneity of variances. Despite the significance of Levene's test for some variables, when the assumption of homogeneity of variances (in the case of equal group sizes and obtaining number 10 when dividing the larger variance by smaller variance) [82] is met, the reliability of the results of ANOVA was confirmed. The homogeneity of the variance and covariance matrices was investigated using the Box’s M test. Pillai's Trace values were used in RFQ, TAS and DERS analysis, and the independent t-test was used in RMET analysis, considering the existence of a dependent variable and an independent variable with two levels in RMET. P-value <0.05 was considered as the significance level.

Results

A total of 100 girls aged 15 to 19 in secondary high school in Tehran who participated in the study were divided into two groups based on BMI calculation; NW (25th<BMI<75th percentiles) and OB (95th<BMI). There was no significant difference between the two groups in terms of age (P = 0.692 and t = 0.398).

Reflective function

The results show a significant difference between the two groups in terms of RF ($\eta^2$ = 0.234, P <0.05, and F = 14.826). ANOVA reported significant differences between groups in term of certainty ($\eta^2$ = 0.198, P <0.05, and F = 24/120) and uncertainty ($\eta^2$ = 0.176, P <0.05, and F = 20.933). Thus, the OB group shows a lower certainty rate and a higher uncertainty rate compared to those of the NW group.

Alexithymia

There is a significant difference between the two groups in terms of TAS scores ($\eta^2$ = 0.288, P <0.05, and F = 12.919). ANOVA results show a significant difference between the two
groups in terms of DIF ($\eta^2 = 0.223$, $P < 0.05$, and $F = 28.109$), DDF ($\eta^2 = 0.095$, $P < 0.05$, and $F = 10.334$), and EOT subscales ($\eta^2 = 0.194$, $P < 0.05$, and $F = 23.569$) and the OB group showed more difficulty in all three components of alexithymia than the NW group.

**Reading the Mind in the Eyes Test**

The results of independent t-test indicate a significant difference between the two groups in terms of theory of mind ($P < 0.05$ and $t = -5.476$) and NW group outperformed the OB group.

**Difficulty in emotion regulation**

The results showed a significant difference between the two groups in terms of difficulty in regulating emotion scores ($\eta^2 = 0.218$, $P < 0.05$, and $F = 4.327$). The OB group showed a high level of difficulty in the subscales of non-acceptance ($\eta^2 = 0.105$, $P < 0.05$ and $F = 11.527$), goals ($\eta^2 = 0.134$, $P < 0.05$, and $F = 15.138$), impulse ($\eta^2 = 0.076$, $P < 0.05$, and $F = 8.138$), awareness ($\eta^2 = 0.140$, $P < 0.05$, and $F = 16.009$) and clarity ($\eta^2 = 0.140$, $P < 0.05$ and $F = 15.914$), but there was no significance difference between the two groups in terms of strategies subscale ($P > 0.05$).

**Table 2** Participant scores on RFQ, DERS, TAS-20 and RMET.

| Dependent variables | Obese (n=50) | Normal weight (n=50) | F     | P       | $\eta^2$ |
|---------------------|--------------|----------------------|-------|---------|----------|
|                     | Mean SD      | Mean SD              |       |         |          |
| RFQ                 | 0.67 0.54    | 1.23 0.60            | 24.120| 0.001   | 0.198    |
| RFQc                |              |                      |       |         |          |
| RFQu                | 1.05 0.66    | 0.55 0.39            | 20.933| 0.001   | 0.176    |
| DERS Non-acceptance | 17.62 5.31   | 13.82 5.87           | 11.527| 0.001   | 0.105    |
| Goals               | 17.56 3.42   | 14.92 3.37           | 15.138| 0.001   | 0.134    |
| Test                                | Mean | SD   | Median | 95% CI Lower | 95% CI Upper | p-value | Effect Size |
|-------------------------------------|------|------|--------|--------------|--------------|---------|-------------|
| Impulse                            | 17.54| 3.18 | 15.44  | 8.095        | 0.005        | 0.076   |             |
| Strategies                          | 16.90| 4.69 | 15.48  | 3.79         | 0.099        | 0.027   |             |
| Awareness                           | 22.54| 5.86 | 17.80  | 16.009       | 0.001        | 0.140   |             |
| Clarity                             | 13.76| 4.00 | 10.64  | 15.914       | 0.001        | 0.140   |             |
| TAS-20 Difficulty Identifying Feeling (DIF) | 24.44| 4.64 | 19.14  | 28.109       | 0.001        | 0.223   |             |
| TAS-20 Difficulty Describing Feeling (DDF) | 16.08| 3.19 | 13.50  | 10.334       | 0.002        | 0.095   |             |
| TAS-20 Externally Oriented Thinking (EOT) | 24.82| 5.63 | 20.10  | 23.569       | 0.001        | 0.194   |             |
| RMET                               | 17.04| 4.60 | 21.48  | 3.42         | 0.001        |         |             |

(a) [Bar chart showing scores for certainty and uncertainty]

(b) [Bar chart showing scores for different tests]
Discussion

The aim of the present study was to explore the psychopathology of obesity using the mentalizing model and the findings showed differences in psychological status of adolescents with and without obesity in terms of the components of mentalization.

The mentalizing model, as a relevant model in describing the psychopathology and guiding the treatment of EDs [e.g., 39, 83-85], was selected based on the similarities between this category of disorders and obesity. Similarities such as emotional dysregulation, unhealthy weight control behaviors, common risk factors, similar neurological vulnerabilities, executive dysfunctions, widespread insecure attachment, and reports of obesity as a disease which is frequently observed before, during and after some forms of ED [23, 25, 72, 86].

The reason behind choosing the young female population was because schools are single sex in Iran, although an equivalent study in boys would be of great interest.

In the present study, as expected, Certainty, which indicates a tendency to scrutinize the mental states of oneself and others, was indicated to be lower in the OB group than the NW group,
indicating that the OB individuals, in addition to having difficulty constructing complex mental patterns from their minds and others, are less confident in what is going on in their internal and external worlds, and behave in a way that shows uncertainty about what they might know. The higher Uncertainty score in the OB group indicates that they have difficulty considering their mental states and those of others. Therefore, they are more likely to perceive and interpret their internal (emotional) and the external (physical) worlds as being equivalent without any curiosity about what is truly happening. In other words, when a person is not efficient enough in considering their own mind and what is happening in their own mental state, they may concentrate on the body and what can be seen as the physical center of their experience. This finding may be reflected in the increased somatization found in obese subjects [56]. They are more likely to see no distinction between the contents of the mind and the external world and through projection make the world predictable and meaningful (they consider their thoughts as equal to reality). The lower certainty and higher uncertainty scores among people with ED [64-65], and an impaired RF among overweight women reported in previous studies [63] are consistent with the results of the present study. A history of maternal rejection is significantly correlated with emotional eating and maladaptive emotional regulation strategies among obese adolescent girls and boys [87]. Impaired RF has been linked to difficulties in attachment relationships [49] and our results add to the evidence that impaired mentalizing may be rooted in primary attachment-based relationships and may led to eating and weight problems.

Considering the association of alexithymia with the symptoms of EDs [88], we expected it to be more pronounced in obese participants, and this proved the case. Numerous studies have confirmed alexithymia among obese people [e.g., 69]. However, some studies have attributed this difficulty to low education or lower IQ among obese subjects [89]. There is disagreement as to
whether or not alexithymia should be considered as a consistent personality trait unrelated to appearance [90]. However, it has been confirmed as a predictor of emotional eating among people with BED under stressful emotional situations. Many studies report reduced scores on all three subscales of alexithymia among obese patients, while others consider impairment only in Difficulty identifying feelings and Externally oriented thinking but not Difficulty describing feelings [33]. The present study reveals consistency between the difficulty of OB adolescents in all three components of alexithymia, including the reduced ability to separate emotional experience from bodily feelings, inadequate ability to communicate emotions or reflecting on them, with the results of RFQ, suggesting a reduced capacity to explore, and reflect on their internal mental state and uncertainty about what is happening in their immediate environment. This difficulty can lead to projection of the inner feelings onto bodily senses which overshadow the person's behavior and interactions. Alternatively, it may lead to emotional dysregulation and isolation. While examining the relationship between alexithymia and obesity, interpersonal dependence has been proposed as the main predictor of alexithymia [91], which can be equated with an impaired RF and the need for an "other" to gain confidence and find meaning for events. Numerous studies have demonstrated an association between low certainty and high uncertainty with alexithymia [e.g., 66-67], which is consistent with the results of the present study. This state will disrupt personal well-being as long as they are not able to find meaning in/for the internal mental state for themselves and others by considering the underlying wishes, desires, needs, feelings, thoughts, and intentions.

With regards to RMET, which examines a person's ability to perceive mood states in others, the OB group's lower scores indicates that they had difficulty considering other people's minds and external cues that are consistent with the aforementioned RF result. This inefficiency can lead to
the misinterpretation of received stimuli and misperception of external signs, in particular facial and physical manifestations in others, and affect their perception of others and events. Therefore, obese individuals appear to have difficulty in their attempts to give meaning to their surrounding world, and consequently, their interpersonal relationships may affect and this could cause tension. The resulting emotional arousal also profoundly impacts RF [92]. One study reported that the impaired theory of mind and emotion recognition in obese patients are similar to those in patients with obesity associated with BED [93], which suggests that BED did not alter TOM and emotion recognition in obesity. The findings of the present study are not only consistent with the forenamed study, but also with studies that have reported limitations in identifying and processing facial emotions in ED [39, 70].

Difficulty in emotion regulation is associated with psychological problems such as depression, anxiety, EDs, alcohol abuse, drug abuse, and suicidal ideation [94]. The difficulty in emotional regulation contributes to the persistence of emotional over-eating and to the etiology of obesity [32] as its subscales have been shown to correlate with eating behaviors [95]. In the present study, the OB group showed higher difficulty than the NW group in all subscales except for limited access to emotional regulation strategies. This subscale has shown a significant difference between obese adults and normal weight adults [94-95], but the lack of such a difference in adolescents in the present study can be attributed to the fact that there is no significant difference between adolescents with and without obesity in terms of choice of and access to emotional regulation strategies perhaps due to limited experience and cognitive processes. However, there is a growing range of differences between individuals with increasing age, experience, and cognitive development. The difficulty in sustaining attention, which is associated with an impaired mentalization [96], is manifested by the subscale of Goals, which indicates difficulty in
concentrating and completing tasks. The subscales of *Emotional awareness and clarity*, which indicate a person's difficulty in recognizing and being aware of emotions, are consistent with the results obtained from alexithymia and RF. The subscale of *Non-acceptance*, i.e., reluctance or inability to reflect upon the internal mental state, demonstrates reduced mentalization. Some studies reported that obese women and girls have more difficulty in *Clarity, Goals, and Strategies* subscales than men and boys [95]. Negative emotional experiences are thought to trigger eating behaviors in obese subjects with but not without BED [31], but the association of obesity with reduced mentalizing and impaired emotion regulation can be confirmed.

**Strength and Limitations**

The present study is the first that examines mentalization with the aim of studying the mental state of an obese population. While enriching the mentalization model in the field of obesity pathology, this study has also considered the relationship of mentalization with pathologies beyond the Diagnostic and Statistical Manual of Mental Disorders (DSM) in a non-clinical population. While providing consistent findings with the findings of previous studies, the present study also suffered a number of limitations caused by COVID-19 pandemic, eliminating the chance to assess height and weight by research team in person. Furthermore, the study had to focus only on the female population. Nonetheless, according to the available evidence, showing the superiority of girls over boys in terms of RF, boys are expected to score lower under equal conditions. However, the findings cannot be confidently generalized to boys and they should be studied separately. As socio-economic factors and cultural in this study were confined to the Iranian context, the study should be repeated in other countries and communities with different socio-cultural foundations to arrive at comprehensive results as the results of this study may not be applicable to all. Other
components such as empathy, perspective, and mindfulness are also included under the concept of mentalization, all of which cannot be investigated in one study alone, suggesting that these components be considered in future research. Genetic and hormonal factors were not screened in either group, with only the psychological characteristics of the subjects being considered in the present study.

**What is already known on this subject?**

According to a review of the obesity research literature, the prevalence of insecure attachment among obese people has been confirmed in many studies. However, there has been no study on mentalization as a model strongly linked to attachment in obese populations. Most studies have investigated EDs or EDs associated with overweight and obesity and a few studies have reported the relationship between caregiver mentalization and high body mass in children. Concepts such as alexithymia and emotional dysregulation in obese population have also been studied separately, but there has been no coherent study which had gathered all these concepts under a specified theory.

**What your study adds?**

This study specifically aimed to examine the components of mentalization in the obese population. Also, it integrated the psychological components involved in obesity under the concept of mentalization as the origin of problem, and explained the relationship between all subscales and reflective function; thus, confirming the fact that mentalization has contributed to eating-related vulnerabilities and obesity, which could lead to the formation of new hypotheses. Therefore, the study contributes to the development of preventive strategies and more specific treatments for affected individuals.
Conclusions

This study is the first research to compare mentalization in two groups of obese and normal-weight adolescents. The results indicate a high difficulty of the OB group compared to the NW group in the components of mentalization. Considering the results of the present study and the explicit contribution of mentalization in obesity, impaired mentalization can be considered as a risk factor for obesity. Improper interpretation of the received stimuli, misperception of events or their own internal world can contribute to the development or persistence of obesity giving directions to behaviors and emotional dysregulation. However, it is still necessary to examine other variables that can be effective in this regard, such as eating behaviors among those affected by impaired mentalization. According to the results of the present study, it is recommended to develop preventive protocols as well as intervention programs for obesity based on the mentalization approach.

Declarations

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Conflict of interest: The authors declare that they have no conflict of interest.

Availability of data and material: Available upon request

Code availability: Not applicable

Authors' contributions: Not applicable

Ethical approval: All procedures involving human participants were in accordance with the ethical principles and the national norms and standards for conducting Medical Research in Iran and Ethical approval was obtained from the Ethics Committee of Shahid Beheshti University (ID IR.SBU.REC.1399.022.)
**Consent to participate:** Verbal inform consent was obtained from all individual participants included in the study, as well as a parent or guardian for each participant prior to completing the questionnaires, although we did ask for names and surnames.

**Consent for publication:** Participants declare their consent regarding publishing their weight, height and date of birth information.

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