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ORIGINAL ARTICLE

Emotion regulation, emotion recognition, and empathy in adolescents with anorexia nervosa

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Abstract

Purpose Emotional functions may play an important role in anorexia nervosa (AN). The onset of the disorder generally occurs during adolescence, which is a critical period of emotional development. However, most studies that evaluated emotional functions in AN were conducted in adult patients. The aim of this study was to evaluate emotion regulation, emotion recognition, and empathy skills in adolescent girls with AN by controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security on emotional functions.

Methods Thirty-two adolescent girls with AN and 32 healthy counterparts completed the Difficulties in Emotion Regulation Scale, the Reading the Mind in the Eyes Test, Toronto Alexithymia Scale-20, and the Child and Adolescent KA-SI Empathic Tendency Scale-Adolescent Form.

Results The results revealed that adolescents with AN were found to have more difficulties in emotion regulation, higher alexithymic tendencies, and lower empathy skills compared with the control group. However, emotion recognition was not found to be significantly different between the two groups. These results were the same when controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security except for empathy skills. Alexithymia and depressive symptoms were significantly related to emotion regulation difficulties in adolescents with AN.

Conclusions Considering the results, it seems that emotion regulation and alexithymia may play a crucial role in the development and maintenance of AN. Accordingly, it is necessary to focus on the improvement of these skills during the treatment of AN. Furthermore, interventions promoting these skills during adolescence may be preventive.

Level of evidence Level III, case–control study.

Keywords Adolescent · Anorexia nervosa · Emotion regulation · Emotion recognition · Alexithymia · Empathy

Introduction

Anorexia nervosa (AN) is associated with significant physical, psychological, and social sequelae, and increases the risk of suicidal behavior [1]. The onset of the disorder generally occurs during adolescence, and it frequently shows a chronic course [2]. However, despite current psychological interventions, the disorder has poor rates of remission and high levels of relapse [3]. Therefore, it is seen that more effective treatments are needed by revealing the underlying factors of the disorder. Expansive literature and several existing conceptual models have been proposed regarding the underlying role of emotional functioning in AN [4, 5].

Emotions are the basis of organizing and directing human cognition and behavior. The ability to regulate, recognize, understand, and express emotions in an appropriate way enables the individual to interact and communicate within

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a social context successfully, and to deal with problems efficiently. On the other side, difficulties in emotional functioning can lead to many adversities. A great number of studies have implied that difficulties in emotion regulation (ER) play a key role in the development and maintenance of different psychopathologies, such as anxiety, depression, substance use, and eating disorders (EDs) [5–7]. ER refers to modifying, monitoring, and regulating emotional reactions, especially their tense and intensive features, to achieve one's goal [8]. Lavender et al. reported that patients with AN had considerable difficulties in regulating their emotions. They suggested that AN was defined by a tendency to use more maladaptive ER skills instead of adaptive ones, such as behavioral dyscontrol during periods of emotional distress, avoidance of emotion-eliciting situations, non-acceptance and suppression of emotions, reduced emotional self-awareness, higher alexithymia, and disability of recognizing emotions in others [4]. The recent study suggested that the impact of body image in the proneness to eating psychopathology was mediated through ER difficulties such as lower levels of decentering and higher levels of experiential avoidance [9]. Finally, the existing literature is consistent regarding difficulties in the ER, especially in adult patients with AN [10–12]. There are a few studies reporting that adolescents with AN have difficulties in regulating their emotions [13, 14].

Emotion recognition is defined as the skill of recognition and interpretation of others' emotional state [15]. It is essential to develop effective interpersonal interactions and social adjustments [16]. Deficiencies in emotion recognition are associated with the socio-emotional difficulties in individuals with AN [17]. It is claimed that this skill is defective in individuals with AN and that the difficulties in emotion recognition contribute to the development and maintenance of AN [17, 18]. Although the onset of AN generally occurs during adolescence, most studies on emotion recognition in AN were conducted in adult patients [17, 19]. Moreover, the results of a few studies on emotion recognition skills in adolescents with AN are inconsistent. Zonnevylle-Bender et al. found that adolescents with AN had worse emotion recognition ability compared with healthy controls (HCs) [20]; Hatch et al. found no difference between the two groups [21], and some researchers found that adolescents with AN were slightly better than HCs [22–24]. These contradictory results suggest that more research is needed on emotion recognition in adolescents with AN. It is also essential to identify and describe feelings as well as recognize the importance of emotion recognition for effective interpersonal interactions [25]. Therefore, the evaluation of alexithymia, which can be defined as difficulty in consciously experiencing, identifying, and describing emotions, seems to be vital because it may help to understand emotional functions in AN [26, 27]. Patients with AN are more alexithymic [4, 27] and have greater difficulties in identifying and describing their feelings than HCs [22, 27].

Empathy is another critical emotional skill that affects socio-emotional functioning and psychological well-being. The two main components of empathy are described as sharing the emotional states (emotional empathy, EE) and understanding the perspective (cognitive empathy, CE) of others. Patients with AN are reported to have difficulties in empathy skills [28–30]. However, most studies have overlooked the relationships between ER and other emotional functions, including empathy skills, in adolescents with AN.

The presence of depression and anxiety symptoms [6, 7], attachment insecurity, and traumatic experiences in childhood [31, 32] affects ER and other emotional functions. Therefore, it is crucial to control these confounding variables when evaluating the emotional functions of patients with AN. However, no studies were found to have explored the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security on these emotional functions in this patient group.

An increasing number of studies in the literature have focussed on emotional processes in AN. Nevertheless, most assessments of emotional functions were conducted in adult patients with AN. Although much attention has been devoted to ER in individuals with AN, little is known about the interrelationships among ER and other emotional functions such as emotion recognition and empathy. In light of current knowledge, we could not find any studies that investigated the interrelationships among ER, recognition of emotional states, alexithymia, and empathy skills in adolescents with AN. Therefore, this study aimed to evaluate ER, emotion recognition, alexithymia, and empathy skills in adolescent girls with AN after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security. We also aimed to investigate the relationships between these assessed areas of emotional functioning. We hypothesized: that adolescents with AN would report greater difficulties in ER, emotion recognition, identifying and describing feelings, and empathy skills than HCs; that the difficulties in the ER would be significantly associated with these variables; that depression and anxiety symptoms, childhood traumatic experiences and attachment insecurity would be more frequent in adolescents with AN than in HCs; and that the emotional difficulties would continue when the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security on these functions were controlled, because we think that emotional difficulties are related to AN.

Methods

Participants

A total of 64 adolescent girls aged 12–18 years were included in the study. The AN group consisted of 32 female patients. The adolescents in the AN group were all outpatients of the Department of Child and Adolescent Psychiatry, Hacettepe University Children's Hospital. All patients with AN underwent a diagnostic assessment before inclusion in the study. AN was diagnosed by a clinical psychiatric evaluation based on the diagnostic and statistical manual of mental disorders, 5th (DSM-5) edition [33] diagnostic criteria for EDs. In this study, all patients were evaluated in the acute phase of the disorder. Patients who met the DSM-5 diagnostic criteria for AN, with a body mass index (BMI) < 18.5 kg/m^2, with stable vital signs and without any other indication for hospitalization at the time of the evaluation, were included in the study. The patients who needed hospitalization were included in the study at their first psychiatric visit after discharge from the hospital. The indication for hospitalization was based on the criteria recommended by the Society for Adolescent Medicine [34]. All adolescents in the study volunteered to participate at no cost. All outpatients who met the inclusion criteria were invited to join the study. There were no adolescents or parents who refused to participate in the study. Among 36 adolescent girls with the provisional diagnosis of AN, who were evaluated between June 2015 and January 2016, two patients were excluded because of the diagnosis of bulimia nervosa (BN), one patient due to an accompanying severe medical disease, and one patient did not meet the DSM-5 diagnostic criteria of AN.

The control group consisted of 32 HCs without a diagnosis or history of chronic medical illness and psychiatric symptoms or disorders who were referred to the Division of Adolescent Medicine at Hacettepe University for a general health check, and matched the AN group with respect to age, sex, and socioeconomic level. The Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL) was administered to rule out psychiatric disorders in the adolescents and parents in the control group. Among 35 adolescents who volunteered to participate in the control group, two were excluded because of a psychiatric disease diagnosed through a semi-structured clinical interview and one due to incomplete forms.

This study was conducted in the Department of Child and Adolescent Psychiatry, Hacettepe University Children's Hospital. The study protocol was approved by the Institutional Review Board of Hacettepe University. Written informed consent was obtained from both the adolescents and their parents. All subjects enrolled in the study were evaluated and physically examined at the Division of Adolescent Medicine, Department of Pediatrics, Hacettepe University Children's Hospital for medical care. The self-reported questionnaires were completed by the adolescents in both the study and control groups.

Measurements

Socio-demographic and Clinical Information Form

Socio-demographic, developmental, medical and family histories, and clinical information regarding the disorder were obtained using a form developed by the researchers.

Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL)

The K-SADS-PL is a semi-structured clinical interview for determining the present and lifetime psychopathologies of children and adolescents [35]. A reliability and validity study of K-SADS-PL for the Turkish population was conducted by Gökler et al. [36].

Eating Attitudes Test-40 (EAT-40)

EAT-40 was developed by Garner and Garfinkel to measure AN symptoms [37]. The Turkish translation of EAT-40 was developed by Savaşır and Erol [38]. In our sample, the internal reliability coefficient (Cronbach's α) value was 0.90.

Difficulties in Emotion Regulation Scale (DERS)

The DERS measures difficulties in ER. It is a 36-item scale, which was developed by Gratz and Roemer [39]. The five-point Likert-type scale assesses mood regulation in six dimensions. Scores range from 36 to 180; greater scores reflect greater difficulties in ER. The six subscales are as follows:

1. Non-acceptance: evaluates the acceptability of negative emotions.
2. Goals: related to the difficulty in engaging in a goal-directed behavior while experiencing negative emotions.
3. Impulse: evaluates the controlling of impulsive behaviors.
4. Awareness: evaluates the awareness of emotional responses.
5. Strategies: this concerns the limited access to ER strategies that are perceived as effective.
6. Clarity: related to the lack of emotional clarity.

Neumann et al. [40] demonstrated the validity and reliability of the DERS for adolescents. The Turkish version of the DERS for adolescents was validated by Sarıtaş and Gençöz [41]. The Cronbach α coefficient of the DERS in this study was found as 0.89.

Reading the Mind in the Eyes Test (RME)

The RME was designed by Baron-Cohen et al. [42, 43]. The RME has been used frequently in studies investigating the relationship between psychopathologies and social cognition. The pediatric version includes a total of 28 photos in which only the eyes are apparent. The Turkish pediatric version of the test was validated by Girli [44]. The Cronbach's α value of the RME in this study was calculated as 0.69.

Toronto Alexithymia Scale (TAS-20)

The TAS-20 was first developed as a 26-item scale to assess alexithymic features and was later revised to 20 items [45, 46]. The TAS-20 has three subscales: Difficulty Identifying Feelings (TAS-1), Difficulty Describing Feelings (TAS-2) and externally oriented thinking (TAS-3). The Turkish version of the TAS-20 was validated by Güleç et al. [47]. The Cronbach's α coefficient of the TAS-20 in this study was calculated as 0.79.

KA-SI Empathic Tendency Scale—adolescent form (KA-SI)

The KA-SI was developed by Kaya and Siyez to measure the empathic tendency of adolescents with a tool specific to the Turkish culture [48]. The KA-SI-Adolescent form consists of 17 items. Seven items measure cognitive empathy and ten items measure emotional empathy. Higher total scores indicate higher levels of empathy. The Cronbach's α coefficient of the KA-SI-Adolescent form in this study was found as 0.91.

Beck Depression Inventory (BDI)

The BDI was developed by Beck et al. [49] and measures vegetative, emotional, cognitive, and motivational symptoms of depression. It was adapted to Turkish by Hisli [50]. The Cronbach's α coefficient of the BDI in this study was calculated as 0.81.

Screen for Child Anxiety and Related Disorders (SCARED)

SCARED was developed by Birmaher et al. to screen childhood anxiety disorders in children aged between 8 and 18 years [51]. It includes a total of 41 items, which are scored between 0 and 2. A total score of 25 or higher may indicate the presence of an anxiety disorder. The Turkish adaptation, reliability and validity study of SCARED was conducted by Çakmakçı [52]. The Cronbach's α coefficient of SCARED in this study was calculated as 0.78.

Childhood Trauma Questionnaire (CTQ)

The CTQ, developed by Bernstein et al. [53], consists of 28 items presented on a five-point Likert-type scale. It includes five subdimensions related to childhood trauma i.e., sexual, physical, and emotional abuse, as well as emotional and physical neglect in childhood. The Turkish adaptation, reliability and validity study of the CTQ was conducted by Şar et al. [54]. The Cronbach's α coefficient of the CTQ in this study was calculated as 0.84.

Short Form of Inventory of Parent and Peer Attachment (IPPA)

The original scale was developed by Armsden and Greenberg and consisted of 28 items [55]. In 1992, Raja et al. developed a shorter version [56]. The IPPA includes Trust, Communication, and Alienation factors, each of which is assessed with four items. The Turkish adaptation, and validity and reliability study of the IPPA was conducted by Günaydın et al. [57]. The Cronbach's α coefficients of the IPPA in this study were found as 0.86 for the mother form and 0.82 for the father form.

Evaluation of the data and statistical analysis

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences, SPSS 23.0 software. The normality of the data was assessed using the Kolmogorov–Smirnov test and Skewness and Kurtosis statistics. Parametric tests were used in the study because all variables were normally distributed. Student's t test was used for comparing data indicated by measurements in two independent groups. The comparison of the nominal data between groups was performed using the Chi-square (χ^2) test or the Fisher's exact Chi-square test. Pearson's correlation analysis was performed to investigate the relationships between two continuous variables in the groups. Analysis of covariance (ANCOVA) was performed to analyze the main effect of an independent variable on a dependent variable. To examine the differences between the two groups in the DERS, TAS-20, and KA-SI test variables, multivariate analysis of variance (MANOVA) was conducted. A linear regression model was used to identify the factors related to the difficulties in ER. p values were expected to be less than 0.05 for statistical significance in all analyses.

Results

Sociodemographic and clinical characteristics of AN and HC groups

A total of 64 participants, consisting of 32 adolescent girls with AN and 32 HCs, were included in the study. No significant differences were found between the two groups regarding age, duration of education, and parental education levels. The socio-demographic data and the clinical characteristics of the AN group in terms of BMI, age at illness onset, duration, and subtypes of AN are presented in Table 1. The depression, anxiety, childhood traumatic experiences, and attachment security scores of the two groups are also shown in Table 1.

Results of emotion regulation, emotion recognition, alexithymia, and empathy

The AN group had significantly higher scores compared with the HCs in all subscales of the DERS, indicating more difficulty in ER, except for the awareness subscale (Table 2). The total scores of the DERS between the AN and HC groups were still significantly different after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security on ER (Table 3).

Table 2 Emotion regulation, emotion recognition, alexithymia and empathy in AN and HC groups

	AN ($n=32$)	HCs ($n=32$)	Statistics	
			Test	p value
DERS, non-acceptance	13.4 (6.0)	9.1 (3.0)		
DERS, goals	17.2 (5.3)	11.6 (4.6)	*F*: 19.56	0.000
DERS, impulse	16.1 (6.6)	10.0 (4.0)	*F*: 19.57	0.000
DERS, awareness	13.6 (4.0)	11.5 (4.5)	*F*: 3.82	N/S
DERS, strategies	21.7 (9.0)	12.4 (4.6)	*F*: 26.73	0.000
DERS, clarity	13.9 (4.8)	10.1 (4.0)	*F*: 11.10	0.001
DERS, total	94.6 (28.0)	66.0 (17.1)	*F*: 25.83	0.000
RME	21.1 (2.9)	22.2 (2.0)	*t*: -1.82	N/S
TAS-20, TAS-1	18.6 (6.8)	12.5 (3.7)	*F*: 19.66	0.000
TAS-20, TAS-2	14.1 (3.8)	10.4 (3.1)	*F*: 17.76	0.000
TAS-20, TAS-3	20.5 (4.3)	19.4 (4.3)	*F*: 1.08	N/S
TAS-20, total	52.9 (11.3)	42.3 (8.4)	*F*: 17.83	0.000
KA-SI, EE	28.8 (7.5)	32.5 (4.5)	*F*: 6.19	0.015
KA-SI, CE	21.6 (4.9)	24.1 (2.8)	*F*: 8.87	0.004
KA-SI, total	49.7 (10.8)	56.3 (6.1)	*F*: 8.20	0.006

Data are represented as means and standard deviations

F multiple variance analysis (MANOVA), *AN* anorexia nervosa, *HCs*: healthy controls, *N/S* non-significant, *DERS* difficulties in emotion regulation scale, *RME*: reading the mind in the eyes test, *TAS-20* toronto alexithymia scale-20, *TAS-1* identifying feelings, *TAS-2* describing feelings, *TAS-3* externally oriented thinking, *KA-SI, EE* KA-SI empathic tendency scale, emotional empathy, *KA-SI, CE* KA-SI empathic tendency scale, cognitive empathy

Table 1 Socio-demographical and clinical characteristics of AN and HC groups

	AN ($n=32$)	HCs ($n=32$)	Statistics	
			Test	p value
Age, years	15.2 (1.6)	15.2 (1.7)		
Education level, years	9.7 (1.7)	9.6 (1.7)	*t*: 0.14	N/S
Maternal education, years	10.9 (5.1)	9.6 (4.3)	*t*: 1.80	N/S
Paternal education, years	11.5 (4.5)	12.3 (3.2)	*t*: 1.11	N/S
EAT-40	44.4 (18.4)	16.9 (5.2)	*t*: 8.11	0.000
BMI	16.6 (1.5)	–	–	–
Age at onset, years	14.1 (1.6)	–	–	–
Illness duration, months	12.5 (8.1)	–	–	–
Restricting type, *n* (%)	28 (87.5)	–	–	–
Binge-eating/purging type, *n* (%)	4 (12.5)	–	–	–
BDI	18.1 (12.1)	8.7 (5.0)	*t*: 4.37	0.000
SCARED	29.7 (16.6)	19.3 (8.0)	*t*: 3.29	0.000
CTQ-28	34.7 (9.0)	27.3 (2.9)	*t*: 4.15	0.000
IPPA-M	63.0 (12.9)	73.9 (9.1)	*t*: −4.13	0.000
IPPA-F	56.1 (19.2)	69.2 (10.3)	*t*: −3.71	0.000

All data are represented as means and standard deviations

AN anorexia nervosa, *HCs* healthy controls, *N/S* non-significant, *EAT-40*: eating attitudes test-40, *BMI* body mass index, *BDI* beck depression inventory, *SCARED* screen for child anxiety and related disorders, *CTQ-28* childhood trauma questionnaire-28, *IPPA-M* short form of inventory of parent and peer attachment, mother, *IPPA-F* short form of inventory of parent and peer attachment, father

Table 3 Corrected DERS, RME, TAS-20 and KA-SI total scores according to depression and anxiety symptoms, childhood traumatic experiences and attachment security

	AN ($n=32$)	HCs ($n=32$)	Statistics	
			F	p value
DERS, total	86.4 (3.8)	73.2 (3.8)	4.9	0.031
RME	21.6 (0.5)	21.7 (0.5)	0.4	N/S
TAS-20, total	50.6 ± 1.8	44.7 ± 1.8	4.5	0.037
KA-SI, total	50.5 ± 1.8	55.5 ± 1.8	3.1	N/S

Data are represented as means and standard deviations

F analysis of covariance *(ANCOVA)*, *AN* anorexia nervosa, *HCs* healthy controls, *SD* standard deviation, *N/S* non-significant, *DERS* difficulties in emotion regulation scale, *RME* reading the mind in the eyes test, *TAS-20*: toronto alexithymia scale-20, *KA-SI* KA-SI empathic tendency scale

The emotion recognition (RME) score was not significantly different between the two groups (Table 2). The total alexithymia (TAS-20) score was significantly higher in adolescents with AN compared with the HCs, indicating more alexithymic tendencies. Although difficulty identifying feelings (TAS-1) and difficulty describing feelings (TAS-2) subscale scores were significantly higher in adolescents with AN than in HCs, no statistically significant difference was found between the two groups in terms of Externally Oriented Thinking (TAS-3). The total alexithymia (TAS-20) score between the AN and HC groups remained significantly different after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security.

Emotional empathy (KA-SI EE) and cognitive empathy (KA-SI CE) subscales and total scores were found to be significantly lower in the AN group compared with the HC group, showing lower levels of empathy in the study group (Table 2). However, no statistically significant difference in empathy (KA-SI total score) was found between the two groups after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security (Table 3).

When the relationships between the DERS and other scales for assessing emotional functioning in the AN group were evaluated, the DERS scores were negatively and moderately correlated with emotion recognition (RME, $r=-0.431$, $p<0.001$) and empathy (KA-SI total score, $r=-0.453$, $p<0.001$) scores, whereas the correlation between the DERS and total alexithymia (TAS-20) scores was found to be high and positive ($r=0.789$, $p<0.001$).

Associated factors of difficulties in emotion regulation (DERS) in the AN group

A linear regression model was used to examine the associated factors of DERS in the AN group. Age and duration of both personal and parental education were excluded from the regression analysis because the p values were greater than 0.20 in the comparisons between the AN and HC groups. The total scores of emotion recognition (RME), alexithymia (TAS-20), empathy (KA-SI), depression (BDI), anxiety (SCARED), childhood traumatic experiences (CTQ-28) and attachment security to mother (IPPA-M) were entered in the model. The model was found to satisfy all assumptions of the linear regression analysis and explained 75.2% (Nagelkerke $R^2=0.752$, $p<0.001$) of the variance of the DERS in AN. In the stepwise regression analysis, alexithymia (TAS-20) explained 60.2% (Nagelkerke $R^2=0.602$, $p<0.001$) of the variance in model 1, whereas alexithymia (TAS-20) and depression (BDI) were found to explain 68.0% (Nagelkerke $R^2=0.680$, $p<0.001$) of the variance in model 2. Linear regression analysis revealed that alexithymic features and depressive symptoms were significantly associated with the DERS in AN (Table 4).

Table 4 Associated factors of difficulties in emotion regulation (DERS) in AN group

Predictors	*B*	*t*	95% confidence interval
RME	−1.666	−1.99$^{N/S}$	−3.408/0.075
TAS-20	1.238	5.661**	0.800/1.676
KA-SI	−0.173	−0.735$^{N/S}$	−0.643/0.298
BDI	0.678	2.193*	0.058/1.297
SCARED	0.026	0.127$^{N/S}$	−0.388/0.441
CTQ-28	−0.344	−1.179$^{N/S}$	−0.1794/0.336
IPPA-M	−0.395	−1.277$^{N/S}$	−0.660/0.387

Linear regression analysis

N/S non-significant, *DERS* difficulties in emotion regulation scale, *RME* reading the mind in the eyes test, *TAS-20* toronto alexithymia scale-20, *KA-SI* KA-SI empathic tendency scale, *BDI* beck depression inventory, *SCARED* screen for child anxiety and related disorders, *CTQ-28* childhood trauma questionnaire-28, *IPPA-M* short form of inventory of parent and peer attachment, mother

*$p=0.033$

**$p=0.000$

Discussion

The current study aimed to further explore the emotional functioning of adolescent girls with AN during the acute phases of the illness. To the best of our knowledge, this is the first study to evaluate ER, emotion recognition, alexithymia, and empathy skills in adolescent girls with AN after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security on these emotional functions. In accordance with our hypothesis, the results demonstrated that adolescent girls with AN had greater difficulties in ER, and identifying and

describing feelings compared with the HCs. However, contrary to our prediction, no significant difference was found in emotion recognition based on the performance of the two groups. Although the empathy level of adolescents with AN was significantly lower than that of the HCs, when controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security, no significant difference was found between the two groups. Our results also revealed that the alexithymia and depressive symptoms were found to be related to ER difficulties in adolescents with AN.

With this study, we were able to highlight the significant difference in ER between adolescent girls with AN and HCs. Previous studies suggested that patients with AN had greater difficulties in attaining appropriate ER strategies, focusing on the aim, advancing in a direction, and preventing impulsive behaviors while experiencing negative emotions compared with HCs. It is proposed that these difficulties play a significant role in the development and maintenance of AN [4, 5]. However, most studies have been performed in adult patients with AN; so, there is limited knowledge of ER in adolescents with AN. A study that assessed emotional functionality in adolescents with AN indicated that the ability to properly identify and express feelings and needs was underdeveloped [25]. Nevertheless, based on the current literature, our findings seem to hold relevant contributions for the development of intervention programs in the community to target emotion regulation difficulties, emphasizing the importance of the development of acceptance ability, goal-directed behaviors, impulsive behaviors, access to effective ER strategies and emotional clarity.

In our study, the emotion recognition (RME) scores of adolescents with AN were lower than those of HCs, but this difference was not statistically significant. In line with the results of previous studies in adolescents [23, 24], we found that emotion recognition in both the AN and HC groups was similar. These results indicate that the previously reported deficits in emotion recognition in adult patients with AN [17, 19] might not be found in adolescent girls with AN. However, the total alexithymia score was significantly higher in adolescents with AN compared with the HCs, indicating more alexithymic tendencies. Although the difficulty in identifying and describing feelings subscale scores was significantly higher in adolescents with AN than in HCs, no statistically significant difference was found between the two groups in terms of the externally oriented thinking subscale. Our results are consistent with the results of another recent study, which suggested that assessment of the externally oriented thinking subscale might be problematic in adolescents with AN [58]. The total alexithymia score between the AN and HC groups remained significantly different after controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security. It was also found that the alexithymic features were significantly related to ER difficulties in adolescents with AN. The difficulties in identifying and describing feelings dimensions of alexithymia have been reported to be a negative prognostic factor for AN, independent of depressive symptoms and disease severity [59]. The ability to identify and describe emotions is crucial in human social interactions because it allows people to make inferences about their mental states and to direct their behaviors. Furthermore, it is known that patients with AN are characterized by an impairment in social and emotional functioning; therefore, it would be useful to focus on these emotional skills in the treatment of AN.

In this study, although difficulties in self-reported identifying and describing feelings were greater in adolescents with AN than in HCs, visual emotion recognition based on reality was not significantly different between the two groups. This suggests that when adolescents with AN concentrate intensely, no problems occur regarding cognitive awareness of emotions and theory of mind skills, but their own perceptions of emotion recognition are negative. Compatible with this result, a meta-analytic study examining social processes in EDs showed that patients with EDs perceived themselves more negatively in the self-reported scales compared with HCs. They had lower self-esteem, self-awareness, and competence, and greater anger towards themselves [19]. In empirical studies in which emotional cues were used to ask patients to express their emotions, patients with AN used less verbal and nonverbal responses and had more negative beliefs about themselves than HCs [60, 61]. The results of our study might support these findings, and the negative self-perceptions of patients with AN may be related to their negative self-perceptions of emotion discrimination/recognition and description skills. Future research is necessary to investigate this negative self-perception of emotion recognition of patients with AN, although it is not different from HCs based on objective measures.

Another emotional skill that we investigated regarding the role of emotional functions in AN was empathy. The results of this study seem consistent with the literature data, which reported that the empathy level of adolescents with AN was lower than that of HCs [28, 62]. However, when controlling for the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security, no significant difference was found between the two groups. Interestingly, the previous studies that investigated the empathy level of patients with AN did not take into account the effects of depression and anxiety symptoms, childhood traumatic experiences, and attachment security. We have shown that this finding can be explained by depression and anxiety symptoms, childhood traumatic experiences, and attachment security rather than the diagnosis of AN.

This study has several strengths and limitations. Different aspects of emotional functions, such as ER, emotion

recognition, alexithymia and empathy, were evaluated together in adolescent patients with AN. In addition, depression and anxiety symptoms, childhood traumatic experiences, and attachment security, which can influence these emotional functions, were also assessed and their effects were controlled. In the present study, only adolescent girls during the acute phase of AN were included, creating a homogeneous group in terms of age, sex, and clinical symptom severity. However, this might also restrict the generalization of the results for all patients with AN. The fact that the sample only consisted of patients admitted to a psychiatry clinic providing tertiary healthcare services makes it challenging to generalize the findings to all adolescents with AN. The direction of the relationships between AN and emotional functions could not be determined because this is a cross-sectional study. The elucidation of mechanisms linking AN and emotional functionality could provide an evidence-based rationale for developing and delivering new effective interventions meant to target specific risk factors found to be precursors of emotional difficulties in individuals with AN. Unfortunately, few longitudinal studies have evaluated the effect of emotional functions on the prognosis and outcomes of AN. Therefore, more follow-up studies are required to illuminate the underlying mechanisms of AN. Also, the evaluation of parents' emotional skills would provide better insight into the development of emotional functions in adolescents with AN.

Finally, the findings of this study have important clinical implications. Emotional functioning involves skillful coordination of multiple psychological processes. Indeed, the problems in interpersonal relationships and social functioning in adolescent patients with AN may come from their difficulties in regulating, describing, and expressing emotions. Thus, socio-emotional functioning is a relevant field that should be taken into consideration when evaluating and treating adolescents with AN. These results indicate that treatment protocols for AN in adolescents should pay particular attention to the difficulties in the ER. Therefore, it would be useful for treatment to focus on these skills to help adolescents identify their feelings and to express themselves better in social interactions.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This research was approved by the Ethics Committee of the Hacettepe University, Medical Faculty.

Informed consent Informed consent was obtained from all individual participants included in the study.

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