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The effect of Ramadan fasting on mental health and some hormonal levels in healthy males

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Abstract

Background Millions of Muslims around the world fast during the holy month of Ramadan as a requirement of their religion Islam. Studies have reported varying effects of Ramadan fasting on mental health and various hormones. This study aimed to examine the effects of Ramadan fasting on mental health and plasma Leptin, Ghrelin, Neuropeptide Y (NPY), Growth Hormone levels in healthy individuals, and to evaluate the possible relationship between their hormone values and scale scores. Male healthcare professionals working at a university hospital without any psychiatric disease were included in the study. In the last week before Ramadan and in the first week after Ramadan, participants' blood samples were taken at 8.00 in the morning after 12 h of fasting, taking into account the release pattern and pulsatile release of these hormones in order to measure plasma Leptin, Ghrelin, NPY and Growth Hormone levels. Simultaneously, a sociodemographic data form, the Brief Symptom Inventory (BSI) and the Scale of Dimensions of Interpersonal Relationships were applied to participants.

Results The sample of the study included a total of 40 healthcare professionals. Participants' BSI interpersonal sensitivity and phobic anxiety subscales scores and their general severity and positive symptom distress index scores decreased significantly after Ramadan compared to those measured before Ramadan. ($p < 0.001$, $p = 0.020$, $p = 0.042$, $p = 0.006$ respectively). Also participants' ghrelin levels increased significantly after Ramadan compared to those measured before Ramadan ($p < 0.001$).

Conclusions The effects of Ramadan fasting on mental health may be mediated by some psychoneuroendocrine mechanisms. In order to elucidate these mechanisms that mediate the effect of Ramadan fasting on mental health, there is a need for better-structured studies with larger samples and more variables.

Keywords Fasting, Mental health, Anxiety, Interpersonal sensitivity, Ghrelin

Background

Millions of Muslims around the world fast during the holy month of Ramadan as a requirement of their religion Islam. Many of the world's major religions recommend a period of fasting or abstinence to their adherents. Muslims abstain from eating and drinking during the time between sunrise and sunset in Ramadan. During Ramadan, most Muslims eat two meals, one just before dawn (the sahur) and one just after sunset (the iftar), in which they not only abstain from eating and drinking, but also restrain their entire body, including eyes, ears, and tongue, avoiding sexual intercourse. Thus, fasting teaches

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Muslims self-control and self-discipline. Therefore, physiological changes occurring during Islamic fasting are considered to differ from those during experimental fasting [1–3].

An intermittent fasting diet has similar characteristics to Ramadan fasting and consists of three periods of fasting and eating at specified time intervals: periodic fasting, alternate-day fasting, and time-restricted feeding [4]. Religious fasting is considered a type of periodic fasting [5]. Studies report that intermittent fasting has positive effects on physical health, such as cancer diseases, cardiovascular diseases, and regulation of inflammatory response in infections [6–9]. However, the idea that decreased eating frequency may have a healing effect on mental health has drawn the focus of researchers to this area, and various studies have been conducted on this subject. Clinicians have emphasized that fasting is often accompanied by an increased level of alertness, improved mood, subjective well-being, and sometimes euphoria [10, 11].

Despite their methodological differences, there are several studies about the effects of fasting on mental health. Kazemi and colleagues examined the mental health and depression levels of university students, using Farrell's 12-Item General Health Questionnaire and Beck's Depression Inventory 10 days before and 10 days after Ramadan, and emphasized Ramadan fasting as an important factor in reducing depression and improving mental health in university students [12]. Another study examined the effect of Ramadan fasting on anxiety at the end of and one month after Ramadan, using the Hamilton Anxiety Rating Scale, and reported that participants had low anxiety at the end of Ramadan and moderate anxiety one month after Ramadan, suggesting that Ramadan fasting had a positive effect on anxiety [13]. One study conducted in Turkey examined the effects of Ramadan fasting on mental health in healthcare workers and found that male participants significantly lower mean scores on the General Health Questionnaire, the Brief Symptom Inventory (BSI) subscales of obsession-compulsion, interpersonal sensitivity, and paranoid ideation, and all three global indexes after Ramadan compared to their mean scores measured before Ramadan [1]. Another study has shown that fasting reduced stress, anxiety, and depression [14].

A voluntary abstinence from eating and drinking during fasting changes the functioning of some hormones that affect hunger-satiety and metabolism, including growth hormone, which stimulates growth and cell regeneration. This peptide hormone, which is secreted by the somatotroph cells of the anterior pituitary gland, is responsible for metabolism and is critical for its pulsatile secretion effect. Growth hormone levels can be affected

by several factors such as stress, sleep timing, glucose level, and exercise. Growth hormone acts as a stress hormone, increasing the concentration of glucose and free fatty acids, and stimulating the production of Insulin-Like Growth Factor 1 [15]. Some studies have reported no significant change in growth hormone levels during fasting, while others have reported an increase in growth hormone levels during short-term fasting [16].

Leptin, also known as the satiety hormone, plays an important role in the regulation of energy balance and food intake. This peptide hormone is produced by fat cells and suppresses the expression of neuropeptide Y (NPY) and agouti-related peptide (AgRP) in the arcuate nucleus of the hypothalamus and activates pro-opiomelanocortin and its cocaine- and amphetamine-regulated transcript, thus creating a feeling of satiety [17]. Leptin levels are highest between 22.00–3.00 and lowest between 8.00–17.00 in healthy people [16]. Ghrelin, also known as another peptide hormone called hunger hormone, works in the opposite direction of leptin and is involved in the regulation of appetite and metabolism through ghrelin/growth hormone-releasing receptors in the brain. Ghrelin stimulates food intake by increasing NPY and AgRP expressions [17]. Ghrelin is an important stimulant for growth hormone release from the anterior pituitary and plays an important role in energy balance during sleep through its interaction with growth hormone [15].

The results of studies about the relationship between Ramadan fasting and leptin-ghrelin levels are contradictory. Some researchers did not observe a significant change while others reported some significant changes in the levels of these hormones during Ramadan [16].

Studies have reported varying effects of Ramadan fasting on mental health and various hormones. Therefore, this study aimed to examine the effects of Ramadan fasting on mental health and plasma leptin, ghrelin, NPY, and growth hormone levels in healthy individuals, and to evaluate the possible relationship between their hormone values and scale scores. Our hypothesis is that the participants' anxiety and interpersonal sensitivity levels will decrease and their interpersonal relationships will improve after Ramadan compared to before Ramadan. If this hypothesis is confirmed, we wanted to examine whether there are processes related to hunger-satiety and metabolism that run parallel to this improvement.

This study will contribute to the literature in this regard and will shed light on further studies on this subject.

Methods

For conducting the study, approval was obtained from the University Clinical Research Ethics Committee (19.02.2020–2020/33). We conducted this prospective study in the sample of university hospital health workers

between April 5 and December 12, 2021. One month before Ramadan, we announced the subject of the study and the place and person that those who want to participate will apply to on the notice boards of the hospital. We interviewed the volunteers who applied for the advertisement and evaluated whether they met the inclusion criteria. We randomly selected 43 of the 62 volunteers on the list and contacted them.

Only male participants were included in the study. In the literature, studies on the effect of fasting on growth hormone are carried out separately for males and females. Estrogens can modulate the effects of growth hormone in the liver by regulating pituitary growth hormone secretion and modulating growth hormone signaling in the periphery. Through the induction of female-predominant transcripts and suppression of male-dominant transcripts, sex-specific differences of growth hormone emerge [18]. Hartman and colleagues showed that male's growth hormone levels increased fivefold in response to 2 days of fasting [19]. Another study showed that females did not see as many similar benefits from fasting as males [20]. The fact that females fast for fewer days in Ramadan due to their menstrual cycles [2] is another reason we only conduct the study for males. Kartal and colleagues reported that there was a 0.19 unit decrease in the BSI interpersonal sensitivity subscale score of the participants after Ramadan compared to before Ramadan [1]. Based on this study while planning this study, it was estimated that the difference between groups (after Ramadan and before Ramadan) in BSI interpersonal sensitivity subscale would be 0.20 points, the power analysis based on these data showed that at least 31 subjects were required to obtain a difference of 0.20 point in BSI interpersonal sensitivity subscale with $\alpha=0.05$ and power $(1-\beta)=0.80$. To eliminate the possible confusing effect of body mass index (BMI) on the results of leptin hormone produced from adipose tissue [17], only male participants with a BMI between 19 and 24.9 were included in the study. The study inclusion criteria were as follows: volunteering to participate in the study, being between the ages of 18–65 years, having a BMI between 19 and 24.9, fasting during Ramadan, and being male. The study exclusion criteria were as follows: having any physical disease that may affect the study results (acromegaly, obesity, for example), psychiatric disease, alcohol-substance addiction, and missing some days of Ramadan fasting. The diagnosis of psychiatric disease was ruled out by interviewing those who agreed to participate in the study, applying the Structured Clinical Interview for DSM-5 Disorders Clinical Version (SCID-5-CV) according to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5). A total of 43 healthcare professionals who agreed to participate in the

study were included in the study. However, two of them were excluded from the study as they had psychiatric diseases (generalized anxiety disorder and depression). One participant was excluded from the study as he missed some days of Ramadan fasting. Accordingly, the sample of the study included a total of 40 participants.

Measurements were made one week before and one week after Ramadan to evaluate the one-month effect of Ramadan fasting. Since leptin, ghrelin, NPY, and growth hormone secretions have pulsatile and diurnal complex temporal oscillations [16] and to reduce the differential effects of different foods on these secretions [17], we thought that it would be more appropriate to take blood samples at 8:00 am after 12 h of fasting. After blood samples were taken at 8:00 am, a sociodemographic data form, the BSI, and the Scale of Dimensions of Interpersonal Relationships (SDIR) were applied to participants. A written consent form was obtained from all participants.

BSI was developed by Derogatis [21]. This is a self-report 5-point likert-type scale to determine the presence and frequency of psychological problems in individuals. It consists of 53 items. The total score varies between 0 and 212. It has no cut-off score, and a higher total score indicates greater severity of symptoms. It has 9 subscales, including somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism, and three global indices, including general severity index, positive symptom total, and positive symptom distress index. The Turkish validity and reliability study of the scale was performed by Şahin and Durak [22].

SDIR was developed by Erden Imamoğlu and Aydın to predict interpersonal relationships and determine relationship dimensions [23]. This is a self-report 5-point likert type scale. It consists of 53 items, some of which are scored in reverse, and 4 subscales: empathy, approval dependence, trusting others, and emotional awareness. As higher approval dependence subscale score indicates greater approval dependence. A higher empathy subscale indicates greater empathy. A higher trusting others subscale score indicates lower trust in others. A higher emotional awareness subscale score indicates lower emotional awareness.

A sociodemographic data form was prepared by the authors and included questions about the participants' sociodemographic characteristics such as age, marital status, education level, and BMI.

Venous blood samples were collected from all participants, using a plain gel biochemistry tube for leptin, ghrelin, NPY, and growth hormone analyses in the week before and the week after Ramadan. Blood samples were collected at 8.00 in the morning after 12 h of fasting,

considering the release pattern and pulsatile release of hormones. Samples were centrifuged at 4000 rpm for 10 min to obtain serum. After centrifugation, the sera were separated and placed in polypropylene tubes for leptin, ghrelin, NPY, and growth hormone analyses, and were taken into Eppendorf tubes and frozen at -80°C until the day of analysis. On the day of analysis, they were brought to room temperature and dissolved. After the dissolved samples were vortexed and homogenized, growth hormone levels were studied using the electrochemiluminescence method in a Roche brand, Cobas e601 model autoanalyzer in the Biochemistry Central Laboratory (Roche Diagnostics GmbH D-68298 Mannheim/Germany). In addition, leptin, ghrelin, and NPY levels were measured using the enzyme-linked immunosorbent assay method and a Biotek brand SYNERGY H1 model device in Biochemistry Research Laboratory.

Data were analyzed statistically using SPSS version 22.0. The categorical data were reported as numbers and percentages. The conformity of quantitative data to normal distribution was assessed with the Kolmogorov–Smirnov test. Quantitative data with normal distribution were expressed as mean (standard deviation), and those that did not show normal distribution were expressed as median (min–max). BSI and SDIR scores, leptin, ghrelin, NPY and growth hormone levels of the participants before and after Ramadan were compared. This assessment was made using the Wilcoxon test for the analysis of quantitative variables. Correlations between ghrelin levels and the interpersonal sensitivity, phobic anxiety, general severity index and positive symptom distress index scores were investigated using Spearman's rank-order correlation. A value of $p < 0.050$ was accepted as statistically significant.

Results

A total of 40 male healthcare professionals were included in the study. Of these, 12 (30%) were doctors, 18 (45%) were nurses, and 10 (25%) were medical secretaries. Their mean age was 31.50 ± 5.68 years, and their BMI was 23.76 (19.03–24.90). Of them, 28 (70%) were married and 12 (30%) were single. Table 1 shows the participants' clinical and sociodemographic data.

The participants' BSI interpersonal sensitivity and phobic anxiety subscales scores and their general severity and positive symptom distress index scores were statistically significantly lower after Ramadan compared to those measured before Ramadan ($p < 0.001$, $p = 0.020$, $p = 0.042$, $p = 0.006$, respectively). In addition, their BSI total score was lower after Ramadan compared to that measured before Ramadan, however, the difference between them was not statistically significant ($p = 0.087$).

Table 1 Participants' sociodemographic data

	Mean \pm SD
Age	31.5 \pm 5.68 Median (min–max)
BMI	23.76 (19.03–24.90) <i>n</i> (%)
Marital status	
Married	28 (%70)
Single	12 (%30)
Education	
High school	13 (%32.5)
University	27 (%67.5)
Wake up for sahur in Ramadan?	
Yes	26 (%65)
No	14 (%35)

BMI body mass index, SD standard deviation

There was no statistically significant difference between the participants' SDIR subscales scores before and after Ramadan. Table 2 shows the participants' scale scores.

The participants' ghrelin levels were statistically significantly increased after Ramadan compared to those measured before Ramadan ($p < 0.001$). There was no statistically significant difference between their leptin, NPY, and growth hormone levels measured after and before Ramadan. Table 3 shows the participants' leptin, ghrelin, NPY, and growth hormone levels.

There was no statistically significant correlation between the participants' plasma ghrelin levels and phobic anxiety subscale, general severity index, and positive symptom distress index scores measured before Ramadan. In addition, no statistically significant correlation was found between their plasma ghrelin levels and phobic anxiety subscale, general severity index, and positive symptom distress index scores measured after Ramadan. A statistically significant negative correlation was found between ghrelin levels and interpersonal sensitivity subscale scores before Ramadan ($r = -0.399$, $p = 0.011$). However, no significant correlation was found between ghrelin levels and interpersonal sensitivity subscale scores after Ramadan. While their scale scores measured before Ramadan were positively correlated with each other, there was also a positive correlation between their scale scores measured after Ramadan. Table 4 shows the correlation between the participants' Ghrelin levels and scale scores.

Discussion

As the most significant result of our study, the participants' BSI interpersonal sensitivity and phobic anxiety subscales scores and their general severity and positive

Table 2 Participants' BSI and SDIR scores

	Before Ramadan Median (min–max)	After Ramadan	<i>p</i>
Somatization	1.00 (0.00–18.00)	2.00 (0.00–14.00)	0.699
Obsession-compulsion	3.00 (0.00–22.00)	3.50 (0.00–17.00)	0.528
Interpersonal sensitivity	1.00 (0.00–12.00)	0.50 (0.00–12.00)	<0.001*
Depression	2.00 (0.00–14.00)	1.00 (0.00–17.00)	0.110
Anxiety	1.00 (0.00–13.00)	1.00 (0.00–15.00)	0.071
Hostility	1.00 (0.00–15.00)	1.00 (0.00–14.00)	0.714
Phobic anxiety	1.00 (0.00–14.00)	0.00 (0.00–6.00)	0.020*
Paranoid ideation	3.00 (0.00–15.00)	2.00 (0.00–15.00)	0.103
Psychoticism	1.00 (0.00–12.00)	1.00 (0.00–13.00)	0.543
BSI total	17.00 (1.00–125)	16.00 (2.00–128.00)	0.087
General severity index	0.29 (0.02–2.19)	0.26 (0.04–2.19)	0.042*
Positive symptom total	13.50 (1.00–51.00)	12.00 (2.00–50.00)	0.189
Positive symptom distress index	1.33 (0.67–2.73)	1.14 (0.67–2.32)	0.006*
Approval dependence	35.50 (28.00–56.00)	37.00 (21.00–58.00)	0.441
Empathy	34.00 (21.00–45.00)	34.00 (20.00–45.00)	0.881
Trusting others	39.50 (18.00–63.00)	41.50 (21.00–53.00)	0.821
Emotional awareness	32.00 (13.00–55.00)	32.00 (16.00–53.00)	0.467

Wilcoxon signed rank test was performed for the analysis of variables. BSI/ brief symptom inventory, *Indicates significance, *p* < 0.050

Table 3 Participants' Leptin, Ghrelin, NPY and GH levels

	Before Ramadan Median (min–max)	After Ramadan	<i>p</i>
Leptin	3.120 (0.166–12.399)	3.836 (0.180–11.850)	0.085
Ghrelin	2.943 (0.313–9.602)	3.510 (0.010–9.77)	<0.001*
NPY	662.468 (0.001–2521)	698.909 (77.540–251.000)	0.220
GH	0.082 (0.020–0.649)	0.086 (0.020–0.380)	0.751

Wilcoxon signed rank test was performed for the analysis of variables. NPY Neuropeptide-Y, GH growth hormone. All values except NPY were expressed as ng/mL. NPY value was expressed as ng/L. *Indicates significance, *p* < 0.050

symptom distress index scores significantly decreased after Ramadan compared to those measured before Ramadan.

Several studies examined the effects of Ramadan fasting on mental health [24–26]. Yousuf and colleagues examined the effect of Ramadan fasting on depression, anxiety and stress levels in diabetic patients, including 100 fasting patients and 50 non-fasting patients. They applied the depression anxiety stress scale (DASS) before and after Ramadan, and reported a statistically significant improvement in depression, anxiety and stress levels in the fasting group after Ramadan [24].

One recently published meta-analysis has suggested that Ramadan fasting is associated with improvement in stress, anxiety, and depression [27]. Erdem evaluated the effects of Ramadan fasting on a sample of 73 healthy participants by applying DASS, and reported a

statistically significant decrease in their depression, anxiety, and stress scores and frequency of anxiety after Ramadan compared to those measured before Ramadan [28]. Unlike the previous study, Furuncuoglu and colleagues reported no significant change in the participants' anxiety levels on the first day and thirtieth day of Ramadan [29].

Kartal and colleagues examined the effects of fasting on mental health and reported a significant decrease in the participants' BSI obsession-compulsion and paranoid ideation subscales mean scores and their general severity and positive symptom distress index mean scores after the Ramadan period compared to those measured before Ramadan. In addition, the authors reported a significant decrease in the males' post-Ramadan mean scores on the General Health Questionnaire and BSI obsession-compulsion, interpersonal sensitivity, paranoid ideation subscales, and all three global indices [1]. Our study found a decrease in the participants' interpersonal sensitivity and phobic anxiety subscales scores and also in their general severity and positive symptom distress index scores after Ramadan compared to those measured before Ramadan. Our results are partially compatible with those in the literature. The decreased interpersonal sensitivity subscale mean score of participants in the study of Kartal and colleagues suggests that Ramadan fasting might have positive effects on one's interpersonal relationships. Therefore, the SDIR was applied to participants in our study. However, there was no significant

Table 4 Correlation between the participants' plasma Ghrelin levels and scale scores

Before Ramadan					
	Ghrelin	IS	PA	GSI	PSDI
Ghrelin					
<i>r</i>	1	− 0.399	− 0.236	− 0.278	− 0.185
<i>p</i>		0.011	0.142	0.082	0.252
<i>n</i>	40	40	40	40	40
IS					
<i>r</i>	− 0.399	1	0.706	0.804	0.736
<i>p</i>	0.011		<0.001	<0.001	<0.001
<i>n</i>	40	40	40	40	40
PA					
<i>r</i>	− 0.236	0.706	1	0.818	0.492
<i>p</i>	0.142	<0.001		<0.001	0.001
<i>n</i>	40	40	40	40	40
GSI					
<i>r</i>	− 0.278	0.804	0.818	1	0.66
<i>p</i>	0.082	<0.001	<0.001		<0.001
<i>n</i>	40	40	40	40	40
PSDI					
<i>r</i>	− 0.185	0.736	0.492	0.66	1
<i>p</i>	0.252	<0.001	0.001	<0.001	
<i>n</i>	40	40	40	40	40
After Ramadan					
	Ghrelin	IS	PA	GSI	PSDI
Ghrelin					
<i>r</i>	1	− 0.275	− 0.305	− 0.169	− 0.055
<i>p</i>		0.086	0.056	0.298	0.735
<i>n</i>	40	40	40	40	40
IS					
<i>r</i>	− 0.275	1	0.719	0.79	0.58
<i>p</i>	0.086		<0.001	<0.001	<0.001
<i>n</i>	40	40	40	40	40
PA					
<i>r</i>	− 0.305	0.719	1	0.683	0.427
<i>p</i>	0.056	<0.001		<0.001	0.006
<i>n</i>	40	40	40	40	40
GSI					
<i>r</i>	− 0.169	0.790	0.683	1	0.781
<i>p</i>	0.298	<0.001	<0.001		<0.001
<i>n</i>	40	40	40	40	40
PSDI					
<i>r</i>	− 0.055	0.580	0.427	0.781	1
<i>p</i>	0.735	<0.001	0.006	<0.001	
<i>n</i>	40	40	40	40	40

IS interpersonal sensitivity, PA phobic anxiety, GSI general severity index, PSDI positive symptom distress index, *p* < 0.050

difference in their SDIR scores before and after Ramadan. This result may be related to our study's small number of participants.

A recent review study introduced various explanations for the differences in research results regarding the effects of fasting on mental health. Accordingly, while there was no significant change in depression, anxiety, and stress levels before and after Ramadan in individuals with initial normal mood, those with initial depression, anxiety, and stress had lower scale scores after Ramadan. As a result, Ramadan fasting may have a positive effect on individuals with depression, anxiety, and stress [30].

Ramadan fasting can affect the circadian rhythms of various biological variables, including hormones [2, 31]. Studies have shown a competitive interaction between ghrelin and leptin in the regulation of food intake [17]. Bogdan and colleagues reported a shift in the circadian rhythm of leptin on the 23rd day of Ramadan in males who fasted during Ramadan. Still, there was no significant change in their plasma leptin levels [32]. On the other hand, another study reported that short-term fasting resulted in a 30–66% decrease in leptin levels [33]. Alzoghaibi and colleagues found no significant change in ghrelin levels during and before Ramadan fasting, and determined a significant decrease in leptin levels at 10 pm during Ramadan [34].

Studies have shown that ghrelin increases not only in response to energy deficiency, but also after exposure to stress, and have reported that prolonged fasting increases plasma ghrelin levels [35]. It has been reported that ghrelin-induced anxiolytic and antidepressant-like responses in rats on a calorie-restricted diet or administered ghrelin. Therefore, activation of the ghrelin signaling pathway in response to chronic stress may be a homeostatic adaptation that helps individuals cope with stress [36]. Another study determined that ghrelin injection caused an increase in food intake, induced anxiety, and increased memory retention in rats [37]. The results of studies on ghrelin vary. This may be because of methodological differences (model, type of subject, amount of ghrelin, research method, for example). Although animal experiments shed light on potential mechanisms of ghrelin regulation of anxiety and depression, further studies are needed in humans.

Our study observed a significant increase in the participants' plasma ghrelin levels after and before Ramadan. While there was a low degree of correlation between ghrelin levels and interpersonal sensitivity subscale scores before Ramadan, no significant correlation was found after Ramadan. Therefore, no further evaluations can be made in this regard.

Our study has some strengths. In some of the previous studies, a psychiatric examination was not

performed, instead, a psychiatric assessment was based on symptom severity and relevant scales. In our study, all participants were interviewed applying SCID-5-CV according to DSM-5, so the diagnosis of psychiatric disease was ruled out. To eliminate the possible confusing effect of BMI on the clinical results of leptin hormone produced from adipose tissue, only participants with a BMI between 19 and 24.9 were included in the study. Blood samples were taken from all participants at 8:00 am after 12 h of fasting, which was significant for the reliability of the clinical results of hormones that oscillated in a circadian pattern. These details, considered in planning the study, are the strengths of our study.

Our study also has some limitations. Muslims are exposed to various life changes during Ramadan, such as mealtime, sleep–wake time, sleep duration, exposure to light, and exercise, which can affect their hormone levels [15, 34]. Methodological differences (sample selection, scales, methods used for biochemical analysis, evaluation times) may have affected the study's results. The small number of participants is also a limitation of our study (Additional file 1).

Conclusions

This study found that participants' BSI interpersonal sensitivity and phobic anxiety subscales scores and their general severity and positive symptom distress index scores decreased. Their plasma ghrelin levels increased after Ramadan fasting compared to those measured before Ramadan. The effects of Ramadan fasting on mental health may be mediated by some psychoneuroendocrine mechanisms. There is a need for better-structured studies with larger samples and more variables to elucidate these mechanisms that mediate the effect of Ramadan fasting on mental health.

Abbreviations

NPY	Neuropeptide Y
BSI	Brief Symptom Inventory
SDIR	Scale of Dimensions of Interpersonal Relationships
AgRP	Agouti-related Peptide
DASS	Depression Anxiety Stress Scale
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, fifth edition
SCID-5-CV	Structured Clinical Interview for DSM-5 Disorders Clinical Version
SPSS	Statistical Package for the Social Sciences

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s41983-023-00623-9>.

Additional file 1. Supplementary material.

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Not applicable.

Author contributions

MA, participated in data collection, analysis and interpretation, literature review and writing of the study. SU, participated in the modeling, design, literature review, critical review, supervision and writing of the study. LGE, participated in conception, design, literature review, supervision and critical review of the study. MCT was involved in the material and data collection of the study. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations**Ethics approval and consent to participate**

The study was approved by Inonu University Clinical Research Ethics Committee (Date-Number: 19.02.2020-2020/33). All participants provided informed written consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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