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Original Article

The effect of anthropometric and metabolic parameters on the development of erosive reflux disease in patients with gastroesophageal reflux disease

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ABSTRACT

Aims: Gastroesophageal reflux disease (GERD) is a common health problem worldwide. Previous studies have reported that central obesity associated with visceral steatosis is an important problem in digestive system diseases, especially reflux-related diseases. This study aimed to examine the effect of body fat distribution on the development of erosive esophagitis.

Methods: A total of 131 individuals, 105 patients and 26 healthy volunteers, were included in this study. The FSSG questionnaire was applied to all individuals. Patients with an FSSG questionnaire score of 10 or more underwent upper gastrointestinal tract endoscopy. Patients with esophagitis on endoscopy were included in the erosive esophagitis group, whereas patients without esophagitis were included in the non-erosive group. Serum biochemistry (fasting glucose, insulin, lipid panel, uric acid, TSH, AST, ALT) analyzes were performed. Waist circumference was measured. Body compositions were evaluated using the bioelectrical impedance method (Tanita).

Results: Erosive esophagitis was found in 68 of 105 patients enrolled in the study, and non-erosive esophagitis in 37. There was no statistically significant difference in age, BMI, and waist circumference between the erosive, non-erosive and control groups. The visceral fat percentage was higher in the erosive esophagitis group than the other groups ($p < 0.001$). At the end of the pairwise comparison of the groups, it was found that visceral fat value was higher in the erosive group than the non-erosive and control groups, while the visceral fat value was similar in the control and non-erosive groups. Except for the control group, when comparing the erosive and non-erosive groups, it was found that most of the patients in the erosive group were male, their FFM values and muscle mass were relatively high, and visceral fat values were significantly higher.

Conclusion: An increase in visceral fat is a more important risk factor for the development of erosive esophagitis than obesity, waist circumference and increased BMI.

Keywords: GERD, Erosive esophagitis, FSSG, bioelectrical impedance, visceral fatigue

INTRODUCTION

Gastroesophageal reflux disease (GERD) is defined by the American College of Gastroenterology (ACG) as a group of symptoms or complications that result from the backflow of stomach contents into the oesophagus, mouth, or lungs. GERD has become an increasingly common health problem worldwide, especially in developed countries.[1,2]

Symptoms associated with GERD negatively affect patients' quality of life, performance, and productivity, and result in various losses in the workforce. Because the disease requires long-term treatment, it also imposes a significant economic burden.[3]

GERD is classified based on the appearance of the oesophageal mucosa during upper endoscopy. Erosive esophagitis (ERD) is characterized by the presence of erosions observed endoscopically in the distal oesophageal mucosa. It may be symptomatic or asymptomatic. Non-erosive reflux disease (NERD) is characterized by the presence of GERD symptoms without erosions in the oesophageal mucosa.1 Endoscopic esophagitis is observed in less than 50% of patients with GERD symptoms. Reflux esophagitis is the most common symptom of oesophageal damage.[4]

The aetiology of GERD is multifactorial, but environmental factors are known to play an important role. Obesity, smoking, and certain foods are among the risk factors.[5] Obesity and weight gain are more prominent in patients with ERD than in those with NERD.[6] Abdominal obesity has been identified as an independent risk factor, especially for ERD. Abdominal obesity is also known to increase the symptoms of GERD.[7]

Previous studies have reported that waist circumference is the best indicator of visceral fat tissue among anthropometric measurements and that visceral fat tissue has a greater impact on insulin resistance than subcutaneous fat tissue.[8] Insulin resistance is thought to play an important role in the pathogenesis of ERD. Visceral adipose tissue is biologically active and can secrete pro-inflammatory cytokines, particularly interleukin-6, and tumor necrosis factor-alpha, which can lead to insulin resistance. Furthermore, these cytokines may be associated with chronic inflammatory statesin obesity, increasing the risk of ERD.[9,10]

Epidemiologic studies have indicated that obesity is an important risk factor for the development of GERD and is associated with oesophageal complications such as ERD, Barrett's oesophagus, and oesophageal adenocarcinoma. The fact that obesity rates have almost tripled worldwide since 1975 and the epidemic rate has become a global health problem is a very important problem in terms of GERD. Risk factors associated with ERD are male gender, obesity, especially abdominal visceral obesity, presence of GERD symptoms for more than one year, alcohol consumption, smoking, and presence of hiatal hernia.[11]

We hypothesized that an increase in visceral fat compared to total body fat in patients with gastroesophageal reflux might increase the risk of developing erosive reflux. This study aimed to evaluate the effects of body fat distribution on the development of ERD using a Tanita quantitative method by evaluating metabolic and anthropometric parameters that may affect the development of ERD.

METHODS

Ethical approval was obtained from the Kırıkkale University Clinical Researches Ethics Committee (Date: 26.02.2019, Decision No: 03/04). All procedures were performed in accordance with the ethical rules and the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants.

Selection of Study Population and Data Collection

In this descriptive cross-sectional study, 105 patients who presented with dyspeptic complaints to the Gastroenterology Clinic of Kırıkkale University Faculty of Medicine and 26 healthy volunteers who agreed to participate in the study were included. The Frequency Scale for the Symptoms of Gastroesophageal Reflux Disease (FSSG) questionnaire was administered to the patient and the control groups. Patients with an FSSG score of 10 or more underwent upper gastrointestinal system endoscopy.

Inclusion criteria for the study:

1. Consent to participate in the study,
2. Age between 18 and 65 years,
3. Patients with FSSG scores of 10 and above and healthy volunteers with FSSG scores below 8.

Exclusion criteria for the study:

1. Individuals who have a history of using medications that can cause ERD (such as tetracycline)
2. Diabetes mellitus
3. Thyroid dysfunction
4. Chronic obstructive pulmonary disease
5. Chronic kidney disease
6. Patients diagnosed with liver cirrhosis
7. Individuals who have used any herbal products
8. History of abdominal surgery (e.g., cholecystectomy, gastric surgery, colon surgery, reflux surgery, hiatal hernia surgery)
9. Patients with coronary artery disease
10. Patients who have used PPİ or H2 receptor blockers in the last 4 weeks
11. Pregnant patients
12. Patients with hiatal hernia, gastric ulcer, duodenal ulcer, or malignancy detected during endoscopy.

Method and Interpretation of the FSSG Questionnaire

We administered the FSSG questionnaire to 642 patients aged between 18 to 65 years who presented to the gastroenterology clinic with reflux and dyspeptic symptoms and were diagnosed with GERD (Table 1). Each question was scored on a scale of 1 to 4 as never (0), rarely (1), sometimes (2), often (3), always (4). Questions related to dyspeptic symptoms were excluded (5 questions), whereas 7 questions related to reflux symptoms were included. A score of ≥10 based on the 7 reflux-related questions was considered as a diagnosis of GERD. Reflux-related symptoms were scored up to 28 points (maximum=7×4), whereas dyspeptic symptoms were scored up to points(maximum=5×5). The total score was calculated as the sum of the reflux-related and dyspeptic

Table 1. F-scale frequency scale for the symptoms of gastroesophageal reflux disease (FSGG)

Do you have any of the following symptoms?					
Name-Surname: Age: Gender: Date:					
Questions	Mark this section				
	Never	Occasionally	Sometimes	Often	Always
1-Do you get heartburn?					
2-Does your stomach get bloated?					
3-Does your stomach ever feel heavy after meals?					
4-Do you sometimes subconsciously rub your chest with your hand?					
5-Do you ever feel sick after meals?					
6-Do you get heartburn after meals?					
7- Do you have an unusual (e.g. burning) sensation in your throat?					
8-Do you feel full while eating meals?					
9-Do you things get stuck when your swallow?					
10-Do you get bitter liquid (acid) coming up into your throat?					
11-Do you burp a lot?					
12-Do you get heartburn if you bend over?					

symptom scores. Extra-oesophageal symptoms (chronic cough, chest pain, hoarseness, sore throat, apnea, choking sensation, teeth grinding) were assessed by questionnaire form. An FSSG score of 10 or more was found in 105 of 642 patients. , Descriptive information such as age, gender, employment status, smoking and alcohol consumption, and the presence of hypertension, about these patients was collected by questionnaire.

Endoscopic Evaluation and Classification of Esophagitis

Upper gastrointestinal endoscopy was performed in patients an FSSG score of 10 and above, which is an indication for endoscopy. The severity of ERD was graded A to D according to the Los Angeles esophagitis classification (**Table 2**).

Table 2. Los Angeles classification

Grade A	≤5 mm mucosal damage in mucosal folds
Grade B	Damage >5 mm in mucosal folds but no continuity between folds
Grade C	Mucosal damage between 2 or more mucosal folds continuous, but not all around
Grade D	All-round mucosal damage (in the oesophageal lumen) more than 75%)

Grade A reflux esophagitis was found in 68 patients. A total of 37 patients without esophagitis were considered as NERDpatients. Among the 146 patients with an FSSG score of 10 or more were excluded from the study because of pangastritis, duodenal ulcer, gastric ulcer, or hiatal hernia on upper gastrointestinal system endoscopy.

Anthropometric Measurements and Tanita

Anthropometric assessment of all participants was performed using the Tanita method (Bioelectrical Impedance) in a standing upright, looking straight ahead with eyes, wearing light clothing, barefoot, and removing all metallic accessories.All participants were instructed to notconsume any food or drink for at least 4-5 hours prior to the test, to avoid exercisein 12 hours before the test, and not consume any food or drink containing alcohol or caffeine in the 24 hours prior to the test. Measurements of height, weight, (BMI), percentage of body fat, fat mass (kg), Fat-Free Mass(FFM), muscle mass (kg), Total Body Water(TBW), percentage of TBW, bone mass (bone mineral weight), Basal Metabolic Rate(BMR), metabolic age, visceral fat rating, and degree of obesity were obtained using the Tanita method. The waist circumference of all participants were measured in the standing position with an inelastic tape measure by assessing the Costas and the longest horizontal diameter passing through both iliac crests.

Laboratory Analysis Methods

Laboratory tests such as fasting glucose, insulin, TSH, AST, ALT, HDL, LDL, triglycerides, and total cholesterol were performed in patients after at least 10 hours of fasting. The HOMA-IR index were calculated as: HOMA-IR=fasting glucose × fasting insulin/405.

Statistical Analysis

Statistical analyses of collected data were conducted using IBM SPSS Statistics for Windows 20.0 (IBM Corp., Armonk, NY, USA). Determination of the normally distributed data was conducted using the Kolmogorov-Smirnov test. Numerical variables that had normal distribution were expressed as the mean ± standard deviation, while those with non-normal distribution were expressed as the median (min-max). For comparisons between groups, Student's T test and ANOVA test (post-hoc test: Bonferroni test) were used for parametric data, whereas Mann-Whitney U test and Kruskall-Wallis test (post-hoc test: Dunn's test) were used for non-parametric data. Correlation analysis was performed using the Spearman's correlation test. Multivariable logistic analyses were conducted to establish any possible independent predictors of erosive reflux. Diagnostic performance analysis was performed with ROC Curve analysis. P < 0.05 was taken as statistical significance.

RESULTS

The mean age of the control group was 44.11±8.49 years, with a gender distribution of 9 females (6.9%) and 17 males (13%). The mean age of the ERD group was 45.34±10.29 years, with a gender distribution of 20 females (15.3%) and 48 males (36.6%). The mean age of the NERD group was 43.92±13.89 years, with a gender distribution of 13 females (9.9%) and 24 males (18.3%). There was no significant difference in age between the groups (p>0.05).The rate of patients working in any occupation was higher in the ERD group compared to the other groups (ERD group=35.9% vs. NERD group=10.7% vs. Control group= 5.3%, p<0.001). The rate of smokers was higher in the ERD group compared to the other groups (ERD group=15.3% vs. NERD group=1.5% vs. Control group= 7.6%, p=0.004). The rate of hypertensive patients was higher in the ERD group compared to the other groups (ERD group=8.4% vs. NERD group=0% vs. Control group= 0%, p=0.004) (**Table 3**).

Table 3. Comparison of sociodemographic data of the erosive and non-erosive group

Variable	Control	Erosive	Nonerosive	t/Z/x²	p
Age (year) mean±SD	44.11±8.49	45.34±10.29	43.92±13.89	0.239ᵃ	0.788
Gender n (%)				0.458‡	0.796
Female	9 (6.9%)	20 (15.3%)	13 (9.9%)		
Male	17 (13%)	48 (36.6%)	24 (18.3%)		
Profession				17.503‡	<0.001
Not working	19 (14.5%)	21 (16.0%)	23 (17.6%)		
Working	7 (5.3%)	47 (35.9%)	14 (10.7%)		
Smoking n (%)				10.941‡	0.004
No	16 (12.2%)	48 (36.6%)	35 (26.7%)		
Yes	10 (7.6%)	20 (15.3%)	2 (1.5%)		
Alcohol n (%)				4.462‡	0.107
No	24 (18.3%)	67 (51.1%)	37 (28.2%)		
Yes	2 (1.5%)	1 (0.8%)	0 (0.0%)		
Hypertension n (%)				11.125‡	0.004
No	26 (19.8%)	57 (43.5%)	37 (28.2%)		
Yes	0 (0.0%)	11 (8.4%)	0 (0.0%)		

(*) Independent Samples t test. (†) Mann Whitney U test. (‡) Pearson Chi-Square test

Mean BMI level did not differ significantly between the groups (ERD group=28.16±3.73 vs. NERD group=27.62±5.76 vs. Control group=27.95±1.62 kg/m2, p=0.819). Mean waist circumference level did not differ significantly between the groups (ERD group=97.57±11.70 vs. NERD group= 97.62±5.76 vs. Control group=96.19±14.13 cm, p=0.876).

Median FFM value was higher in the ERD group compared to the other groups (ERD group=56.75 [range: 32.70-79.0] vs. NERD group=47.10 [range: 35-81] vs. Control group=47.80 [range: 35-78.70], p=0.036). Median muscular mass value was higher in the ERD group compared to the other groups (ERD group=53.85 [range: 31-75.10] vs. NERD group=47.70 [range: 33.30-77.40] vs. Control group= 47.55 [range: 36.60-74.80], p=0.047). Median visceral fat value was higher in the ERD group compared to the other groups (ERD group=11.5 [range: 6-27] vs. NERD group=9 [range: 1-21] vs. Control group= 8 [range: 3-18], p=0.001). These findings were similar in the NERD and control groups (**Table 4**).

Table 4. Comparison analysis of Tanita values between groups

Variables	Group(I/J)	Z	p
FFM			
	Control/NERD	-0.216	0.829
	Control /ERD	-2.211	0.027
	NERD / ERD	-1.979	0.048
Muscular mass			
	Control / NERD	-0.265	0.791
	Control / ERD	-2.025	0.043
	NERD / ERD	-1.989	0.047
Visceral fat			
	Control / NERD	-0.161	0.872
	Control / ERD	-3.517	<0.001
	NERD / ERD	-3.434	0.001

Excluding the control group, the rate of males (X2=15.035, p<0.001), the ratio of working in a business sector (X2=9.630, p=0.002), the rate of smoking (X2=8.338, p=0.004), and the rate of hypertension (X2 =6.686, p=0.010) was higher in the ERD group than the NERD group. Excluding the control group, the rate of males in the ERD group (X2=15.035, p<0.001), the rate of those working in a business sector (X2=9.630, p=0.002), the rate of smoking (X2=8.338, p=0.004), and the rate of hypertension (X2=6.686, p=0.010) was higher than the NERD group. In this patient group, FFM values (Z=-1.979, p=0.048) and muscle mass (Z=-1.989, p=0.047) were found to be relatively high, while visceral fat values were found to be significantly higher (Z=-4.309, p<0.001).

As a result of the correlation analysis, visceral fat value and age (r=0.376, p<0.001), gender (r=0.407, p<0.001), glucose level (r=0.294, p=0.002), triglyceride level (r=0.266, p). =0.006), body weight (r=0.498, p<0.001), BMI value (r=0.449, p<0.001), waist circumference measurement value (r=0.451, p<0.001), fat mass value (r=0.368, p<0.001), FFM value (r=0.313, p=0.001), muscle mass value (r=0.312, p=0.001), TBV value (r=0.352, p<0.001), bone mass value (r=0.291, p=0.003), BMR value (r=0.329, p=0.001), metabolic age (r=0.471, p<0.001) and obesity degree (r=0.446, p<0.001) were found to be positively correlated. In addition, body weight and gender (r=0.428, p<0.001), glucose level (r=0.260, p=0.007), insulin level (r=0.235, p=0.016), triglyceride level (r=0.285, p=0.003), ALT level (r=0.200, p=0.041), height (r=0.454, p<0.001), BMI value (r=0.690, p<0.001), waist circumference measurement value (r=0.693, p<0.001), fat mass value (r=0.520, p<0.001), FFM value (r=0.718, p<0.001), muscle mass value (r=0.718, p<0.001), TBV value (r=0.736, p<0.001), positive between bone mass value (r=0.713, p<0.001), BMR value (r=0.760, p<0.001), metabolic age (r=0.416, p<0.001), obesity grade (r=0.686, p<0.001) were found to be positively correlated.

Diagnostic performance of the variables in diagnosing ERD was examined with the ROC-Curve test. According to this; male gender 69% specificity and 70% sensitivity (area=0.697, p=0.001), smoking 30% sensitivity and 94% specificity (area=0.380, p=0.030), 63% sensitivity and 62% for body weight >75 kg specificity (area=0.629, p=0.030), 56% specificity and 57% sensitivity for glucose level >91.50 mg/dL (area=0.625, p=0.034), 65% sensitivity and 54% specificity for FFM value >52.1% (area) =0.617, p=0.048), 58% sensitivity and 62% specificity for muscle mass value >51.75 (area=0.618, p=0.047) and 88% sensitivity and 51% specificity for visceral fat value >8.5 (area=0.629, p =0.030) were found to exhibit diagnostic performance (**Table 5**).

Table 5. Comparison of biochemical data of erosive-nonerosive groups

Variable			t/ Z/ x^2	p
Glucose median (min-max)/	92.50 (67-199)	89 (60-122)	-2.118†	0.086
Triglyceride median (min-max)/	113.50 (43-463)	99.80 (43-341)	-1.224†	0.221
Total cholesterol mean±SD/	193.87±43.07	194.19±35.13	-0.039*	0.969
HDL mean±SS/	51.24±13.87	53.82±13.26	-0.925*	0.357
LDL mean±SS/	113.31±38.33	118.46±28.46	-0.716*	0.475
TSH median (min-max)/	1.55 (0.01-6.30)	1.80 (0.40-4.10)	-1.470†	0.142
ALT median (min-max)/	19 (8-58)	16 (6-84)	-1.958†	0.050
AST median (min-max)/	17.50 (10-50)	16 (8-34)	-1.363†	0.173
IInsulin median (min-max)/	8.15 (1.30-115)	8 (1-38)	-1.016†	0.310
BMI mean±SD/	28.38±3.68	27.86±5.28	0.587*	0.559
BMR median (min-max)/	6964.50 (4540-10046)	6100 (4556-10075)	-1.855†	0.064
Weist circumference mean±SD/	97.53±11.70	97.62±12.47	-0.038*	0.970
Metabolic age mean±SD/	51.51±15.92	45.95±19.01	1.598*	0.113
TBW percent mean±SD/	50.17±5.79	49.78±8.77	0.274*	0.785
FFM median (min-max)/	56.75 (32.70-79)	47.10 (35-81)	-1.979†	0.048
Fat percent median (min-max)/	27.75 (12.30-54.70)	30.80 (3-45.50)	-0.295†	0.768
Fatmass mean±SD/	23.03±8.26	22.73±10.32	0.162*	0.871
Musclemasss median (min-max)/	53.85 (31-75.10)	44.70 (33.30-77.40)	-1.989†	0.047
Bonemass median (min-max)/	2.85 (1.70-3.90)	2.40 (1.80-4.94)	-1.591†	0.112
Visceral fat median (min-max)/	11.50 (6-27)	8.00 (1-18)	-4.309†	<0.001
Obesity grade mean±SD/	29.16±16.82	27.04±24.10	0.528*	0.598
HOMA-IR median (min-max)/	1.95 (0.26-8.57)	1.68 (0.18-7.04)	-1.311†	0.190

HDL; High density lipoprotein, LDL; Low density lipoprotein, TSH: Thyroid stimulant hormone, ALT; Alanin aminotranspherase, AST; Aspartate aminotranspherase, BMI: Body mass index, BMR: Basal metabolic rate, TBW: Total body water, FFM: Fat-free mass, HOMA-IR: Homeostasis model assessment-insulin resistance

Multivariate logistic regression analysis showed that gender (B= -1.438, Wald=9.223, p=0.002), smoking (B=-1.672, Wald=4.275, p=0.039), body weight (B=-0.061, Wald=6.235, showed that visceral fat value (B=-0.365, Wald=17.811, p<0.001) and degree of obesity (B=0.033, Wald=4.814, p=0.028) were independent predictors of increasing risk of ERD (**Tablo 6**).

Table 6. Logistic regretion analysis

Değişken	B	Wald	p
Cinsiyet (Step 6)	-1.438	9.223	0.002
Sigara kullanımı (Step 6)	1.672	4.275	0.039
Kilo (Step 3)	-0.061	6.235	0.013
Viseral yağ (Step 6)	-0.365	17.811	<0.001
Obezite derecesi (Step 6)	0.033	4.814	0.028

DISCUSSION

Gastroesophageal reflux disease and its complications including ERD, Barrett's oesophagus, and oesophageal adenocarcinoma are increasing worldwide.[12,13] Obesity plays an important role in the development of GERD by impairing the function of the lower oesophageal sphincter, increasing stomachacid and intra-abdominal pressure.[14] Recent studies have shown that transient lower oesophageal sphincter relaxations (TLESRs) is the most important factor in the pathophysiology of GERD. TLESR is the most common reflux mechanism in patients with normal sphincter pressure. It occurs independently of swallowing, is not association with oesophageal peristalsis, lasts longer (>10 seconds) than LES relaxation associated with swallowing, and is associated with inhibition of the crural diaphragm.[15]

In a systematic meta-analysis including 12 population-based studies, 8 studies from Asian countries, 2 from Europe, and 1 from the United States, evaluating the data of 67056 patients between 1997 and 2011, reflux esophagitis was found to occur less frequentlyin femalethan in male. Male gender was identified as an independent risk factor for ERD.[16] In a study conducted by Nam et al.[17] the effects of dietary factors on erosive and non-erosive reflux in 11690 people in Korea in 2017, and it was reported that erosive reflux was more common in male, while non-erosive reflux was more common in female. In a study by Nurleili et al.[18] male formed the majority in the group with ERD, while female formed the majority in the group with NERD. They explained this by the fact that female are more aware of the symptoms compared to male.[18] In the experimental study conducted by Masaka et al.[19] The effects of gender on the risk of developing ERD in and the controlling effect of oestrogen on oesophageal mucosal damage were investigated. It has been reported that oestrogen has an anti-inflammatory effect that can modulate the immune system, such as cell activation and proliferation, cytokine production, and wound healing. This has been suggested as the reason for the lower incidence of erosive esophagitis in female than male. In the present study, which is consistent with the literature,the majority of patientsthe ERD are male, and the majority of the NERD group are female.A study by Chung et al.[20] reported that smoking, alcohol consumption, and metabolic syndrome were associated with an increased risk of reflux esophagitis. In a study of 9840 asymptomatic Japanese male patients conducted by Gunji et al.[21] ERD was found in 1831 patients, and factors such as alcohol, smoking, metabolic changes and hiatal hernia were shown to increase the risk of ERD. Consistent with the literature, we found that smoking increased the risk of ERD, but we found no association with alcohol consumption. This could be due to the small number of patients who consume alcohol. It is known that serum TSH levels are higher in obese individuals. Increased accumulation of fat in the body leads to disruption of the hypothalamic-pituitary-thyroid axis and various disorders of thyroid function.[22,23] In obesity, increased expression of pro-inflammatory cytokines such as tumor necrosis factor (TNF)-α, interleukin (IL)-1, IL-6 inhibits sodium-iodine mRNA expression and iodine uptake in thyrocytes, leading toa reversible increase in TSH. In our study, the values of glucose, insulin, TSH, ALT, and HOMA-IR did not differ significantly between the patient and the control groups. Metabolic syndrome, animportant public health problem, is considered to be a combination of metabolic abnormalities such as abdominal obesity, hypertension, hyperglycaemia, low-density lipoprotein cholesterol (HDL-C), and high triglycerides.[24] Numerous studies have shown that metabolic syndrome is associated with ERD.[25,26] Some studies have reported that abdominal obesity, the main component of metabolic syndrome, may be a stronger predictor for ERD than obesity. A study conducted by Hsieh et al.[27] in Taiwan to examined the effect of metabolic syndrome components on ERD and they found that there was a linear relationship between the number of metabolic syndrome components and the severity of ERD. The results of the present study are consistent with previous studies that found a significant association between hypertension and ERD.[28,29] In our study, the presence of hypertension was statistically significant in ERD group compared to NERD and control groups. The majority of hypertensive patients in the ERD group were using angiotensin-converting enzyme inhibitors. The high rate of hypertension in the ERD group was associated with visceral adiposity, which is a risk factor for both diseases, rather than a cause-and-effect relationship.

Many studies have suggested that an increased BMI increases thesymptoms of GERD or the risk of development of ERD.[25,30,31] Fujikawa et al.[32] reported a significant relationship between increased BMI and GERD symptoms in patients with NAFLD. In a cohort study of 6215 individuals with GERD conducted by Nocon et al.[33] they examined the effects of BMI on reflux symptoms, frequency, and severity of esophagitis and showed that higher BMI was associated with frequency and severity ofreflux symptoms and an increase in the frequency of esophagitis. Ayazi et al.[34] evaluated 1659 patients with 24-hour pH monitoring and manometer between 1998 and 2008, divided them into four groups based on their BMI values, and assessed their LES pressure and oesophageal acid exposure. In their comparison, increased BMI showed a positive correlation with increased oesophageal acid exposure, and patients with higher BMI were found to have a higher prevalence of defective LES.The likelihood of having a mechanically defective LES was more than twice as high in obese patients compared to normal-weight patients. Our study, no significant difference in BMI values was found between all groups.

In a study of 265 Japanese male with metabolic syndrome conducted by Sogabe et al.[35] it was shown that the risk of developing ERD was higher in individuals with highvisceral fat than those with more subcutaneous fat tissue. In their study, individuals with metabolic syndrome without symptoms of reflux or dyspepsia underwent ultrasonography, visceral and subcutaneous fat tissues were determined and then upper gastrointestinal endoscopy was performed. It has been reported that the frequency of ERDis higher in these individuals with metabolic syndrome, which is consistent with the literature. Several studies have demonstrated the association between visceral adiposity and increased risk of erosive esophagitis, using expensive imaging modalities such as CT, MRI, and ultrasound to assess visceral fat percentages.

Ze et al.[28] performed endoscopy, blood analysis of metabolic parameters, measurement of waist circumference and CT to examine fat distribution in 728 patients over the age of 40 and reported that patients with ERD had a significantly higher visceral to subcutaneous fat ratio. In a study conducted by Nurleili et al.[18] to determine the difference in visceral fat between patients with ERD and NERD. The gastroesophageal reflux disease questionnaire (GERDQ) was administered to patients, upper gastrointestinal endoscopy was performed in 56 patients diagnosed with reflux based on the questionnaire, and their visceral fat ratio was examined by ultrasonography. ERD was found in 54% of the patients, and it was reported that 64% of these patients were men. As a result of the study, visceral fat thickness measurements did not differ significantly between the NERD and ERD groups. However, it was reported that the severity of esophagitis tended to increase with increasing visceral fat thickness.

Visceral adipose tissue is a source of inflammatory cytokines and is associated with systemic inflammation in obese individuals. Both subcutaneous and visceral fat are considered major features of the metabolic syndrome, and in particularly an excessive accumulation of visceral fat releases several bioactive substances known as adipokines, including TNF-a, resistin, leptin, and adiponectin. These mediators may affect the stomachand/or esophagogastric junction. It has been reported that pro-inflammatory cytokines, such as IL-1 and TNFα, stimulate gastrin secretion around the gastric antrum.[36] Thus, pro-inflammatory mediators such as adipokines can exacerbate or maintainlocal inflammation in the esophagogastric junction afterpathological exposure to oesophageal acid.[35] In addition, obesity is known to be associated with an increased frequency of tLESR and increased acid exposure.[37] However, the underlying metabolic mechanisms and whether other factors play a role in the pathogenesis of erosive esophagitis associated with obesity remain unclear. In our study, higher values of visceral fat percentage, FFM, and muscle mass were found in the ERD group compared with the NERD and control groups. The reason for the high values of FFM and muscle mass in the ERD group is that most of the patients in this group are male. Our study is important in terms of demonstrates the association between visceral adiposity and ERD, regardless of an increase in body fat composition.

This is the first study to assess the relationship between ERD and visceral fat percentage using Tanita, a quantitative, easy-to-use and person-independent method. The present results can contribute to the literature by showing the relationship between adipose tissue and body fat composition studied in the physiopathology of many diseases such as GERD and ERD, which are contemporary disease groups. In patients with GERD complications in our study, Tanita, a method that supports lifestyle changes, which is the first step of treatment, can be used in routine clinical practise and may guide future studies.

CONCLUSION

When the ERD group was compared with the NERD and the control groups, it was found that visceral adiposity was significantly higher in the ERD group. There was no significant difference between the NERD and the control groups. This suggested that visceral adiposity may be a risk factor for ERD. Despite similar mean BMI values across all groups, the statistically significant presence of visceral adiposity in the ERD group suggests that visceral adiposity is a more serious problem than obesity.When comparing the ERD and NERD groups except for the control group, it was found that the majority of patients in the ERD group were male and smokers. Our study confirmed that male gender, smoking, and metabolic syndrome increase the risk of ERD, as has been previously established. A limitation of our study was the high number of smokers in the ERD group. A noteworthy aspect of our study is that this is the first study to assess the relationship between ERD and visceral fat percentage using Tanita in the literature.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Kırıkkale University Clinical Researches Ethics Committee (Date: 26.02.2019, Decision No: 03/04).

Informed Consent: Written consent was obtained from the patient participating in this study.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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