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Research Article / Araştırma Makalesi

Turkish adaptation, validity, and reliability study of the Low Energy Availability in Females Questionnaire (LEAF-Q)

Kadınlarda Düşük Enerji Kullanılabilirliği Anketi (LEAF-Q-Tr)'nin Türkçe'ye uyarlama, geçerlilik ve güvenilirlik çalışması

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ABSTRACT

Objective: This study aimed to adapt the Low Energy Availability in Females Questionnaire (LEAF-Q) to Turkish language.

Materials and Methods: After obtaining the necessary permissions, translation and back-translation of the questionnaire were provided by independent experts, and the Turkish version was obtained. Opinions from 52 athletes were gathered to ensure the content validity. The Turkish version of the questionnaire and the SCOFF Questionnaire were applied to 125 female athletes to evaluate the construct, predictive and concurrent validity. Reliability was evaluated through a test-retest process involving 23 athletes.

Results: The Item-Content Validity Index (I-CVI) values ranged from 0.92 to 1.00. The Scale-Content Validity Index (S-CVI) value of the questionnaire was determined as 0.98. When the predictive validity was examined, the Eta coefficient was determined as 0.514 and the Phi coefficient as 0.425 ($p<0.001$). According to the risk category of the SCOFF Questionnaire, the LEAF-Q score of the athletes in $Group_{SCOFF\ without\ risk}$ was 4.53±0.41, while the LEAF-Q score of those in the $Group_{SCOFF\ at\ risk}$ was 7.14±0.47 ($p<0.001$). A weak-moderate positive correlation was found between LEAF-Q and SCOFF Questionnaire scores ($r=0.429$, $p<0.001$). The Intraclass Correlation Coefficient (ICC) value of the questionnaire was calculated as 0.803 from the test-retest phase. In the Bland-Altman plot test, the results are found to be reliable with 95% of them distributed within the range of -4 to +4. LEAF-Q total scores and LEAF-Q risk category did not significantly differ in the test-retest phase ($p>0.05$).

Conclusion: Overall, the Turkish adaptation, validity, and reliability of the LEAF-Q were ensured.

Keywords: *Female athlete, LEAF-Q, validity, reliability*

ÖZ

Amaç: Bu çalışmada, 'Kadınlarda Düşük Enerji Kullanılabilirliği Anketi (LEAF-Q-Tr) (*İng. Low Energy Availability in Females Questionnaire (LEAF-Q)*)'ni Türkçeye uyarlamak amaçlanmıştır.

Gereç ve Yöntemler: Gerekli izinlerin alınmasından sonra, birbirlerinden bağımsız uzmanlar tarafından anketin çevirisi ve geri çevirisi sağlanıp anketin Türkçe versiyonu elde edilmiştir. Anketin kapsam geçerliliğini sağlamak için 52 sporcunun görüşleri alınmıştır. Anketin Türkçe versiyonu ve REZZY Yeme Bozuklukları Ölçeği 125 kadın sporcuya uygulanarak yapı, kestirim ve uyum geçerliliği değerlendirilmiştir. Anketin güvenilirliği, 23 sporcunun dahil edildiği test-retest süreci ile değerlendirilmiştir.

Bulgular: Maddelerin Madde-Kapsam Geçerliliği İndeks değerleri 0,92-1,00 aralığında saptanmıştır. Anketin Ölçek-Kapsam Geçerliliği İndeks değeri 0,98 olarak belirlenmiştir. Anketin kestirim geçerliliği incelendiğinde Eta katsayısı 0,514 ve Phi sayısı 0,425 ($p<0,001$) olarak belirlenmiştir. REZZY Yeme Bozuklukları Ölçeği'nin risk kategorisine göre Grup $_{REZZY\ risksiz}$'de yer alan sporcuların LEAF-Q-Tr puanı 4,53±0,41 iken Grup $_{REZZY\ riskli}$'dekilerin LEAF-Q-Tr puanı 7,14±0,47 bulunmuştur ($p<0,001$). LEAF-Q-Tr ve REZZY Yeme Bozuklukları Ölçeği puanları arasındaki zayıf-orta düzeyde pozitif yönlü ilişki tespit edilmiştir ($r=0,429$, $p<0,001$). Test-retest aşamasında elde edilen verilere göre anketin sınıf içi kolerasyon katsayısı değeri 0,803 olarak hesaplanmıştır. Bland-Altman plot testinde ise sonuçların %95'i -4 ile +4 aralığında dağılım göstererek güvenilir bulunmuştur. Test-tekrar test aşamasındaki LEAF-Q-Tr toplam puanları ve LEAF-Q-Tr risk kategorisi fark oluşturmamıştır ($p>0,05$).

Sonuç: Böylece Kadınlarda Düşük Enerji Kullanılabilirliği Anketi (LEAF-Q-Tr)'nin Türkçeye uyarlanması, geçerliliği ve güvenilirliği sağlanmıştır.

Anahtar Sözcükler: *Kadın sporcu, LEAF-Q-Tr, geçerlilik, güvenilirlik*

INTRODUCTION

In sports medicine, it is essential to identify individuals at risk, prevent sports injuries, and ensure their participation in sports at the optimal level by protecting their health. It has been pointed out that there may be gender-specific effects in sports-related injuries with the increase in women's participation in sports activities (1). The female athlete triad

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is a problem characterized by low energy availability, functional hypothalamic amenorrhea, and osteoporosis. If this situation is not recognized early, the athlete may face irreversible health problems (2).

Overexercising or underfueling can cause Relative Energy Deficiency in Sport (RED-S). RED-S is the impaired physiological functioning caused by relative energy deficiency. RED-S includes impairments of metabolic rate, menstrual function, bone health, immunity, protein synthesis, and cardiovascular health. Chronic low energy availability leading to RED-S can limit training adaptation and substantially increase injury risk (3). RED-S has low energy availability at its core (4).

Low energy availability is the situation the energy received is insufficient to meet the body's primary physiological functions (5). This causes adverse effects on the general health and performance of the athlete. In case consuming insufficient nutrients according to energy requirements, disruptions occur in many body functions; including growth, immunity, thermoregulation, gastrointestinal system functions, and endocrine functions (6). Health issues caused by low energy availability such as the depletion of muscle glycogen stores, muscle mass losses, anemia, fluid-electrolyte imbalances, disruption of bone structure, and stress fractures negatively impact athletic performance and lead to sports injuries (7).

The daily optimal energy value recommended to maintain all physiological functions has been reported as at least 45 kcal/kg lean body mass; it has been found that when the energy level in the female body drops below the level of 30 kcal/kg lean body mass, pulsatile LH secretion is impaired, and this can result in menstrual dysfunction (8). Studies have shown that the risk of musculoskeletal injuries increases in female athletes due to restricted eating behaviour, menstrual dysfunction, and low bone mineral density. Also, when there is prolonged energy deficiency exposure, intestinal function impairments and mucosal atrophy occurs in the gastrointestinal tract, that may result in gastrointestinal problems such as diarrhoea, constipation, and motility disorders (9).

Low bone mineral density may increase incidence of injury. Stress fractures develop from recurring excessive strain caused by repetitive microtrauma to bone at a rate greater than repair. An increased risk of injury has been observed among athletes, particularly younger ones, who exhibit components of the RED-S. Therefore, it is crucial to promptly detect the strains and sprains that athletes experience (8).

Various questionnaires can be used to identify symptoms of low energy availability. One of these tools is the 'Low Energy Availability in Females Questionnaire (LEAF-Q)' published in 2014 by Melin et al. (10). This questionnaire was developed as a screening tool to enable early diagnosis of energy deficiency in female athletes. The questionnaire includes questions about injuries, gastrointestinal system functions, and reproductive functions to identify female athletes who may be at risk.

Early detection of low energy intake and taking necessary precautions are critical in protecting athletes' health. It has been seen that tools related to RED-S in Turkish language are limited in current literature. Therefore, this study aimed to adapt the LEAF-Q to Turkish.

MATERIAL and METHODS

In validity and reliability studies, it is recommended to reach participants at least 2-10 times the number of items used (11). Our study aimed to reach at least 100 participants since there were 26 items in the LEAF-Q. The characteristics of the participants in the original article served as a reference for selection. Inclusion criteria were defined as follows: being a female athlete between 18 and 40 years old, not being pregnant, not using contraceptive methods other than oral contraceptives, not having an active musculoskeletal injury, engaging in active training, and being willing to complete the survey.

Translation and adaptation from the original language to Turkish

The questionnaire was translated into Turkish by two independent field experts (sports medicine) and a non-field expert (linguist) who speaks English fluently. The three translations created were converted into a single questionnaire by two field experts by correcting the conceptual errors and inconsistencies. The questionnaire, translated into Turkish, was back-translated into English by a native English speaker who did not see the original version of the test beforehand but had a good command of Turkish. All translations were compared with the original, and the Turkish version of the questionnaire was obtained (Appendix 1). The scoring key was also translated into Turkish (Appendix 2).

To evaluate the clarity of the Turkish questionnaire, a 4-point Likert rating ('1- Completely understood, 4- Not understood') and open-ended questions were prepared to increase clarity. This form was used to express an opinion on the clarity of the questionnaire.

Content validity

Content validity was obtained by taking the opinions of 52 female athletes with a mean age of 23.84 years (n=18, 34.6% team sports; n=34, 65.4% individual sports discipline). Content validity was ensured by determining that the I-CVI

values of the items were calculated in the range of 0.92-1.00, and the S-CVI value of the questionnaire was 0.98.

Pilot study

With the questionnaire form translated into Turkish and with content validity, the SCOFF Questionnaire (12), and The Eating Attitude Test-26 (EAT-26) (13) Turkish versions were applied to 125 females (n=36, 28.8% team sports; n=89, 71.2% individual sports discipline) athletes with a weekly training duration of 4 hours or more, simultaneously in a face-to-face environment. The participants themselves filled in the questionnaires. The study did not include those who are younger than 18 years and older than 40 years, pregnant, use contraceptive methods other than oral contraceptive drugs, and have active injuries that prevent them from training for two weeks or more.

SCOFF Questionnaire: It is a scale whose validity and reliability in Turkish have been provided by Aydemir et al. (12). Eating disorders can be screened with a small number of items through this scale. The scale consists of five items in total. The developers created the acronym SCOFF from the questions. The SCOFF questions (14);

- Do you make yourself **S**ick because you feel uncomfortably full?
- Do you worry that you have lost **C**ontrol over how much you eat?
- Have you recently lost more than **O**ne stone (14 lb) in a 3-month period?
- Do you believe yourself to be **F**at when others say you are too thin?
- Would you say that **F**ood dominates your life?

The participants give 1 point to each item that fits them. A score between 0 and 5 can be obtained from the scale. A participant's score of 2 or more on the scale is considered risky regarding eating disorders. In the reliability analysis of the Turkish version of the scale, the internal consistency coefficient was 0.74 (12).

Eating Attitude Test-26: It is a tool adapted to Turkish by Ergüney-Okumuş et al. (13) and consists of 3 parts. There are 7 questions about the participants' demographic information in the part A, 26 questions about the eating habits in the part B, and 5 questions about the eating behaviours in the part C. Parts A and C of the scale are not included in the scoring, and information that may be needed regarding eating disorders can be obtained from these parts. The answers given to the first 25 items in section B are scored as 3 for 'Always', 2 for 'Very often', 1 for 'Often', and 0 for 'Sometimes', 'Rarely', and 'Never'. In the 26th item with reverse scoring, 'Sometimes' 1, 'Rarely' 2, 'Never' 3, while 'Always', 'Very often' and 'Often' statements correspond to 0 points. If the score obtained from the scale is 20 and above, it is thought there is a deterioration in eating attitudes. In the Turkish reliability analysis of EAT-26, the internal consistency coefficient was reported as 0.84, and the test-retest reliability as 0.78 (13).

Reliability of the questionnaire

To test the reliability of the questionnaire, 23 (18.4%) of the athletes who participated in the pilot application participated in the retest phase and answered the questionnaire again after 15 days. The sample size was calculated using the sample size calculator provided by Borg et al. (15), available at https://wnarifin.github.io/ssc/ssicc.html.

Validity of the questionnaire

Construct validity of the questionnaire was determined according to the LEAF-Q scores of the athletes in the independent groups grouped as 'no risk' and 'with risk' according to the SCOFF Questionnaire.

The relationship between female athletes' LEAF-Q, SCOFF Questionnaire, and Eating Attitude Test-26 scores was evaluated to determine concurrent validity of the questionnaire. The questionnaire's predictive validity analyses were performed by considering the LEAF-Q scores of the athletes in independent groups grouped as 'no risk' and 'with risk' according to the SCOFF Questionnaire and risk categories according to LEAF- Q.

Ethical aspect of research

To adapt the questionnaire to Turkish, permission was obtained from Anna Melin et al. (10), who developed the LEAF-Q, via e-mail on 12.01.2021. The study was approved by the local ethics committee's decision dated 03.02.2021 and numbered 62.

Statistical analysis

SPSS v.23 package programs were used for the descriptive characteristics of the participants and the validity and reliability analyses of the questionnaire. Whether the quantitative data fit the normal distribution was checked with the Shapiro-Wilk Test. Independent-Samples Mann-Whitney U and Chi-Square tests were used in the difference analysis of independent groups formed according to the risk category of the SCOFF Questionnaire. Descriptive characteristics of the participants; were presented as frequency (n), percentage (%), and mean ± standard error.

For content validity of the questionnaire, I-CVI values were calculated with the formula agreed item/number of experts, and the S-CVI value was calculated with the formulas

of the sum of I-CVI scores/number of items (16). The lowest acceptable value was 0.78 for I-CVI and 0.80 for S-CVI (16).

The reliability of the questionnaire was determined by analyzing the test-retest scores with the Intraclass Correlation Coefficient (ICC), Bland-Altman plot test, McNemar test, and dependent groups t-test. The lowest acceptable value for the ICC was determined as 0.70 (17). It was desired that 95% of the data distributed in the Bland-Altman plot should be between the 'mean of differences - 1.96 x standard deviation of differences' and 'mean of differences + 1.96 x standard deviation of differences' (17). McNemar test and Related-Sample Wilcoxon Signed A $p>0.05$ as a result of the rank test was interpreted as the test-retest results being indifferent (17).

Construct validity was interpreted by examining the LEAF-Q values of independent groups grouped according to the risk level in the SCOFF Questionnaire according to the Independent-Samples Mann-Whitney U test result. A $p<0.05$ was accepted as an indication of a difference between the groups (17).

The Spearman correlation test was used in concordance validity analyses. r value when $p<0.05$; $0<r<0.20$ poor; $0.20\leq r<0.40$ fair; $0.40\leq r<0.60$ moderate; $0.60\leq r<0.80$ strong; $0.80\leq r<1$ was accepted as very strong relationship (18).

The Eta coefficient and Phi number were calculated by considering the LEAF-Q values and LEAF-Q risk categories of independent groups grouped according to the risk level in the SCOFF Questionnaire. The Eta and Phi coefficients when $p<0.05$; 0.00-0.19 very low; 0.20-0.39 low; 0.40-0.69 moderate; 0.70-0.89 strong; 0.90-1.00 were accepted as very strong relationship (17).

RESULTS

The pilot study included 125 female athletes aged 21.93±0.43 years. While the current body mass index (BMI) of the athletes is 21.09±0.25 kg/m^2, the highest BMI is 22.53±0.31 kg/m^2, and the lowest BMI is 19.18±0.18 kg/m^2. The smoking rate among athletes was determined as 5.6% (n=7). Regular drug use for treatment, except for oral contraceptives, was 11.2% (n=14). The training duration of the participants was calculated as 6.69±0.25 hours/week. While the LEAF-Q score of female athletes was 5.76±0.33, according to LEAF-Q, the presence of risk was 28.8% (n=36). The SCOFF Questionnaire score was determined as 1.45±0.11. The EAT-26 total score was 10.42±1.00, sub-dimension scores were 1.59±0.25 in bulimia and food preoccupation, 5.77±0.61 in dieting, and 3.07±0.33 in oral control.

Reliability

For the reliability phase of the questionnaire, 23 female athletes were included in the test-retest phase. According to the data obtained, the ICC value of the questionnaire was 0.803 (at 95% Confidence Interval lower bound =0.668; upper bound =0.902) and was found reliable.

The mean of the differences in the Bland-Altman plot test was 0.478 (at 95% Confidence Interval lower bound=-0.539; upper bound=1.495), and the standard deviation of the differences was 2.352, while the p-value was 0.340. Thus, 95% of the test and retest results were reliable, ranging from -4 to +4 (Figure 1).

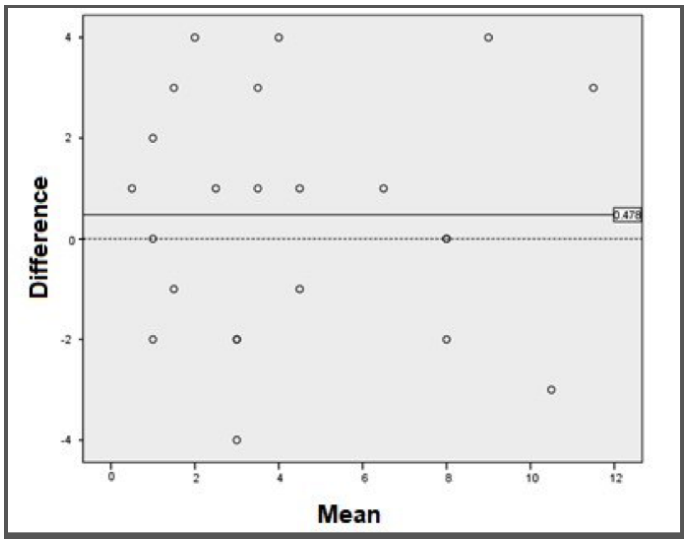

Figure 1. Reliability of test-retest LEAF-Q total scores

Considering the LEAF-Q total scores, no difference was found when the test-retest results were subjected to the Related-Sample Wilcoxon Signed Rank Test (test LEAF-Q score= 4.17±0.72; retest LEAF-Q score= 4.65±0.73; p=0.366). When dependent groups were formed according to the LEAF-Q risk category and the McNemar test was applied, no difference was found between the test-retest results (p=1.00), (Table 1).

Table 1. Reliability of test-retest LEAF-Q risk category distributions

		Retest the LEAF-Q risk category			
		No risk	Risky	Total	p value
Test LEAF-Q risk category	No risk	17 [a]	1 [b]	18	1.00
	Risky	1 [a]	4 [b]	5	
	Total	18	5	23	

[a,b]: Each upperscript letter denotes a subset of Retest LEAF-Q risk categories whose column proportions do not differ significantly from each other at the 0.05 level.

Construct validity

When the risk category was determined according to the SCOFF Questionnaire and the difference analysis was made in independent groups, the LEAF-Q score of the athletes in Group $_{\text{SCOFFwithout risk}}$ was 4.53±0.41, while the LEAF-Q score of those in Group $_{\text{SCOFF at risk}}$ was 7.14±0.47 ($p<0.001$), (Table 2). Thus, the questionnaire provided construct validity.

Table 2. Construct validity of the LEAF- Q

	Risk category according to the SCOFF Questionnaire Group		
	SCOFF without risk (n = 66)	SCOFF at risk (n = 59)	p-value
Age, years	22.11±0.54	21.73±0.68	0.123
Current BMI, kg/m²	21.05±0.32	21.14±0.38	0.917
The highest BMI, kg/m²	22.32±0.41	22.76±0.46	0.318
The lowest BMI, kg/m²	19.27±0.23	19.09±0.29	0.517
Feature of sports discipline, n (%) Team / n (%) Individual	20 (30.3) / 46 (69.7)	16 (27.1) / 43 (72.9)	0.846
Training time, hours/week	6.11±0.26	7.36±0.42	0.041*
LEAF-Q score	4.53±0.41	7.14±0.47	<0.001*
Presence of LEAF-Q risk, n (%)	7 (10.6)	29 (49.2)	<0.001*
SCOFF Questionnaire score	0.42±0.06	2.59±0.09	<0.001*
EAT-26 total	6.74±1.06	13.96±1.54	<0.001*
EAT-26 bulimia and food preoccupation	0.64±0.22	2.50±0.40	<0.001*
EAT-26 dieting	3.60±0.69	7.85±0.90	<0.001*
EAT-26 oral control	2.50±0.41	3.62±0.51	0.054
Smoking, n (%)	3 (4.5)	4 (6.8)	0.706
Regular drug use for treatment, n (%)	7 (10.6)	7 (11.9)	1,000

BMI: Body mass index. *: The p-value is significant at the 0.05 level. The Score Ranges; SCOFF Questionnaire: 0 to 5. EAT-26 Total: 0 to 78. EAT-26 Bulimia and Food Preoccupation: 0 to 18. EAT-26 Dieting: 0 to 39. EAT-26 Oral Control: 0 to 21. A total score ≥8 from LEAF-Q is to be considered at risk for the Triad.

Predictive validity

When the risk category was determined according to the SCOFF Questionnaire and the predictive validity of the questionnaire was examined with both the LEAF-Q score and the LEAF-Q risk category values (Table 2), the Eta coefficient was determined as 0.514 and the Phi number as 0.425 ($p<0.001$). Thus, it was detected that LEAF- Q provided moderate predictive validity with the SCOFF Questionnaire.

Concurrent validity

A fair-moderate positive correlation was found when the concurrence of the LEAF-Q score, the SCOFF Questionnaire, and the EAT-26 scores were analyzed using the Spearman correlation test (Table 3).

Table 3. Concordance validity of the LEAF- Q

		LEAF-Q score
SCOFF Questionnaire score	Correlation Coefficient	0.429 **
	p value	<0.001
EAT-26 total	Correlation Coefficient	0.315 **
	p value	0.001
EAT-26 bulimia and food preoccupation	Correlation Coefficient	0.358 **
	p value	<0.001
EAT-26 dieting	Correlation Coefficient	0.273 **
	p value	0.006
EAT-26 oral control	Correlation Coefficient	0.205 *
	p value	0.038

*: Correlation is significant at the 0.05 level (2-tailed)., **: Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

When the data obtained from the study were evaluated, it has been seen that validity and reliability of Turkish adaptation of LEAF-Q were ensured. While the total LEAF-Q score of the participating female athletes was 5.76±0.33, the presence of risk was determined as 28.8% according to LEAF-Q.

In the literature, LEAF-Q scores and the risk of eating disorder change according to sports disciplines and level of par–

ticipation. Meng et al. evaluated the risk of low energy availability in Chinese elite and recreational female aesthetic sports athletes using the LEAF-Q. They reported that 55.8% of elite aesthetic sports athletes and 35.1% of recreational aesthetic sports athletes were identified as being at increased risk of low energy availability (4). In the study of Carr et al., within a population of elite cross-country skiers in Sweden, an increased low energy availability risk was reported in 31% of athletes (19). In another study by Witkos et al., an assessment of relative energy deficiency using the LEAF-Q showed low energy availability in 23.3% of female triathletes (9).

In the article published by Melin et al., who developed the questionnaire, getting 8 or more points from the LEAF questionnaire was defined as risky regarding the female athlete triad. In addition, cut-off values that may indicate dysfunction were determined for the subgroups of the questionnaire. These values are; 2 and above for injuries, 2 and above for gastrointestinal function, and 4 and above for menstrual function (10).

De Maria et al. performed an adaptation, validity, and reliability study of the LEAF questionnaire to Brazilian culture (20). When the researchers subjected the differences between the normally distributed test-retest scores of 54 athletes to the Bland-Altman plot analysis, they showed that 95% of the results were between -4 and +4 points. No statistically significant change was observed in the paired t-test results between the mean test-retest scores and the McNemar test they used to evaluate the change according to the LEAF-Q risk categories. Thus, it was reported that the reliability of the Brazilian version of the questionnaire was reinforced (20). Similarly, in our study, according to the mean of the differences in the Bland-Altman plot test, 95% of the test-retest results were reliable, showing a range of -4 to +4. When the test-retest results were subjected to the Related-Sample Wilcoxon Signed Rank test considering the LEAF-Q total scores, and dependent groups were formed according to the LEAF-Q risk category and the McNemar test was applied, no difference was found between the test-retest results. In the light of these findings, the reliability of the Turkish version has been demonstrated.

In the original version developed by Melin et al., the ICC value was reported as 0.79 in test-retest measurements evaluated at two-week intervals (10). The test-retest reliability of the Brazilian version of the LEAF-Q, evaluated at a two- to four-week interval, was excellent, with an ICC of 0.92 (20). In our study, the ICC value of the questionnaire was calculated as 0.803, and it was found reliable, according to the data obtained from 23 female athletes who were included in the test-retest phase for the reliability phase of the questionnaire.

Validity can be expressed as a concept about how accurately a measurement tool can measure the feature it wants to measure without confusing it with any other features (17,21). With content validity, the extent to which each item in the scale and the whole scale serves the purpose is examined (21). In this study, the method of applying expert opinions, which is reported to be a practical approach to evaluate the content validity of the questionnaire, was used (17). In line with the recommendations in the literature, 0.78 for the I-CVI value and 0.80 for the S-CVI value were taken as the lowest acceptable value (16). The S-CVI value of the questionnaire was found to be 0.98. It has been determined that these calculated values are higher than the acceptable lower limits, thus ensuring content validity.

Construct validity is the expression of a pattern formed by specific elements or relations between elements that are considered to be related to each other (21). In this study, the SCOFF Questionnaire, which allows the risk determination of eating disorders, which can be a component of the female athlete triad, was used, and construct validity was ensured by revealing a significant difference between the risk categories of the groups and their LEAF-Q scores. Parallel to this study, Roger et al. found that the SCOFF score had been higher in participants categorized as at risk of the triad (22). Kendir et al. also reported that eating disorders are associated with low energy availability in athletes (23).

Predictive validity is obtained by calculating the correlation between the estimation score obtained from a scale and the criterion known to measure the characteristics to be measured (21). In our study, the risk category was determined according to the SCOFF Questionnaire, and the predictive validity of the questionnaire was examined with both the LEAF-Q score and the LEAF-Q risk category values. It was determined that the LEAF-Q provided moderate predictive validity with the SCOFF Questionnaire.

Concordance validity is evaluated as the correlation between the scores obtained from the scale and the specified criteria (21). Our study examined the compatibility of the LEAF-Q score with the SCOFF Questionnaire and EAT-26 scores, and a weak to moderate positive correlation was detected. This correlation was found at a weak to moderate level because the mentioned tools included the dimension related to eating behaviour. However, the questions about injuries and menstruation in the LEAF- Q did not have an answer.

The limitation of our study is the absence of measurement tools for assessing injury and menstruation dimensions. In–

corporating such tools would have been valuable for conducting concordance validity analyses.

CONCLUSION

This study presents a Turkish version of a questionnaire designed to identify low energy availability in female athletes. The Turkish version of the LEAF-Q was adapted with a focus on ensuring its validity and reliability. The LEAF-Q Turkish form serves as a valuable tool for screening Turkish female athletes for the risk of the female athlete triad, which is crucial for both their overall health and performance.

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We would like to thank all participants.

Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Suleyman Demirel University Medicine Faculty Ethics Committee (Decision No: 62, dated 03.02.2021).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept – EA,SE; Design - EA,SE; Supervision –SE; Materials–EA,SE; Data Collection and/or Processing – EA,SE; Analysis and İnterpretation– EA,SE; Literature Review – EA; Writing manuscript – EA,SE; Critical Reviews –EA,SE. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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