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Psychometric Properties of the Fear of Falling Scale for Older Adults–Turkish Version (FFSO-T): A Validity and Reliability Study

Short Title (Running Head): Turkish Version of the Fear of Falling Scale for Older Adults

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Abstract

Objective:

This study aimed to adapt the Fear of Falling Scale for Older Adults (FFSO), developed by Lee and Tak (2025), into Turkish and to evaluate its validity and reliability among older adults within the Turkish cultural context.

Methods:

This methodological study was conducted with 278 older adults aged 65 years and older who applied to the outpatient and inpatient clinics of Erzurum City Hospital between February and May 2026. Participants were recruited using a convenience sampling method, and data were collected through face-to-face interviews. The language adaptation process was performed using translation and back-translation procedures. Content validity was evaluated by 11 experts using the Davis technique. Construct validity was assessed through Confirmatory Factor Analysis (CFA).

Reliability analyses included Cronbach's alpha, McDonald's omega, item-total correlations, and test-retest reliability using the Intraclass Correlation Coefficient (ICC) with a 15-day interval.

Results:

The Scale Content Validity Index (S-CVI/Ave) was 0.995. CFA supported the original 21-item four-factor structure consisting of Unpredictability, Fragility, Vigilance, and Fear of Suffering Harm dimensions (χ^2/df=2.68, RMSEA=0.078, CFI=0.96, TLI=0.95, SRMR=0.064). The total Cronbach's alpha and McDonald's omega coefficients were both 0.919, while sub-dimension reliability coefficients ranged from 0.691 to 0.899 and from 0.701 to 0.901, respectively. Test-retest analysis demonstrated excellent temporal stability (ICC=0.991).

Conclusion:

The Turkish version of the Fear of Falling Scale for Older Adults (FFSO-T) demonstrated acceptable evidence of validity and satisfactory reliability among Turkish older adults. The FFSO-T may be used as a research instrument to evaluate multidimensional aspects of fear of falling in older adults. Further studies examining criterion validity, responsiveness, measurement invariance, and the distinctiveness of the latent constructs are recommended.

Keywords: Accidental Falls; Fear; Aged; Psychometrics; Geriatric Nursing

Introduction

The world population is aging at an unprecedented rate; it is expected that the global population will reach approximately 10 billion by 2050 and that older individuals will constitute a significant part of this population [1]. This demographic transformation is not only a numerical increase, but also a complex process that needs to be managed for health systems. Along with the aging population, the prevalence of geriatric syndromes such as frailty, depression, and loss of physical function is increasing; this situation both threatens individual quality of life and brings severe burdens to the global health economy [2-4]. Among the geriatric syndromes in question, falls are accepted as one of the leading causes of morbidity and mortality. Falls triggered by the decrease in physiological reserves and losses of balance are devastating events that can result in hip fractures, long-term hospitalizations, and even death [5, 6]. However, the effect of falls is not limited only to physical injuries. Even the event of a fall or just the perception of fall risk creates a severe psychological trauma and loss of confidence in the older individual, preparing the ground for the condition defined as "fear of falling" in the literature [4, 7].

Fear of falling, which is reported to affect 21% to 85% of community-dwelling older adults, demonstrates considerable variability across studies. This variation may be attributed to differences in participants' age distribution, functional status, previous fall experiences, assessment instruments used, and cultural characteristics of the studied populations [8, 9]. Fear of falling leads to a "vicious cycle" that causes older individuals to restrict their daily activities, and this restriction causes muscle atrophy, loss of balance, and ultimately, ironically, an even further increase in the risk of falling. Therefore, fear of falling is not only a result but also a strong predictor of future falls [10, 11].

In order for this risk to be managed, first of all, the level of fear must be accurately determined. However, when the current literature is examined, it is seen that the measurement tools used (for example, the Falls Efficacy Scale-International [FES-I]) generally focus on measuring "fall efficacy," which expresses the individual's self-confidence while performing certain activities [12]. The Short Falls Efficacy Scale-International (Short FES-I), developed as a brief version of the FES-I, assesses concerns about falling during selected daily activities and retains the activity-based conceptual framework of fall-related concerns rather than evaluating broader psychological dimensions of fear of falling [13]. Similarly, the Activities-specific Balance Confidence (ABC) Scale focuses mainly on individuals' perceived confidence in maintaining balance while performing various activities, whereas the Iconographical Falls Efficacy Scale (Icon-FES) evaluates concerns related to balance, mobility, and environmental challenges through activity-based scenarios [14, 15]. Although these instruments have substantially contributed to understanding fall-related self-efficacy and activity avoidance, they may not fully capture the multidimensional psychosocial components of fear of falling, such as perceived vulnerability, unpredictability of falls, hypervigilance toward the environment, and concerns about potential harm. Therefore, instruments specifically designed to assess these psychological and cognitive dimensions may provide additional information regarding specific components of fear of falling that are not fully captured by activity-based measures [10, 12, 14].

In Türkiye, the Falls Efficacy Scale-International (FES-I) has been adapted and validated for use among older adults and has been widely utilized to assess concerns about falling during daily activities [16]. However, similar to its original version [12], the Turkish FES-I primarily focuses on activity-related concerns about falling and perceived confidence in performing specific activities rather than the broader emotional, cognitive, and perceptual aspects underlying fear of

falling. Therefore, although the FES-I has made an important contribution to fall-related assessments, an instrument specifically designed to evaluate fear of falling as a multidimensional psychological construct may provide complementary information within the Turkish cultural context.

To address this gap, the Fear of Falling Scale for Older Adults (FFSO), developed by Lee and Tak (2025), conceptualizes fear of falling beyond activity avoidance or reduced self-efficacy by evaluating dimensions such as apprehension caused by unpredictable falls, anxiety about one's own fragility, increased vigilance toward the environment, and concern about potential harm after fall events [10]. This multidimensional framework may provide complementary information to existing activity-based measures by capturing psychological and cognitive aspects of fear of falling that may not be fully reflected in conventional fall efficacy scales. Therefore, adapting the FFSO into Turkish may contribute to the availability of a culturally appropriate instrument for assessing the multidimensional aspects of fear of falling among older adults. Accordingly, this study aimed to examine the validity and reliability of the Turkish version of the FFSO (FFSO-T).

Methods

Design

This study was designed as a cross-sectional psychometric validation study to evaluate the validity and reliability of the Turkish version of the Fear of Falling Scale for Older Adults (FFSO-T).

Participants and Sample

The study sample consisted of older adults who were admitted to the outpatient and inpatient clinics of Erzurum City Hospital between February and May 2026. Participants were recruited using a convenience sampling method. The researcher collected the data through one-on-one and face-to-face interview techniques. Both outpatient and inpatient older adults were included because the aim of this study was to evaluate the psychometric properties of the FFSO-T rather than to compare differences between healthcare settings. Including participants from different clinical contexts was considered appropriate to ensure variability in responses and to enhance the applicability of the scale among older adults.

Inclusion and Exclusion Criteria

The inclusion criteria for the study were: (a) being aged 65 years or older, (b) being open to communication, (c) having no diagnosed cognitive impairment that would prevent answering the

questions (Standardized Mini-Mental Test score ≥24), and (d) volunteering to participate in the research.

The exclusion criteria were: (a) having severe hearing or vision loss that prevented communication and (b) having a severe psychiatric or neurological disorder diagnosed by a physician**.**

Sample Size and Selection

Sample size adequacy was evaluated according to recommendations for confirmatory factor analysis (CFA). Although various criteria have been proposed for CFA sample size, a sample size of at least 200 participants is generally considered acceptable for stable parameter estimation in structural equation modeling [17]. In the present study, the final sample consisted of 278 older adults, which was considered adequate for testing the hypothesized four-factor structure of the FFSO-T using CFA.

Within the scope of the study, 308 older adults were approached. Of these, 20 individuals declined to participate, 5 individuals were unable to complete the questionnaire due to difficulties in responding to the items, and 5 individuals withdrew during the data collection process. Therefore, the final sample consisted of 278 eligible older adults who completed the assessment and were included in the final analysis.

Data Collection Tools

The data collection tools of the study consisted of the "Sociodemographic Information Form" and the "Fear of Falling Scale for Older Adults - FFSO."

Personal Information Form: This form, created by the researchers, contains questions aimed at determining the descriptive characteristics of older individuals and the factors that may be associated with falling. In the form, participants' age, gender, educational status, marital status, place of residence, income level, health insurance, and occupational status were questioned. Current working status was categorized according to participants' employment status at the time of data collection. Participants who were actively working at the time of data collection, including those who had officially retired but continued working, were classified as currently working, whereas retired individuals who were no longer working were classified as not currently working. In addition, information regarding the presence of chronic diseases, regular medication use, the status and number of falls in the last year, fall-related injury status, and the status of having balance/walking problems was also collected through this form. Fall-related injury was defined as

any physical consequence experienced following a fall. Minor injuries, such as bruises and abrasions, were also included in the injury category.

Fear of Falling Scale for Older Adults (FFSO): It was developed by Lee and Tak (2025) to evaluate the fear of falling in older individuals [10]. The scale consists of 21 items and has four sub-dimensions. The sub-dimensions are as follows: "Uneasiness caused by unpredictable falls" (Items 1-4), "Worry about one's own vulnerability" (Items 5-7), "Increased attention and vigilance regarding the environment" (Items 8-12), and "Worry about potential harm after falling events" (Items 13-21). The scale uses a 5-point Likert-type rating. Each item is scored as "Never (1)", "A little (2)", "Moderately (3)", "Frequently (4)", and "Very much/Strongly agree (5)". The total score that can be obtained from the scale ranges between 21 and 105. It is concluded that as the score obtained from the scale increases, the individual's level of fear of falling also increases. The reliability of the original version of the scale was evaluated with the Cronbach's Alpha coefficient, and it was reported to range between 0.835 and 0.965 for the total score and all factors [10].

Adaptation Process

The adaptation of the Fear of Falling Scale for Older Adults (FFSO) into Turkish and the cross-cultural adaptation study were carried out in three stages.

First stage (Translation, expert opinion, and creation of the pre-application form):

The original English version of the scale was independently translated into Turkish by two language experts proficient in both English and Turkish. The two forward translations were subsequently compared, discussed, and synthesized into a single reconciled Turkish version through consensus among the translators and the research team [18, 19]. The synthesized Turkish version was then submitted to a panel consisting of a total of eleven experts, including nine nursing experts with doctoral degrees in the fields of Public Health Nursing (3), Psychiatric Nursing (2), Internal Medicine Nursing (3), and Child Health and Diseases Nursing (1), all proficient in English and Turkish, one Turkish language expert, and one Sociology expert, to identify inadequate expressions and inconsistencies in the translation. The Content Validity Index (CVI) was calculated based on the experts' evaluations. Following Polit and Beck (2006), an I-CVI value of ≥0.78 is considered acceptable when the content validity evaluation is performed by a panel of 11 experts; therefore, a threshold of 0.80 was adopted in the present study. As a result of the analysis, no items were removed from the scale because there were no items with a CVI value below 0.80 [20]. Although all items demonstrated acceptable content validity (I-CVI ≥ 0.91), Item 4 received

a relatively lower expert rating than the other items. Specifically, 10 of the 11 experts rated Item 4 as 3 or 4, whereas one expert rated it as 2 (I-CVI = 0.91). This item was carefully reviewed based on expert feedback. Specifically, the initial Turkish wording of Item 4, "Kendi hareketlerime dikkat etsem veya çevreyi iyileştirsem bile düşebileceğimi düşündüğüm için endişeleniyorum" ("I feel anxious because I think I may fall even if I am careful with my actions or improve my surroundings"), was revised to "Hareketlerime dikkat etsem ve çevredeki düşme risklerini ortadan kaldırsam bile düşebileceğim düşüncesi beni endişelendiriyor" ("The thought that I may fall even if I am careful with my actions and eliminate fall risks in my surroundings makes me anxious"). This revision was made to improve the clarity and comprehensibility of the item for Turkish older adults while preserving its intended conceptual meaning. Following these revisions, the revised Turkish version was back-translated into English by two different language experts. After the back-translation process, item-by-item comparisons conducted by an expert (the third author) confirmed that there were no significant conceptual or linguistic differences between the original scale and the back-translated English version. Permission for the Turkish adaptation of the scale was obtained via email from the original scale developer prior to the study. The final Turkish version was not submitted to the original scale developer for further review. After these stages were completed, the pilot version of the Turkish scale was created.

Second stage (Pilot application): The pilot application was conducted to test the comprehensibility of the scale items by the target audience and to perform preliminary reliability analyses. During the pilot application, cognitive debriefing was conducted with participants to evaluate the comprehensibility, clarity, and cultural appropriateness of each item. Participants were asked to explain the meaning they attributed to each item and whether any wording caused difficulty in understanding. No discrepancies between the intended meaning of the items and participants' interpretations were identified, and no further modifications were required. In this stage, 30 older individuals who met the inclusion criteria were reached. As a result of the item analysis performed on the pilot application data, it was determined that the item-total correlation values of all items were above 0.30. Additionally, the Cronbach's Alpha internal consistency coefficient calculated for the entire scale was found to be above 0.70. Since these values are considered sufficient in the literature [21-23], no items were removed during the pilot stage, and the main application stage was initiated with the scale form consisting of 21 items.

Third stage (Main application): In the main application stage, fundamental analyses regarding the validity and reliability of the scale were performed. Data were collected by the researcher using a one-on-one and face-to-face interview technique, and the study was completed with 278 older individuals who met the inclusion criteria. Confirmatory Factor Analysis (CFA) was applied to test the structural validity of the scale. The fit indices obtained as a result of the analysis were compared with the reference values specified in the literature [24, 25], and it was observed that the four-factor original structure of the scale was confirmed for the Turkish form.

To evaluate the temporal stability of the scale (test–retest reliability), the scale was re-administered 15 days later to 39 participants randomly selected from the main application sample. The 15-day interval was selected based on recommendations in the literature suggesting that an interval of approximately 15–30 days is appropriate for test–retest reliability assessments [23, 26]. The consistency between the two measurements was evaluated by calculating the Intraclass Correlation Coefficient (ICC).

Statistical Analysis

Data were analyzed using SPSS version 27 and LISREL 8.80. Prior to statistical analyses, the dataset was examined for missing values. Because the questionnaires were administered face-to-face by the researchers, who verified the completeness of all responses before electronic data entry, no missing data were identified. Therefore, no missing data handling procedures were required.The distributional characteristics of the scale scores were assessed by examining skewness and kurtosis values (within the range of −2 and +2) and histogram plots. Potential outliers were examined using standardized scores, and no extreme observations requiring exclusion were identified. Item-total correlation coefficients and Cronbach's alpha coefficients were calculated to evaluate item performance and internal consistency reliability [23]. Since the FFSO items were measured on a 5-point Likert scale, they were treated as ordinal indicators. Therefore, confirmatory factor analysis (CFA) was performed in LISREL 8.80 using the Diagonally Weighted Least Squares (DWLS) estimation method based on the polychoric correlation matrix and asymptotic covariance matrix. This ordinal estimation approach does not require the assumption of multivariate normality and is considered appropriate for Likert-type categorical indicators. Because the FFSO was developed based on a theoretically established four-factor model, EFA was not performed in the present study. Instead, CFA was conducted to test whether the original factor structure could be confirmed in the Turkish population. This approach is consistent with recommendations for cross-

cultural adaptation and validation studies of instruments with an established theoretical structure [18, 27, 28]. To evaluate construct validity, model fit was assessed using the fit indices obtained from the LISREL analysis, including the Relative Chi-Square Index (CMIN/DF), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Residual (RMR). Acceptable model fit was evaluated according to established criteria: CMIN/DF <5, RMSEA <0.08, CFI >0.90, TLI >0.90, and SRMR/RMR <0.08 [23-25, 29]. The reliability of the scale was assessed using Cronbach's alpha coefficients and McDonald's Omega coefficients. A reliability coefficient above 0.60 was considered acceptable [30]. Additionally, test–retest reliability was examined to evaluate the temporal stability of the scale [23]. The intraclass correlation coefficient (ICC) was calculated using a two-way random-effects model with a consistency definition (ICC (2,1)). ICC values were interpreted according to established criteria, with values above 0.75 indicating good reliability and values above 0.90 indicating excellent reliability. The 95% confidence intervals (CIs) for ICC estimates were also reported. Convergent validity was further evaluated by calculating the Average Variance Extracted (AVE) and Composite Reliability (CR) for each latent construct. AVE values of ≥0.50 and CR values of ≥0.70 were considered indicative of adequate convergent validity; however, lower AVE values were considered acceptable when CR values were satisfactory and factor loadings were adequate [31]. Discriminant validity was assessed using the Fornell–Larcker criterion by comparing the square roots of the AVE values with the inter-factor correlations [31]. In addition, floor and ceiling effects were examined to evaluate the distribution of scores across the scale. Floor and ceiling effects were considered acceptable when fewer than 15% of respondents achieved the lowest or highest possible scores, respectively [28]. In accordance with the COSMIN framework, the present study evaluated the measurement properties relevant to the validation of the FFSO, including content validity, structural validity, internal consistency, and reliability (test–retest reliability). Other measurement properties, such as measurement error, hypothesis testing, criterion validity, and responsiveness, were not assessed because the primary aim of this study was to evaluate the factorial structure, reliability, and cultural appropriateness of an existing instrument rather than to examine diagnostic accuracy or responsiveness to change [28, 32].

Ethical Considerations

Permission for the study was obtained from a University Ethics Committee. Official permission was obtained via email from the owner of the scale regarding the adaptation of the scale used in the study into Turkish. The research was conducted in accordance with the principles of the Declaration of Helsinki.

Results

Table 1. Descriptive Characteristics of the Participants (n=278)

Characteristics	Number (n=278)	%
Age Groups		
65-74 years	204	73.4
75-84 years	60	21.6
85 years and over	14	5.0
Gender		
Female	156	56.1
Male	122	43.9
Marital status		
Married	230	82.7
Single	48	17.3
Educational status		
Illiterate	55	19.8
Primary Education	80	28.8
Secondary Education	38	13.7
High School	45	16.2
Bachelor's degree and above	60	21.6
Current Working Status		
Currently working	134	48.2
Not currently working	144	51.8
History of Falling in the Past Year		
Yes	135	48.6
No	143	51.4
Injury Due to Falling		
Did not fall	143	51.4
Fell but not injured	13	4.6
Fell and injured	122	44
Number of Regularly Used Medications		
None	59	21.2
1–3 medications	176	63.3
4 or more medications	43	15.5
Chronic Disease Status		
Yes	121	43.5
No	157	56.5
Visual Problems		

Yes	163	58.6
No	115	41.4
Independence in Activities of Daily Living		
Completely independent	121	43.5
Needs minor assistance	121	43.5
Needs significant assistance	32	11.5
Completely dependent	4	1.4
Concerns About Balance		
Yes	102	36.7
No	176	63.3
In-home Physical Activity Level		
Mostly sitting during the day	118	42.4
Frequently standing and walking around	160	57.6
Perception of Environmental Safety Against Falls		
Yes (Safe)	204	73.4
No (Unsafe)	74	26.6

Note: Currently working refers to participants who were actively working at the time of data collection, including those who had officially retired but continued working. Fall-related injury refers to any physical consequence experienced following a fall. Minor injuries, such as bruises and abrasions, were also included in the injury category.

The majority of the participants were in the 65–74 age group (73.4%), female (56.1%), and married (82.7%). The most common education level was primary education (28.8%). Of the participants, 48.2% were currently working (including individuals who continued working after retirement), and 48.6% had experienced a fall within the past year. Among all participants, 44.0% reported fall-related injuries. Among those who experienced a fall (n=135), 90.4% reported an injury following the fall. It was found that 63.3% of the individuals used 1–3 regular medications, 43.5% had a chronic disease, and 58.6% had visual problems. Regarding activities of daily living, 43.5% of the participants were completely independent. The rate of those experiencing concerns about balance was 36.7%. Additionally, 57.6% of the participants stated that they were active within the home, and 73.4% evaluated their living environment as safe against falls (Table 1).

Findings Related to Validity

Content Validity

In the study, the item-level content validity index (I-CVI) ranged from 0.91 to 1.00, and the scale-level content validity index based on the average method (S-CVI/Ave) was 0.995.

Construct Validity

To evaluate the construct validity of the existing 21-item, 4-factor structure, CFA was conducted without performing EFA, as the original factor structure of the instrument was theoretically established. The CFA results showed that factor loading values ranged between 0.520 and 0.840, supporting the proposed four-factor structure (Table 2).

Table 2. Mean, Item-Total Correlation Coefficients, and CFA Parameter Estimates

Scale Items	Mean±SD	Corrected Item-Total Correlation	Factor	Standardized Factor Loading	SE	t-value	p
Item 1	2.71±0.67	0.487	F1	0.680	0.040	11.49	<0.001
Item 2	2.73±0.62	0.321	F1	0.560	0.038	9.06	<0.001
Item 3	2.85±0.70	0.436	F1	0.690	0.043	11.56	<0.001
Item 4	2.78±0.69	0.366	F1	0.620	0.042	10.27	<0.001
Item 5	2.97±0.81	0.546	F2	0.610	0.050	10.32	<0.001
Item 6	2.88±0.74	0.483	F2	0.630	0.043	10.66	<0.001
Item 7	2.93±0.79	0.626	F2	0.740	0.046	12.94	<0.001
Item 8	2.93±0.81	0.598	F3	0.650	0.047	11.34	<0.001
Item 9	3.15±0.93	0.554	F3	0.620	0.055	10.69	<0.001
Item 10	2.93±0.74	0.460	F3	0.520	0.044	8.68	<0.001
Item 11	3.11±0.91	0.588	F3	0.630	0.053	10.98	<0.001
Item 12	3.04±0.86	0.609	F3	0.620	0.049	10.82	<0.001
Item 13	3.18±0.93	0.671	F4	0.730	0.049	13.63	<0.001
Item 14	3.15±0.91	0.728	F4	0.820	0.046	16.11	<0.001
Item 15	3.08±0.88	0.748	F4	0.840	0.044	16.76	<0.001
Item 16	3.18±0.93	0.617	F4	0.700	0.051	12.87	<0.001
Item 17	3.18±0.92	0.623	F4	0.730	0.050	13.58	<0.001
Item 18	3.09±0.90	0.593	F4	0.640	0.050	11.41	<0.001
Item 19	3.11±0.93	0.670	F4	0.730	0.050	13.76	<0.001
Item 20	3.03±0.86	0.626	F4	0.660	0.048	11.92	<0.001
Item 21	2.86±0.77	0.455	F4	0.500	0.044	8.49	<0.001

Note: SE = Standard Error; CFA = Confirmatory Factor Analysis; F = Factor. Factor loadings represent standardized estimates. SE and t-values are based on LISREL parameter estimates. All factor loadings were statistically significant ($p<0.001$).

Confirmatory Factor Analysis

The initial four-factor CFA model demonstrated acceptable but suboptimal fit ($\chi^2/df = 3.57$, RMSEA = 0.096, CFI = 0.95, TLI = 0.94, SRMR = 0.069, RMR = 0.048, and AIC = 749.05) (Table 3). To preserve the original theoretical structure of the scale, modification indices were examined only after estimation of the initial model. Residual covariances were considered exclusively between items belonging to the same latent factor and only when supported by conceptual overlap. Specifically, residual covariances were specified between Items 16 and 17 because both items address concerns about loss of independence following a fall, including becoming a burden on family members and being unable to perform activities of daily living independently. Residual covariances were also specified between Items 18 and 19 because both items reflect concerns regarding severe long-term functional consequences of falling, including institutionalization, loss of independent mobility, and wheelchair dependence. Finally, residual

covariance was specified between Items 19 and 20 because both items address dependence on others after a fall, with one focusing on mobility loss and the other on concerns about receiving adequate assistance and avoiding neglect. Because these item pairs share closely related psychosocial content beyond the common latent construct, correlated residuals were considered theoretically justified. No residual covariances were added across different latent factors, and no modifications altering the original theoretical four-factor structure were performed. Following these theoretically guided modifications, the four-factor model demonstrated improved fit (χ^2 = 482.60, df = 180, $p < 0.05$, $\chi^2/df = 2.68$, RMSEA = 0.078 [90% CI: 0.070–0.086], CFI = 0.96, TLI = 0.95, SRMR = 0.064, RMR = 0.044, and AIC = 584.60), while preserving the original four-factor structure (Table 3). Because these post-hoc modifications were identified and evaluated within the same sample, the improved fit indices should be interpreted with caution. Future studies should replicate and cross-validate the modified model in independent Turkish older adult samples. To enhance transparency, the polychoric correlation matrix used for the DWLS estimation is provided as Supplementary Table S1.The path diagram of the final CFA model is presented in Figure 1.

Table 3. Comparison of the Initial and Final Confirmatory Factor Analysis Models

Fit criteria	Initial model	Final model	Appropriate	Acceptable
χ^2/df	3.57	2.68	<2	<5
RMSEA	0.096	0.078 (90% CI: 0.070–0.086)	<0.05	<0.08
CFI	0.95	0.96	≥0.95	≥0.90
TLI	0.94	0.95	≥0.95	≥0.90
SRMR	0.069	0.064	<0.05	<0.08
RMR	0.048	0.044	<0.05	<0.08
AIC	749.05	584.60	–	–

Note. *Initial model = original four-factor CFA model without correlated residuals. Final model = original four-factor CFA model after specifying three residual covariances (Items 16–17, 18–19, and 19–20) between items belonging to the same latent factor on the basis of conceptual overlap. No cross-factor residual covariances or structural modifications were introduced. CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; RMR = Root Mean Square Residual; SRMR = Standardized Root Mean Square Residual; TLI = Tucker–Lewis Index; AIC = Akaike Information Criterion.*

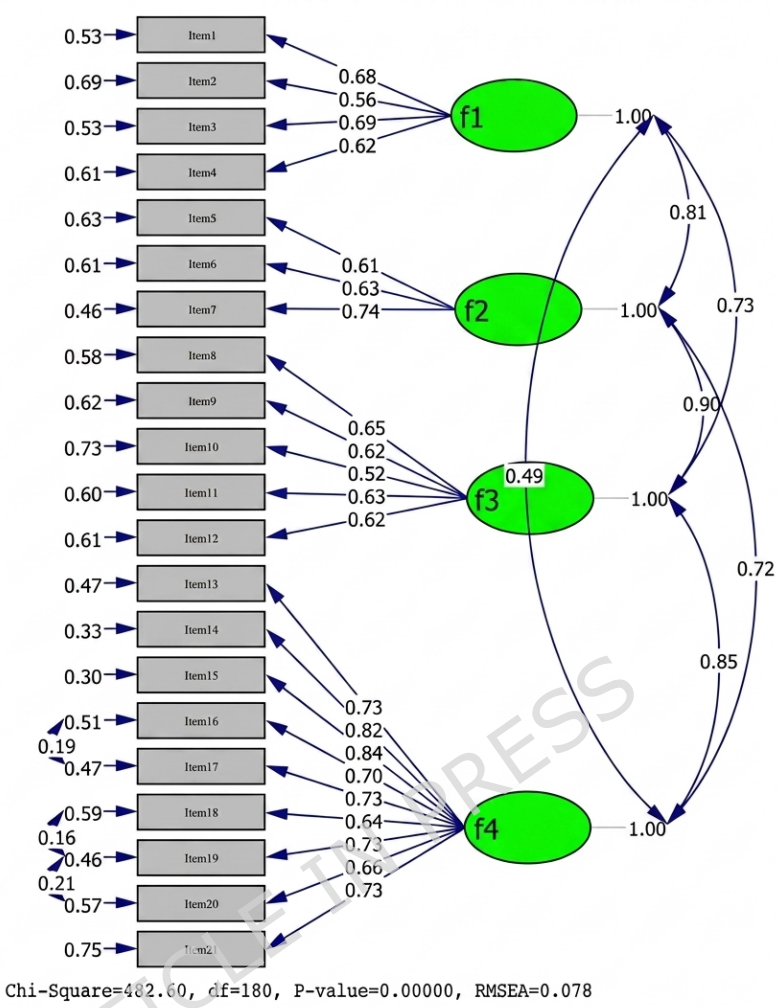

Figure 1. Standardized Path Diagram of the Final Four-Factor CFA Model

Note. Standardized factor loadings and latent factor correlations estimated from the final CFA model are presented. The curved double-headed arrows represent correlations between the latent constructs. The latent factor correlations reported in this figure are identical to those presented in Table 4.

Convergent and Discriminant Validity

Convergent validity was assessed using Composite Reliability (CR) and Average Variance Extracted (AVE). The CR values ranged from 0.700 to 0.901, indicating satisfactory composite reliability. The AVE values ranged from 0.372 to 0.507. Although the AVE values for F1 (0.409), F2 (0.439), and F3 (0.372) were below the commonly recommended threshold of 0.50, their corresponding CR values met or exceeded the recommended value of 0.70. According to Fornell and Larcker (1981), this pattern may still provide acceptable evidence of convergent validity when composite reliability is adequate. Nevertheless, the relatively low AVE values suggest that these

factors explain a limited proportion of the variance in their indicators and therefore convergent validity should be interpreted with caution.

Discriminant validity was examined using the Fornell–Larcker criterion based on the standardized latent factor correlations estimated from the final CFA model. The square roots of the AVE values (√AVE) ranged from 0.610 to 0.712 (Table 4). The Fornell–Larcker criterion was not fully satisfied, as several latent factor correlations exceeded their corresponding √AVE values. Specifically, the correlations between Factors 1 and 2 (r = 0.81), Factors 2 and 3 (r = 0.90), and Factors 3 and 4 (r = 0.85) exceeded the corresponding √AVE values, indicating substantial conceptual overlap among these dimensions. Therefore, discriminant validity should be interpreted with caution. Nevertheless, the original four-factor structure was retained because it is theoretically grounded in the original instrument, demonstrated acceptable overall model fit, and all items showed satisfactory standardized factor loadings within their intended latent constructs.

Floor and Ceiling Effects

Floor and ceiling effects were examined based on the percentage of participants achieving the minimum and maximum possible total and sub-dimension scores. The FFSO total score ranges from 21 to 105 points. None of the participants obtained the minimum possible total score (21 points), whereas two participants obtained the maximum possible score (105 points). Therefore, the floor effect was 0% and the ceiling effect was 0.72%, indicating that neither a floor nor a ceiling effect was present, as both values were well below the commonly accepted threshold of 15%. Similarly, no participant obtained the minimum possible score for any of the four sub-dimensions (floor effect = 0% for all sub-dimensions). Ceiling effects were also minimal, with values of 0.72% for Factor 1, 1.08% for Factor 2, 0.72% for Factor 3, and 1.44% for Factor 4, all of which were well below the recommended threshold of 15%. These findings indicate that both the total scale and its sub-dimensions demonstrated an adequate score distribution without floor or ceiling effects.

Table 4. Latent Factor Correlations, Convergent Validity, and Reliability Estimates

Scale and sub dimensions	F1	F2	F3	F4	AVE	CR	α	McDonald's ω
F1	**0.640**				0.409	0.733	0.722	0.720
F2	0.810	**0.663**			0.439	0.700	0.691	0.701
F3	0.730	0.900	**0.610**		0.372	0.746	0.803	0.806
F4	0.490	0.720	0.850	**0.712**	0.507	0.901	0.899	0.901

Total	-	-	-	-	-		0.919	0.919

F = Factor; F1 = Apprehension caused by the unpredictable nature of falls; F2 = Worry about one's own vulnerability; F3 = Increased vigilance toward the environment; F4 = Concern about potential harm after fall events. Values below the diagonal represent standardized latent factor correlations estimated from the final CFA model. Bold diagonal values represent the square root of the Average Variance Extracted (√AVE). AVE = Average Variance Extracted; CR = Composite Reliability; α = Cronbach's alpha coefficient; ω = McDonald's omega coefficient.

Findings Regarding Reliability

The internal consistency of the Fear of Falling Scale for Older Adults was evaluated using Cronbach's alpha and McDonald's omega coefficients. The Cronbach's alpha values for the sub-dimensions ranged from 0.691 to 0.899, while the McDonald's omega values ranged from 0.701 to 0.901. The total internal consistency coefficient of the scale was 0.919 for both alpha and omega values (Table 4). These findings indicate that the FFSO-T and its sub-dimensions demonstrated adequate to high levels of internal consistency.

Table 5. Test-retest results and mean scores (n=39)

Scale and sub-dimensions	Scale Score Means		Analysis Results				ICC(95% CI)
	First Implementation X ± SD	Second Implementation X ± SD	r	p	t	p	
F1	10.76±1.58	10.84±1.74	0.982	.000	-1.356	0.183	0.977 (0.957–0.988)
F2	9.10±1.78	9.00±1.67	0.934	.000	1.000	0.324	0.932 (0.873–0.963)
F3	15.51±2.70	15.53±2.71	0.998	.000	-1.000	0.324	0.998 (0.997–0.999)
F4	28.74±6.74	29.05±6.69	0.985	.000	-1.638	0.110	0.985 (0.971–0.992)
Total	64.12±10.44	64.43±10.35	0.908.	.000	-1.374	0.177	0.991 (0.983–0.995)

**Correlation is significant at the 0.01 level (2-tailed); F: Factor; r: Pearson Correlation Coefficient; t: Paired sample t-test; F1, Uneasiness caused by unpredictable falls; F2, Worry about one's own vulnerability; F3, Increased awareness and alertness regarding the environment; F4, Anxiety about potential harm after falling events; ICC: Intraclass Correlation Coefficient.

Table 5 presents the test–retest results of the scale obtained from a convenience subsample of 39 participants who completed the FFSO-T on two occasions with a 15-day interval. No statistically significant differences were found between the mean scores of the first and second administrations

($p > 0.05$). Test–retest correlation coefficients were high and positive ($r = 0.908–0.998$), and the ICC values ranged from 0.932 to 0.998. The ICC value for the total scale was 0.991 (95% CI: 0.983–0.995), indicating excellent temporal reliability. However, this finding should be interpreted with caution because the relatively short 15-day retest interval and the use of a convenience subsample may have introduced recall or response consistency effects, potentially resulting in an overestimation of temporal stability. In addition, the Standard Error of Measurement (SEM) and the Minimal Detectable Change at the 95% confidence level (MDC95) for the total scale were calculated as 0.74 and 2.05, respectively, indicating the precision of individual scores and the minimum change required to exceed measurement error. Considering that the total FFSO-T score ranges from 21 to 105, the MDC95 value of 2.05 indicates that a change of at least 3 points is required in clinical practice to represent a true change in fear of falling beyond measurement error.

Discussion

In the present study, 48.6% of participants reported a fall within the previous year, and among those who experienced a fall, 90.4% reported at least one fall-related injury. This relatively high proportion of injuries among fallers may be related to the broad operational definition of injury used in this study, as minor physical consequences such as bruises and abrasions were also included in the injury category. Furthermore, differences in injury definitions and assessment methods across studies may contribute to variations in reported fall-related injury rates. Therefore, this finding should be interpreted considering the criteria used to define and assess fall-related injuries.

This study was conducted to evaluate the psychometric properties of the Turkish version of the FFSO, developed by Lee and Tak (2025), to provide a comprehensive assessment of fear of falling among older adults [10]. Unlike existing instruments such as the FES-I, which primarily assess concerns about falling during the performance of daily activities [12], FFSO-T evaluates broader psychosocial dimensions of fear of falling, including unpredictability, perceived fragility, and concerns about potential harm [10]. Therefore, the two instruments should be considered complementary rather than interchangeable. By assessing these additional psychosocial dimensions, the FFSO-T may provide clinically relevant information that is not fully captured by activity-based measures alone. However, the present study did not examine whether the FFSO-T provides incremental validity beyond the FES-I. Future studies should investigate whether the FFSO-T explains additional variance in fear of falling and predicts fall-related outcomes beyond

activity-based measures. The relatively high prevalence of previous falls and balance concerns among participants further supports the clinical relevance of fear of falling in this population and indicates that the sample was appropriate for evaluating the psychometric properties of the scale.

In scale adaptation studies, content validity is a fundamental indicator of whether the items adequately represent the intended construct and are culturally appropriate [33]. In the present study, content validity of the FFSO-T was evaluated by a multidisciplinary panel of 11 experts, exceeding the recommended number of experts in the literature [34]. The high content validity results obtained through the Davis technique [35], which were comparable with those reported in the original scale development study [10], indicate that the items maintained their conceptual relevance and cultural appropriateness in the Turkish context. Considering that content validity values above 0.80 are generally accepted as adequate [36], and that no items required removal following expert evaluation, the original conceptual framework of the scale was largely retained during the adaptation process. Although some previous adaptation studies [37] have reported item modifications or removals due to cultural differences, the current findings suggest that the FFSO structure can be meaningfully applied within the Turkish older adult population.

The 21-item, four-factor theoretical structure proposed in the original study was directly tested in our research using CFA. The fit indices obtained from the CFA ($\chi^2/df = 2.68$, RMSEA = 0.078, CFI = 0.96, SRMR = 0.064, TLI = 0.95) indicated an acceptable to good model fit [24]. Although the chi-square test was statistically significant ($p < 0.05$), this result should be interpreted with caution because the chi-square statistic is highly sensitive to sample size and may become significant even when a model demonstrates acceptable fit, particularly in studies with larger samples. Therefore, model fit was evaluated based on multiple fit indices rather than relying solely on the chi-square statistic [17, 29]. The fit indices obtained in the present study were comparable to those reported in the original scale development study (CFI=0.91, RMSEA=0.096). However, differences in sample characteristics, sample size, and estimation methods between studies should be considered when interpreting these findings. Overall, the results provide support for the applicability of the original four-factor structure in the Turkish older adult population. Furthermore, factor loadings ranging from 0.540 to 0.840 indicated that the items generally represented their respective sub-dimensions, although some items demonstrated comparatively lower loadings and may benefit from further evaluation in future studies [38]. The correlations among the sub-dimensions ($r = 0.335–0.673$) remained below the recommended threshold of 0.85,

supporting the discriminant validity of the FFSO-T and suggesting that each factor represents a distinct psychosocial aspect of fear of falling [17]. Although the correlation between Factor 1 and Factor 4 was relatively lower (r = 0.335), this does not necessarily indicate that these dimensions are unrelated. Rather, this pattern suggests that unpredictability of falls and fear of suffering harm represent distinct but theoretically related components within the broader construct of fear of falling.

In the internal consistency analyses, the Cronbach's alpha coefficient for the total FFSO-T score was 0.919, indicating good internal consistency and showing similarity to the original study (α = 0.97). Cronbach's alpha coefficients for the four sub-dimensions ranged from 0.691 to 0.899. Although the internal consistency of Factor 2 (Anxiety about one's own fragility) was slightly below the conventional threshold of 0.70 (α=0.691), this value should be interpreted cautiously. The relatively lower alpha coefficient may be partly related to the small number of items included in this sub-dimension (three items). The corrected item-total correlations for its items ranged from 0.483 to 0.626, and the standardized factor loadings ranged from 0.610 to 0.740, suggesting that the items demonstrated acceptable performance. Therefore, no item removal was considered appropriate. Nevertheless, the reliability of this sub-dimension should be further examined in future studies with different Turkish older adult populations. The Cronbach's alpha values were interpreted according to commonly accepted reliability criteria [30, 39]. In addition, the McDonald's omega coefficient was 0.919 for the total scale and ranged from 0.701 to 0.901 across the sub-dimensions, supporting acceptable to excellent internal consistency [40]. The close similarity between Cronbach's alpha and McDonald's omega coefficients across the total scale and sub-dimensions suggests that the items contribute relatively equally to their respective constructs and that the assumption of tau-equivalence is reasonably supported in this sample [40]. Furthermore, the corrected item-total correlation coefficients ranged from 0.321 to 0.748, indicating that all items demonstrated acceptable associations with the total scale score [39, 41].

In the test–retest analysis conducted to evaluate the temporal stability of the scale, the ICC was 0.991, indicating excellent temporal stability of the FFSO-T scores over the 15-day interval [42]. The absence of a statistically significant difference between the two assessments performed 15 days apart ($p > 0.05$) further supported the temporal stability of the scale scores [26]. However, these findings should be interpreted cautiously, as the relatively small convenience retest sample recruited from a single hospital and the short 15-day retest interval may have contributed to inflated

ICC estimates because of potential recall or response consistency effects. Additional evidence regarding the construct validity of the FFSO-T was obtained through convergent and discriminant validity analyses. The CR values of all sub-dimensions were at or above the acceptable level, supporting the internal consistency and reliability of the latent constructs. Although the AVE values of three sub-dimensions were below the commonly recommended threshold of 0.50, the corresponding CR values met the recommended criterion and the factor loadings and overall model fit indices were satisfactory. Nevertheless, the relatively low AVE values indicate that these factors explained a limited proportion of the variance in their indicators. Therefore, convergent validity for these factors should be interpreted with caution, and further refinement of individual items may strengthen the measurement model. The relationships between the square roots of the AVE values and the standardized latent factor correlations were examined using the Fornell–Larcker criterion [31]. The results indicated that the Fornell–Larcker criterion was not fully satisfied, as several latent factor correlations exceeded their corresponding √AVE values. According to Fornell and Larcker [31], this finding suggests limited discriminant validity and indicates that some latent constructs share substantial variance. However, fear of falling is inherently a multidimensional construct comprising closely related psychological domains. Therefore, the relatively high latent correlations observed among perceived vulnerability, environmental vigilance, and concerns about potential harm may reflect meaningful theoretical relatedness rather than complete construct redundancy. Similar observations have been reported in psychometric research, where conceptually related latent constructs may exhibit substantial correlations despite representing distinguishable theoretical dimensions [43]. Accordingly, although discriminant validity should be interpreted with caution, the original four-factor structure was retained because the observed overlap was considered theoretically plausible within the multidimensional nature of fear of falling rather than sufficient evidence of construct redundancy. Specifically, the four dimensions represent conceptually distinguishable but interrelated psychological aspects of fear of falling within the same overarching construct. This theoretical distinction, together with the acceptable overall model fit and satisfactory standardized factor loadings, provided support for retaining the four-factor structure proposed by the original developers of the FFSO [44]. However, the observed overlap indicates that the distinctiveness of these dimensions requires further confirmation. Future studies should therefore investigate these dimensions using independent samples and compare the

four-factor structure with alternative structural models, such as higher-order or bifactor models, as recommended in contemporary psychometric literature [43].

[43].

Limitations

Some limitations should be taken into consideration when evaluating the results of this study. First, the study was conducted in a single center, which may restrict the socio-demographic diversity of the sample and limit the generalizability of the findings to the broader older adult population in Türkiye.In addition, although convenience sampling is commonly used in pctsychometric validation studies due to its feasibility, it may increase the risk of selection bias because participants who were more accessible or willing to participate may differ from the broader older adult population. Therefore, future studies using probability-based sampling methods and including older adults from different geographic regions are recommended to enhance the generalizability of the findings. Second, the data were based on self-reports of the participants. Although cognitive debriefing was conducted during the pilot application to evaluate the comprehensibility and cultural appropriateness of the scale items, Item Impact Score calculation was not performed, which may be considered a methodological limitation. In addition, because all data were obtained through self-report measures, the potential influence of common method variance cannot be completely excluded. Furthermore, although the overall internal consistency of the FFSO-T was excellent, the Cronbach's alpha coefficient for Factor 2 (Anxiety about one's own fragility) was slightly below the conventional threshold ($\alpha = 0.691$). Nevertheless, the acceptable McDonald's omega coefficient ($\omega = 0.701$), satisfactory standardized factor loadings (0.610–0.740), and corrected item-total correlations (0.483–0.626) supported the retention of all items. Therefore, scores derived from this sub-dimension should be interpreted with appropriate caution until further evidence from larger and more diverse Turkish older adult samples becomes available. Additionally, the majority of participants were in the 65–74 age group (73.4%), whereas the proportion of individuals aged 85 years and older was relatively small (5.0%). Therefore, the psychometric performance of the FFSO-T among the oldest-old population, who may have a higher risk of falls and fear of falling, could not be fully evaluated. Future studies involving larger samples of individuals aged 85 years and older are recommended to further confirm the applicability and measurement properties of the scale in this subgroup. Although the present study evaluated several key measurement properties recommended by the COSMIN framework,

including content validity, structural validity, internal consistency, convergent validity (Average Variance Extracted and Composite Reliability), discriminant validity (Fornell–Larcker criterion), floor and ceiling effects, and test–retest reliability, some measurement properties were not examined. Specifically, hypothesis testing, responsiveness, and measurement invariance across relevant subgroups (e.g., sex and age groups) were beyond the scope of this study. Future studies should investigate measurement invariance across relevant demographic groups (e.g., sex and age) and evaluate alternative structural models to further examine the dimensionality and discriminant validity of the FFSO-T. Furthermore, although EFA was not performed because the original four-factor structure of the instrument had already been theoretically established and the aim of this study was to confirm this existing structure using CFA, future studies may further examine the factorial structure of the FFSO-T in different Turkish older adult populations using alternative analytical approaches. Furthermore, although the Composite Reliability values of all sub-dimensions were acceptable, the Average Variance Extracted (AVE) values for three of the four factors were below the commonly recommended threshold of 0.50. This finding indicates that the amount of error variance exceeded the variance explained by these latent constructs at the indicator level. Therefore, the convergent validity of these factors should be interpreted with caution, and future studies should consider refining or replacing individual items to strengthen the convergent validity of the FFSO-T. Furthermore, although the Composite Reliability values of all sub-dimensions were acceptable, the standardized latent factor correlations indicated that the Fornell–Larcker criterion was not fully satisfied for several factor pairs. These findings suggest substantial conceptual overlap among some dimensions of the FFSO-T and indicate that discriminant validity should be interpreted with caution. Because fear of falling is a multidimensional construct comprising closely related psychosocial domains, some degree of overlap among these dimensions may be expected. Nevertheless, future studies should further investigate the distinctiveness of these constructs using independent samples, measurement invariance analyses, and alternative structural models (e.g., higher-order or bifactor models), and should consider refinement of specific items if necessary. Furthermore, the residual covariances incorporated into the final CFA model were identified and evaluated using the same dataset. Although these modifications were restricted to conceptually related items within the same latent factor and did not alter the original theoretical four-factor structure of the instrument, the modified model was not cross-validated using either an independent sample or a split-sample approach. Therefore, the improved model fit

should be interpreted with caution. Future studies should examine the stability, replicability, and generalizability of the modified model in independent samples of Turkish older adults. Moreover, the relatively high ICC values observed in the test–retest analysis should be interpreted cautiously, as the relatively small retest sample and the short retest interval may have contributed to recall effects or may have resulted in an overestimation of temporal stability. Future studies with larger retest samples and different retest intervals are recommended to further confirm the temporal stability of the FFSO-T [28, 32]. Furthermore, criterion validity was not examined by comparing the FFSO-T with other established instruments assessing fear of falling, such as the Falls Efficacy Scale-International (FES-I) or the Activities-specific Balance Confidence (ABC) Scale. Therefore, although the FFSO-T demonstrated satisfactory content validity, structural validity, and acceptable convergent validity evidence based on Average Variance Extracted (AVE) and Composite Reliability (CR), future studies should evaluate criterion validity and provide additional external convergent validity evidence through associations with established fear of falling measures.

Finally, this study is cross-sectional in nature. Consequently, it remains limited in terms of evaluating changes in fear of falling over time or establishing temporal relationships between fall-related experiences and fear of falling.

Conclusion

In this study, the Turkish version of the Fear of Falling Scale for Older Adults (FFSO-T) demonstrated satisfactory evidence of validity and reliability, consisting of four sub-dimensions and 21 items. The findings provided support for the applicability of the original theoretical structure of the scale in the Turkish older adult population and indicated acceptable psychometric properties, with model fit indices comparable to those reported in the original study.

The FFSO-T evaluates multiple dimensions of fear of falling, including activity-related concerns as well as psychosocial aspects such as unpredictability, perceived fragility, and concerns about potential harm. Therefore, it may serve as a useful tool for assessing different aspects of fear of falling in older adults and may contribute to research and clinical evaluations. The scale may provide healthcare professionals, including geriatric nurses and physiotherapists, with additional information for understanding fear of falling from a multidimensional perspective. However, further longitudinal studies are needed to evaluate the responsiveness, predictive validity, and clinical utility of the FFSO-T, particularly regarding its ability to detect changes following interventions and its associations with fall-related outcomes.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Erzurum Technical University Scientific Research and Publication Ethics Committee (Date: 13.11.2025, Decision No: 2025-ETÜ-0051). In addition, institutional permission was obtained from Erzurum City Hospital before the commencement of data collection. All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all individual participants included in the study. Participants were informed that their participation was voluntary and that they could withdraw at any time without any consequences. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

GBT contributed to conceptualization, methodology, investigation, and writing the original draft.

EB contributed to methodology and writing – review and editing.

BCK contributed to formal analysis, visualization, and writing – review and editing.

All authors read and approved the final manuscript**.**

Trial registration

Not applicable.

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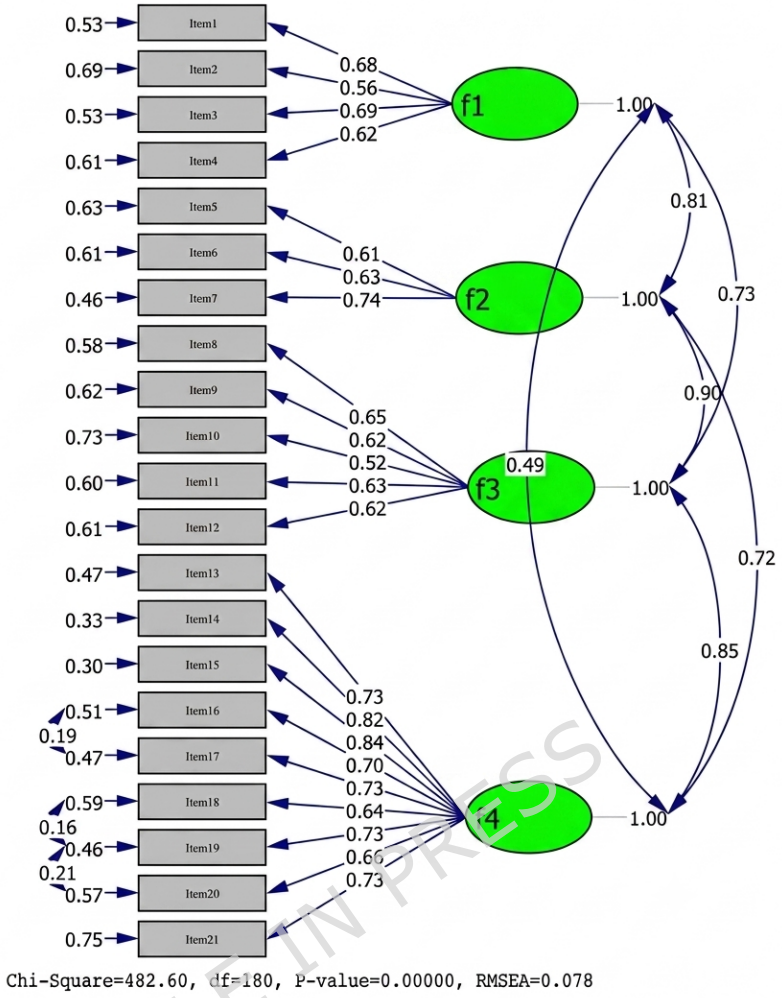
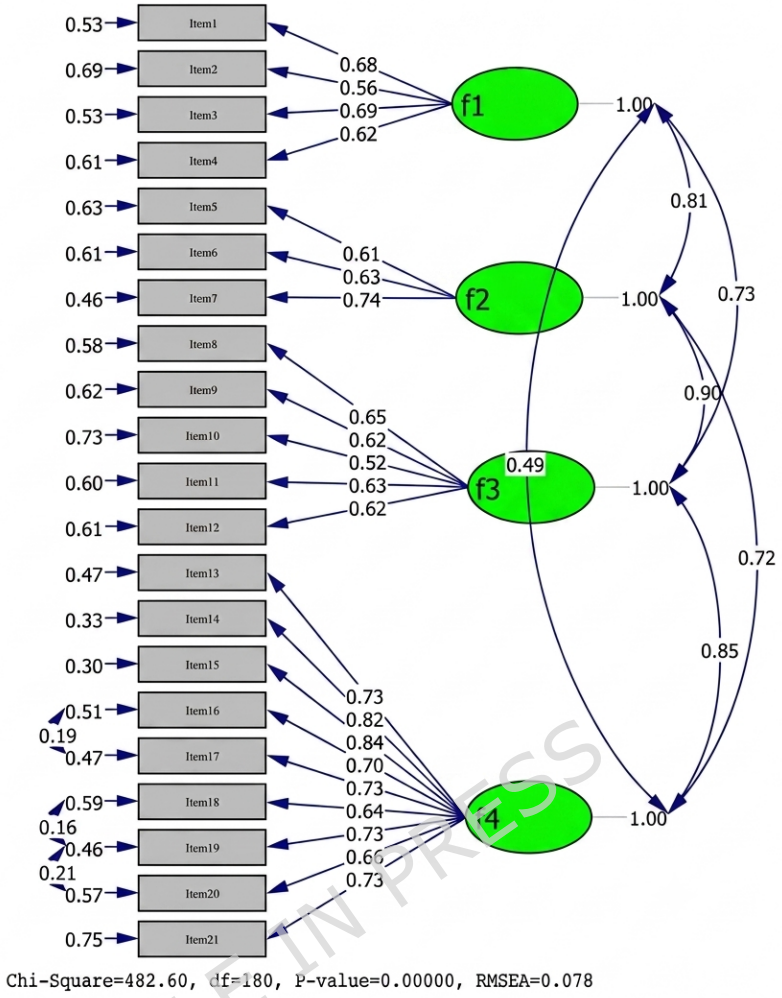


Chi-Square=482.60, df=180, P-value=0.00000, RMSEA=0.078



Chi-Square=482.60, df=180, P-value=0.00000, RMSEA=0.078