ORIGINAL ARTICLE

# Psychometric Properties of Frailty Syndrome Checklist 5-Items in Frail Older Adults in Iran

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## Abstract

**Background:** Frailty syndrome involves a complex combination of the natural process of getting old with different medical problems. Different indexes have been designed for each physical, mental, and social dimensions of frailty. Fried's five-item index of frailty syndrome checklist is one of the most applicable scales to screen frailty. This study aimed to determine a psychometric index of frailty and the cut-off points for the Iranian elderly population.

**Methods:** In a cross-sectional and psychpmetric study, 249 frail elderly people were selected among members of two Iranian Army Retirees Clubs in 2019. This was a cross-sectional-psychometric study which aimed at determining the psychometric index and cut-off points of a brief checklist of 5-item FSC among Iranian adults older than 60 years old and comparing this to prior results in different countries.

**Results:** The data were analyzed by ANOVA, multi-variable regression, confirmatory, and exploratory factor analysis, and ROC analysis via SPSS 25 and AMOS 24. The validity of the study findings was determined by internal validity, high correlation of 5 questions, confirmatory and exploratory factor analysis of 3 subdomains with a clarity value of 0.87, and high goodness of fit index (GFI).

**Conclusion:** The determined cut-off points were compatible with those of Fried's prior study. The designed tools used in this study evaluated frailty syndrome of the Iranian elderly in elderly rehabilitation studies with high confidence. The application of the tool would provide caregivers and policymakers with additional information as to caring for this population.

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**Keywords:** Factor analysis, ROC Curve, Frail elderly, Aged, Healthy aging, Aging, falling, Instrumentation, Health status indicators, Patient health questionnaire, Frailty, Accidental falls, Psychometrics, Psychological tests, Neuropsychological tests, Behavior rating scale

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## Introduction

The world population has become older due to the decreasing mortality rate, increasing life expectancy, and enhanced healthcare technologies.[1] Worldwide, the elderly population is expected to increase from 9% to 16% during 35 years from 1995 to 2030. Regionally, the elderly population is expected to increase in Asia and Iran from 9.3% to 18.6% and from 5.17 to 6.5% over the same period, respectively.[2] Increased chronic diseases and multi-morbidity in the elderly and the associated increased prevalence of inabilities are the main concern in the growth of the elderly population. Senescence syndromes are groups of prevalent characteristics among the elderly and, as such, are not considered a disease. These syndromes are a group of prevalent characteristics among the elderly, which are not considered a disease. Frailty syndrome involves a complex combination of the

natural processes of getting old with different medical problems,[3] such as weakness, dullness, decreased energy, decreased physical activity, and unintentional weight loss (in more intense cases).[3] Frailty syndrome consists of physiological disorders in six different systems (hematic, inflammatory, hormonal, obesity, neuromuscular, and nutritional).[4] The brain, endocrine, musculoskeletal, and immune systems are mostly associated with frailty syndrome, which have been studied considerably.[4] The prevalence of frailty due to its wide definition and variety of measurement tools is estimated 19.6% in Latin America and the Caribbean,[5] from 3.9 per cent in China to 26% and 51.4% in India and Cuba, respectively,[6] 35.7% in Brazil,[7] 10% in Japan,[8] and in European countries from 7.7 per cent of the Swedish elderly to 15.6% Portuguese older adults.[9].There are no national frailty data in the elderly population of Iran, bBut it can be assumed to be similar to developing countries like India and Brazil. Most of the tools developed to evaluate frailty have a frailty pre-diagnosis, enabling the authorities to identify people at high risk of frailty.[10, 11]

Frailty can be examined in both clinical and social contexts. The clinical view argues that frailty increases the risks of side effects, such as fall, hospitalization, inability, and death.[12] The social view identifies the groups in need of additional medical care services and at high risk of dependency.[12] Policymakers and providers of health services have realized that frailty could significantly affect people, caregivers, healthcare systems, and society.[11, 12] Furthermore, concerns have been raised regarding prevention and health management plans due to the effect of frailty on the healthcare of patients.[13] If frailty can be diagnosed, prevented, and treated by identifying its different reasons and factors, this can lead to the prevention or at least delay in the onset of frailty syndrome. As some recent studies have suggested, frailty sequences could be reversed by implementing specific practical plans and nutritional supplements.[3, 14, 15] Therefore, identification of consequences relevant to frailty is highly vital, indicating the need for a tool to predict frailty challenges in Iran. These challenges can be screened, and definite cut-off points can be determined for Iranian frail patients. These actions help the healthcare policymakers in the country to systemize and optimize their decisions, just as many developed countries have done in recent years.[16] Fried's five-item index of frailty syndrome checklist (5-Item FSC) is one of the most applicable scales to screen frailty.[16]

Psychometric properties and cut-off points of FSC differ from one country to another regarding their cultural, social, nutritional, and even phenotypical differences[17] compared to other indices. Therefore, the present study aimed to determine the validity, reliability, and cut-off points of 5-item FSC for Iranian elderly.

## Methods

The 5-item checklist FSC can be said to have a significant scientific and diagnostic value based on several studies conducted in this field, among the several tools available to screen frailty.[13, 18, 19] The FSC includes sections such as weight loss, exhaustion, low physical activity, slowness, and weakness. The FSC categorizes the elderly into three frailty stages: not frail (score 0), pre-frail (score 1–2), and frail (score 3–5). The phenotypic frailty index (FI) (score of 3-5 on FSC) is usually considered as a criterion for senescence studies, particularly as an entry criterion in the present study. Another advantage of FSC is that the duration of testing is not a problem with the five variables.[16]

This is a cross-sectional-psychometric study which aimed to determine the psychometric index and cut-off points of a brief checklist of 5-item FSC among the Iranian elderly. The study population included 249 Iranian elderly individuals over 60 years old who were the members of two Army Retirees Clubs (*Farhikhtegan* Foundation and Jahandidegan Club, Shiraz, Iran). We selected the retirees from all occupations randomly as representatives, taking into account the proper selection and observance of diversity in sample distribution; most of them were supported by the *Jahandidegan* Club and *Farhikhtegan* foundation. The Iranian veterans had an independent club, who were selected based on their membership card number via PASS 15 (NCSS LCC., Kaysville, Utah, USA, 2017). The sample size (n=249) was determined by power of 0.85 at the 5.2 standard deviation in Fried's and psychometric studies with power of 0.95, the deference index of 0.001 for negative and positive groups, and areas under the curve. Two subjects were excluded from the study due to medical reasons. Inclusion and exclusion criteria of this study include the age of 60 years old and over, no severe orthopedic disorder and neurology, no severe visual and auditory impairment, unwillingness to participate in the research, and musculoskeletal injury that required the use of assistive devices or treatment. Upon receiving the ethics code and informed consent form, the researcher explained the study phases and the way to fill out the questionnaire for the subjects to complete the tool. The data were collected from 19 August to 13 December 2019. The scale was rated from 0 to 5, and people with 3 items were regarded as frail (247 persons). Anyone who had none of the items was considered non-frail, and those with 1 or 2 item(s) were considered as pre-frail. The data were analyzed by ANOVA, multi-variable regression, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), path analysis, and ROC analysis using SPSS 25 and AMOS 24 (IBM Corp., Armonk, N.Y., USA, 2019). The significance level was set at $P \leq 0.05$ (Ethical approval code: IR.SUMS.REC.1398.387, Shiraz

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## Results

The subjects included 117 women (47%) and 132 men (53%) with a mean age of 66.95 (SD=8.05, 95% CI=65.04-68.88). The mean height was 158.62 (SD=7.61, 95% CI=155.21-165.32), and 170.61 (SD=7.37, 95% CI=168.08-178.47) for women and men, respectively. In addition, the mean weight was 67.05 (SD=10.94, 95% CI=52.11-77.05) and 73.35 (SD=12.07, 95% CI=65.55-86.01) for women and men, respectively. The mean BMI was 26.09 (SD=3.51, 95% CI=24.49-27.69) 3.51 and 25.13 (SD=3.50, 95% CI=24.13-25.22) 3.50 for women and men, respectively. The mean fatigue index, physical activity, walking time (in second), and handgrip strength were 1.5±1.3, 1203.32±1428.78, 7.07±3.60 and 10.87±23.46, respectively. Table 1 presents the subjects' situation based on FSC.

As to the ICC coefficient, a high degree of reliability was found with two-week intervals between the tests, a 95% confidence interval from 0.794 to 0.901, and F (42, 231)=6.211, P<0.001. Table 2 presents the results from the analysis of variance for frailty indices based on the personal parameters. The scores of the effect size (0.30 and above) represent the high impact of individual components.

*Exploratory Factor Analysis:* The internal correlation and similar matrix of FSC and EFA were used to evaluate the possibility of a better health intervention in future studies. Bartlett's test of Sphericity and sample size adequacy were implemented through the Kaiser-Meyer-Olkin test (KMO=0.612, Bartlett's Test of Sphericity=976.12, DF=132, P≤0.001), followed by exploratory and confirmatory factor analyses. Therefore, the questionnaire had subdomains and common latent attributes. The five factors were extracted using the principal components method, 8 Varimax rotations, and Kaiser Normalization based on the eigenvalue higher than 73.89 (Quite desirable). Table 3 shows that these factors contained 5 questions, including subdomains of weight loss (factor loading=0.740), weakness (factor loading=0.820), mental exhaustion (factor loading=0.712), slow step (factor loading=0.734), and physical activity (factor loading=0.740). The results suggested a factor loading shared between 1-2 and 4-5 subdomains.

Figure 1 displays the subdomains of FI and GFI. The loading factor of each subdomain demonstrates its explanatory power in total scale score.

*Confirmatory Factor Analysis:* Confirmatory factor analysis was conducted after accepting the loading factor and distributing the factors in EFA. Table 4 indicates GFI and confirms the model.

Table 4 demonstrates GFI of distributing the questionnaire factors in the questionnaire internal distribution model with a high-quality factor structure. Therefore, its results could be trustable to examine the frailty syndrome. However, as Figure 2

**Table 1:** Characteristics of the samples in the application of Fried's FSC (n=249)

| Index | Test Component Failure Factor | Number of Older Sample | | | ICC [b] | Sig. [c] |
|---|---|---|---|---|---|---|
| | | n | % | 95% CI [a] | | |
| Index 1. Unintentional weight loss over the last year | | | | | 0.871 | 0.000 |
| Interview | 1. Lack of weight control in the past: Yes | 226 | 90.76 | 6.2–11.3 | | |
| | 2. Lack of weight control in the past: Nay | 23 | 9.23 | 17.1–23.1 | | |
| | Total (1+2) | 249 | 100 | 22.5–30.2 | | |
| Index 2. Weakness | | | | | 0.884 | 0.001 |
| The measurement of handgrip strength | 1. The test completed | 247 | 99.19 | 6.2–11.3 | | |
| | 2. Contraindication for the test | 1 | .40 | 0.6–2.1 | | |
| | 3. The test not completed | 1 | .40 | 0.4–3.5 | | |
| | Total (1+2+3) | 249 | 100 | 5.5–8.3 | | |
| Index 3. Exhaustion | | | | | 0.794 | 0.000 |
| A standardized interview by questionnaire | 1. The test completed | 248 | 99.59 | 6.4–11.7 | | |
| | 2. The test not completed | 1 | .20 | 0.3–3.8 | | |
| | Total (1+2) | 249 | .20 | 5.6–10.1 | | |
| Index 4. Slow gait | | | | | 0.901 | 0.000 |
| The measurement of the transit time of 5 meters | 1. Inability to walk | 1 | .40 | 0.1–2.0 | | |
| | 2. The test completed | 246 | 98.79 | 13.2–15.9 | | |
| | 3. The test not completed | 2 | .80 | 0.3–3.6 | | |
| | Total (1+2+3) | 249 | 100 | 15.2–23.1 | | |
| Index 5. Low physical activity | | | | | 0.894 | 0.001 |
| A standardized interview by questionnaire | 1. The test completed | 249 | 100 | 11.0–15.3 | | |

a. CI: confidence interval, b. Intra-Class correlation coefficient with two week intervals between tests, c. Two-sided Chi-squared test between male & female samples, P≤0.05.

**Table 2:** ANOVA for frailty indices by personal parameters (n=249)

| Parameters | Sources of Variance | SS | DF | MS | R Sqr | R Sqr (Pred.) | F | P | Effect Size |
|---|---|---|---|---|---|---|---|---|---|
| Gender on Grip Strength | Between Group | 2896.536 | 1 | 2896.536 | 0.502 | 0.312 | 3.41 | 0.000 | 0.355 |
| | Within Group | 5264.956 | 247 | 77.426 | | | | | |
| | Total | 8161.493 | 248 | | | | | | |
| Weight Loss on Grip Strength | Between Group | 311.276 | 1 | 311.276 | 0.414 | 0.301 | 2.696 | 0.005 | 0.438 |
| | Within Group | 7850.216 | 247 | 115.444 | | | | | |
| | Total | 8161.493 | 248 | | | | | | |
| Exhaustion on Walk Time | Between Group | 72.07 | 1 | 172.07 | 0.617 | 0.417 | 5.943 | 0.007 | 0.381 |
| | Within Group | 824.572 | 247 | 12.126 | | | | | |
| | Total | 896.643 | 248 | | | | | | |
| Height on Grip Strength | Between Group | 4527.176 | 25 | 181.087 | 0.510 | 0.417 | 2.192 | 0.001 | 0.555 |
| | Within Group | 3634.317 | 223 | 82.598 | | | | | |
| | Total | 8161.493 | 248 | | | | | | |
| Height on Walk Time | Between Group | 610.954 | 25 | 124.438 | 0.407 | 0.328 | 3.764 | 0.000 | 0.681 |
| | Within Group | 285.689 | 223 | 6.493 | | | | | |
| | Total | 896.643 | 248 | | | | | | |
| Weight on Grip Strength | Between Group | 616.954 | 34 | 118.146 | 0.512 | 0.407 | 2.736 | 0.002 | 0.542 |
| | Within Group | 232.13 | 214 | 6.632 | | | | | |
| | Total | 849.083 | 248 | | | | | | |
| Weight on Walk Time | Between Group | 691.043 | 34 | 120.325 | 0.467 | 0.325 | 3.46 | 0.000 | 0.771 |
| | Within Group | 205.6 | 214 | 5.874 | | | | | |
| | Total | 896.643 | 248 | | | | | | |
| BMI on Grip Strength | Between Group | 4427.129 | 1 | 106.696 | 0.519 | 0.405 | 1.78 | 0.000 | 0.405 |
| | Within Group | 3734.364 | 247 | 4.514 | | | | | |
| | Total | 8161.493 | 248 | | | | | | |

SS=Sums squares, MS=Mean squares, Effect size=Partial $\eta^2$. P<0.05, R Sqr (Pred.)=predicted R squared indicates well-predicting model for new observations

**Table 3:** Rotated component matrix in Varimax Kaiser normalization with principal component analysis

| Subdomains | N0. | Items | Factors | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 |
| Weight Loss | 1 | Unintentional weight loss more than 4.5 kg in the last year | 0.740 | | | | |
| Weakness (BMI & Grip Strength) | 2 | Measure by having the male/female sample squeeze a hand-held dynamometer | 0.101 | 0.820 | | | |
| Exhaustion | 3 | How often in the last week did you feel like this? | | | 0.712 | | |
| Slow Gait (Slowed Walking Speed) | 4 | Measured by the speed at which a sample walks 5 meters, average of 3 trails of normal walking | | | | 0.734 | |
| Low Physical Activity | 5 | Inquiring on leisure time activities for the previous two weeks upon MLTAQ & reporting kcal/week | | | | 0.112 | 0.801 |

MLTAQ: Minnesota leisure time activities questionnaire

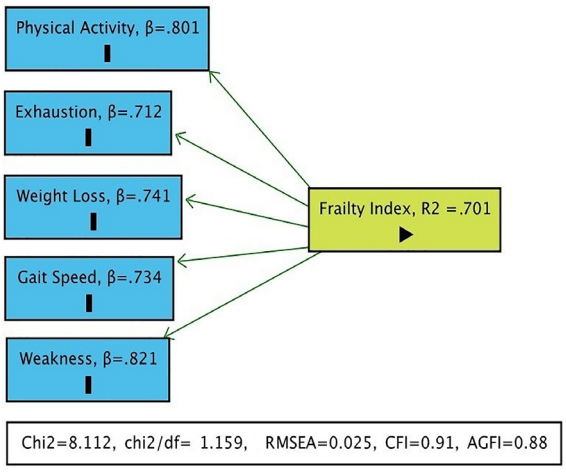


**Figure 1:** Path analysis of five subdomains in frailty index

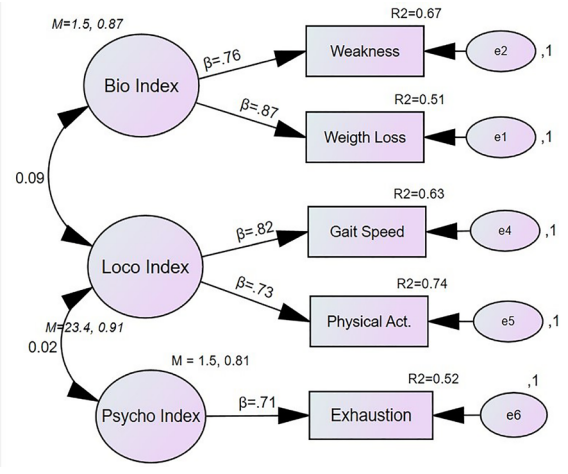


**Figure 2:** Path analysis of five items and three latent subdomains in the FSC

**Table 4:** The results of distributing goodness of fit index (249 old adults)

| Fit Indices | $\chi^2$ | df | $\chi^2$/df≤3 | AGFI | GFI | RMSEA | RFI | IFI | NFI | PNFI | TLI | CFI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Values | 12.140 | 8 | 1.518 | 0.88 | 0.89 | 0.046 | 0.87 | 0.90 | 0.92 | 0.80 | 0.87 | 0.88 |

Goodness of Fit Indices: Adjusted Goodness of Fit Index (AGFI), Goodness of Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), Relative Fit Index (RFI), Incremental Fit Index (IFI), Bentler & Bonnet's Normed Fit Index (NFI), Parsimony Normed Fit Index (PNFI), Tucker–Lewis Index (TLI), Confirmatory Fit Index (CFI)

**Table 5:** AUC, sensitivity, specificity, and Youden's index for possible cut-off points of subdomains of the FSC

| Test Result Variables | | | AUC | 95% CI | | Mean (SD) | P [a] | Cut-off Point (≥) | Sensitivity | Specificity | Youden's J | D Value | DIFF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | | | | | | |
| Subdomains of AFC | Physical Activity | Total | 0.928 | 0.885 | 1.000 | 1203.3 (142.8) | 0.000 | 483.05 | 1 | 0.936 | 0.957 | 0.0041 | 0.064 |
| | | Male | 0.729 | 0.580 | 0.878 | 1447/3 (155.7) | | 552.5 | 0.93 | 0.64 | 0.901 | 0.1996 | 0.29 |
| | | Female | 0.801 | 0.602 | 0.912 | 663.9 (85.6) | | 315 | 0.94 | 0.713 | 0.94 | 0.1423 | 0.227 |
| | Walk Time | Total | 0.771 | 0.543 | 0.892 | 7.08(3.6) | 0.000 | 7.5 | 1 | 0.892 | 0.936 | 0.0116 | 0.108 |
| | | Male | 0.626 | 0.372 | 0.878 | 6.4 (2.9) | | 6.39 | 0.92 | 0.609 | 0.56 | 0.2328 | 0.311 |
| | | Female | 0.690 | 0.401 | 0.905 | 8.7 (4.4) | | 8.6 | 0.92 | 0.71 | 0.633 | 0.1641 | 0.21 |
| | Grip Strength | Total | 0.652 | 0.519 | 0.876 | 23.5 (10.8) | 0.001 | 20.27 | 1 | 0.934 | 0.892 | 0.0043 | 0.066 |
| | | Male | 0.688 | 0.532 | 0.843 | 27.6 (9.7) | | 20.5 | 0.87 | 0.741 | 0.479 | 0.1970 | 0.129 |
| | | Female | 0.670 | 0.491 | 0.901 | 13.6 (5.9) | | 13.6 | 0.88 | 0.654 | 0.59 | 0.2397 | 0.226 |
| | BMI | Total | 0.913 | 0.834 | 0.992 | 25.4 (3.5) | 0.000 | 21.85 | 1 | 0.833 | 0.934 | 0.0278 | 0.167 |
| | | Male | 0.917 | 0.824 | 1.000 | 25.1 (3.5) | | 23 | 0.97 | 0.79 | 0.711 | 0.0741 | 0.18 |
| | | Female | 0.891 | 0.702 | 1.000 | 26.1 (3.5) | | 23 | 0.98 | 0.89 | 0.634 | 0.0321 | 0.09 |

a. Two-sided Chi-squared test, P≤0.05. AUC=area under curve; CI=confidence interval; DIFF=abs(sensitivity– specificity); D Value=Sqrt((1-Sensitivity)²+(1-Specificity)²).

shows, three latent variables called mental, biologic, and motor indices were identified by confirmatory factor analysis.

Latent subdomains were extracted from the main frailty scale, including 1) Bio-index of factor loading on the weakness variable (0.76) and weight loss (0.87), 2) Loco-index of factor loading on mobility speed (0.8) and physical activity (0.73), and 3) Psycho-index of factor loading on fatigue (0.71).

*ROC curve analysis and FSC cut-off points:* The receiver operating characteristic curve (ROC) is frequently used to graphically estimate the connection/trade-off with a possible cut-off point between clinical sensitivity and specificity, and in psychometric studies to estimate EFA & CFA. Also, the area under the ROC curve (AUC) gives an idea about the benefit of using the test(s) in question, which leads to raising the questions of "whether the test is appropriate or not?" and "what is the advantage of using it?"

According to Fried et al.,[16] the cut-off points of the three main subdomains of FI and BMI were obtained in the study based on Table 5, using ROC curve distribution. The scores of the area under the curve demonstrate the proper diagnostic capability of the scales and cut-off points of numerical subdomains, which were obtained for old females and male adults separately. Youden's J index, distribution coefficient (D), and DIFF suggest the desirability of the scores. These three statistical indices are regarded as suitable to determine the cut-off points and area under the ROC curve. The scores of tool cut-off points are satisfactory if Youden's J index≥0.60 and DIFF≤0.2.

## Discussion

The world population aged 60 years and older is expected to increase above the natural population growth rate in all countries, especially in developing countries such as Iran.[20] Senescence is accompanied by a set of changes in physical, mental, and social aspects of human. The changes appear mainly as diseases and inabilities, among which frailty syndrome affects and weakens human performance.[17, 19] As mentioned before, the syndrome is particularly accompanied by weakness, reduced energy, reduced physical activity [21], weight loss (in more intense cases), and the outbreak of nutritional disorder.[22, 23] If frailty can be diagnosed, prevented, and treated by identifying its different reasons and factors, this can lead to the prevention or at least the delay in the onset of frailty syndrome.[24, 25] The Persian version of this scale has not yet been prepared to be used in domestic studies. Chang Woung (2019) indicated that indicators of fertility assessment have been used in various studies, including PRISMA-7 tool, 7 the Gerontopole Frailty Screening tool, 8 the Frail non-Disabled questionnaire, 9 the Frailty Screening Questionnaire,10 and the FRAIL scale, but the Frailty Phenotype Questionnaire is an accurate and easy tool for screening physical frailty as well as having sensitiivity and specificity which can be a practical

instrument in screening for frailty at the community level.[26]

In Szewieczek (2020)[27] and Chen's (2018)[28] studies, FSC can be applied as one of the most comprehensive assessment of frailty because it can include mental and psychological aspects of the individual as well. Given Cronbach's alpha and ICC, the tool had a high validity. EFA verified the distribution of factors by Varimax rotation. Amos software identified and named three latent variables, including 1) BIO-index with the common factor of weakness and weight loss, 2) LOCO-index with the common factor of walking speed and physical activity, and 3) Psycho index with the common factor of fatigue variable. FSC could be summarized into three subdomains, including LOCO-index, BIO-index, and Exhausted. Therefore, the cut-off points were separately achieved for women and men by determining the area under the ROC curve via Youden's J index, distribution coefficient (D), and DIFF (The equivalent measures in parentheses are from a 2016 study by Bieniek et al. in the Polish elderly population, n=500.)[29]

- Physical activity was 552.5 (951.2) and 315(397.1) kcal for men and women, respectively.
- Walking time was 7.5 (6.4) and 6.39 (8.8) for men and women, respectively.
- Handgrip strength was 20.27 (28.6) and 13.6 (13.6) for men and women, respectively
- BMI was 23 (26.7) for both men and women,

The present study results with high validity could be generalized to the Iranian population over 60 years old. FSC could be more efficient than other time-consuming tools in health screening, medical diagnoses, and rehabilitation scope. The findings from FSC are similar to the results reported for Arab and Korean elderly,[30, 31] chronic patients[32] compared to other frailty indices.[23, 24] This study was limited by inaccessibility to specific groups of the elderly, such as residents of village and nursing homes. Moreover, interpretation of how a group of older people performs certain physical activities requires more time and precision for examiners.

## Conclusion

Fried's five-item index of frailty syndrome checklist provided acceptable psychometric properties in the Iranian context. It can clearly measure physical evaluation, motor disorders, and functional weakness in a motor limb by evaluating motor balance and preventing injury, especially among the elderly at risk of falls. It is not only valid in the community context, but also among the residents of nursing homes.[33]

The positive point of the research is validity and reliability of Frailty Fried index for the first time in Iran and in Persian version. The limitations of the study included attracting the participation of the samples, obtaining the necessary permits to evaluate and carry out the plan, and preparing the device needed for measurement.

**Conflict of Interest:** None declared.

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