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Research paper

Validation of the Comprehensive Frailty Assessment Instrument against the Tilburg Frailty Indicator

N. De Witte^{a,b,*}, R. Gobbens^{c,d}, L. De Donder^e, S. Dury^e, T. Buffel^e, D. Verté^e, J.M.G.A. Schols^f

^a Faculty of Education, Health and Social Work, University College Ghent, Keramiekstraat 80, 9000 Ghent, Belgium

^b Faculty of Psychology and Educational Sciences, Vrije Universiteit Brussel, Brussels, Belgium

^c Rotterdam University of Applied Sciences, Rotterdam, The Netherlands

^d Department of Tranzo, Scientific Center for Care and Welfare, Tilburg University, PO Box 90153, 5000 Tilburg, The Netherlands

^e Faculty of Psychology and Educational Sciences, Vrije Universiteit Brussel, Pleinlaan, 2, 1050 Elsene, Brussels, Belgium

^f Department of General Practice and Department of Health Services Research Caphri, School for Public Health and Primary Care, Maastricht University, Polvertorenstraat 4, 6211 LX Maastricht, The Netherlands

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ABSTRACT

Purpose: Assessing the validity of the Comprehensive Frailty Assessment Instrument (CFAI) in comparison with the Tilburg Frailty Indicator (TFI).

Background: When ageing, most individuals prefer to age in place even if they are frail. Detecting frail older persons in the community becomes a challenge for professionals and policymakers. Most international frailty instruments emphasize physical factors. The CFAI was developed from a multidimensional perspective, measuring a physical, a psychological, a social and an environmental domain and showed good validity and reliability. The novelty of the CFAI is the environmental domain, which is important because older people will highly depend on their environment when ageing in place. In this study, the CFAI is validated against the TFI.

Design: Scale validation study.

Methods: One hundred and seventy-eight respondents aged 60 and over participated in this study. Internal consistency and explained variance of the CFAI and the subscales was assessed. Next, the correlation between the two scales was evaluated. Convergent and divergent validity between the subscales of the CFAI and TFI was assessed.

Results: The internal consistency of the CFAI was 0.759. The correlation between the CFAI and TFI was 0.590. Correlations between the physical, psychological and social domains of both scales was good and the environmental domain showed weak correlations with all other domains, pointing to convergent and divergent validity.

Conclusion: The CFAI is found to be valid in comparison with the TFI and can be used by health care professionals for the detection of frail older people living in the community.

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1. Introduction

Population ageing is affecting all Western societies [1]. In order to cope with the challenges of an ageing population, governments are changing their policy on care for elderly people. Older people are motivated to “age in place” [2] and institutionalisation is restricted to severely dependent elderly.

Staying as long as possible in their own homes is also most preferred by older people themselves [3,4] and is less expensive than institutionalisation.

This changed governmental policy creates new challenges. First, growing numbers of frail older people living at home can be expected. Second, in order to remain in their own house, these older people have to rely on both their environment (e.g. quality of housing) and social resources [5]. As a consequence, empowering older people to age in place and the detection of frailty have become very relevant governmental issues. In practice, considerable differences between the definitions of frailty can be found [6]. Frailty can be defined as a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological and social) [7].

* Corresponding author. Faculty of Education, Health and Social Work, University College Ghent, Keramiekstraat 80, 9000 Ghent, Belgium.

E-mail addresses: nico.dewitte@hogent.be (N. De Witte), gobbens.rjj@casema.nl (R. Gobbens), Liesbeth.de.donder@vub.ac.be (L. De Donder), sdury@vub.ac.be (S. Dury), tine.buffel@vub.ac.be (T. Buffel), dverte@vub.ac.be (D. Verté), jos.schols@maastrichtuniversity.nl (J.M.G.A. Schols).

Although different instruments are used to detect frail older people, some needs are still undetected. It was shown that 6.4% of the older people living at home in Belgium report care shortages [8], which points to undetected needs. As a consequence, a new approach in frailty assessment is needed. This necessity is also documented in literature [6,9–11].

In response to this, the Comprehensive Frailty Assessment Instrument (CFAI), capturing four domains of frailty (physical, psychological, social and environmental) was developed [12].

The CFAI was validated among 33,629 older adults using a second-order confirmatory factor analysis and showed good construct validity [12]. Next to confirmatory factor analysis, convergent and divergent validity is another way to assess construct validity [13]. In the light of the further development of the instrument, this study evaluates the construct validity of the CFAI by assessing convergent and divergent validity against a validated instrument, the Tilburg Frailty Indicator (TFI) [14]. This instrument is chosen because both instruments are based on the same integral conceptual model and because the TFI has shown to be potentially suitable for detecting frailty in primary care setting [15,16]. Moreover, the TFI is based on an integral view on human functioning by including physical, social and psychological components in the instrument and excluding disability and diseases. The novelty of the CFAI is the environmental domain, which is important because older people will highly depend on their environment when ageing in place [17].

2. Methods

2.1. Study population and data collection

For this study, convenience sampling was used. Nursing students ($n = 193$) enrolled in the first year of the nursing bachelor programme at University College Ghent, Faculty of Education, Health and Social Work, selected a respondent of at least 60-years-old and living in the community. We asked the students to let their respondents complete a self-administered questionnaire containing the CFAI, the TFI and demographic variables (age and gender). Prior to data collection, students were notified about the self-administered character of the questionnaire. The study was conducted according to the ethical guidelines laid down in the Declaration of Helsinki. As no experiments on humans were conducted and the actual burden of the questionnaire was very low, ethical approval was not necessary.

In total, 178 older people (67.2% females) completed the questionnaire, resulting in a response rate of 92.2%. The median age was 74 years and 47.5% were aged 75 or older. Compared to the sample used for the validation of the TFI, our sample is younger (74.0 years compared to 80.2 for the TFI validation study) and shows an over-representation of women (67.2% women against 59.0% for the TFI validation study [14]).

2.2. Measures

2.2.1. Description of the Tilburg Frailty Indicator

The TFI was developed and validated with the aim to approach frailty in an integral way [14]. In order to do so, three domains of frailty are assessed (Fig. 1). The physical domain is evaluated by asking questions about physical health, weight loss, walking, balance, hearing, vision, strengths in hands and tiredness. The psychological domain contains memory, feeling down, anxiety or nervousness and coping with problems. The social domain is assessed by living alone, missing people and receiving enough support. The total score of the TFI is calculated by adding all scores of the items, resulting in a total score ranging from 0 to 15. The score of the subscales range from 0 to 8

for the physical domain, from 0 to 4 for the psychological domain and from 0 to 3 for the social domain. The TFI was validated in a sample of community-dwelling older persons aged 75+ [14] and has proven to be a valid instrument in predicting disability, health care utilization and quality of life of older people [18].

2.2.2. Description of the Comprehensive Frailty Assessment Instrument

The CFAI was developed and validated with the aim to approach frailty in a multidimensional way [12]. In contrast with the TFI, the CFAI (Fig. 2) measures four domains of frailty. For the physical domain of frailty, the respondent's general physical health is assessed. The psychological domain is captured by measuring mood-disorders and emotional loneliness. The social domain of frailty is measured twofold, capturing older people's social loneliness, and their social support. Finally, the environmental domain of frailty is assessed by propositions regarding push factors of the respondent's actual housing and environmental conditions. Push factors [19] refers to conditions of physical inadequate environments, threatening the mobility of ageing individuals as to a lack of comfort.

The total score of the CFAI is calculated by summing the scores on each indicator, resulting in a score ranging from 19 to 97. The scores for the subscales are calculated by adding the scores of the specific items. As a consequence, the physical subscale ranges from 4 to 12, the psychological subscale from 4 to 20, the emotional and social subscale from 3 to 15, the environmental subscale from 5 to 25 and the social support subscale from 0 to 10. The CFAI was validated among 33,629 older adults, using a second-order confirmatory factor analysis. Due to the large sample size, only those fit indices which are insensitive to sample size were used. The model showed good model fit indices: Root Mean Square Error of Approximation (RMSEA) = 0.032 (90% interval = 0.032 to 0.033), Comparative Fit Index (CFI) = 0.974 and Tucker-Lewis Index (TLI) = 0.970 and produced factor loadings ranging from 0.32 to 0.80. The CFAI also proved to be internally consistent, with a Cronbach's α of 0.812, explaining 63.6% of the variance in frailty.

2.3. Analytic strategy

The data were coded and entered into IBM SPSS v20.0. First, the internal consistency of the CFAI and the subscales was calculated. Afterwards, the mean scores of both the CFAI and TFI were calculated. Second, the correlation between the two scales was assessed. Third, internal consistency of the subscales of the CFAI was assessed and the sub-scores of the CFAI and TFI calculated. Fourth, convergent and divergent validity was assessed by calculating the Spearman correlation coefficient between the subscales of the TFI and the CFAI. It was expected that the highest correlation coefficients between subscales are found between those measuring the same domain, and the lowest coefficients between measures of other domains. Although no cut-offs are suggested [20], scholars like Reid [21] suggest that different tests of the same construct should have correlation coefficients greater than 0.30.

3. Results

3.1. Validity of the Comprehensive Frailty Assessment Instrument

3.1.1. Internal consistency of the Comprehensive Frailty Assessment Instrument and mean score of the Comprehensive Frailty Assessment Instrument and Tilburg Frailty Indicator

The CFAI showed a Cronbach's α of 0.759 and a mean score of 38.7 (SD = 10.8) (Table 1), the TFI showed a mean score of 3.8

Tilburg Frailty Indicator (TFI)

Gobbens RJJ, van Assen MALM, Luijckx KG, Wijnen-Sponselee MTh, Schols JMGA. The Tilburg Frailty Indicator: psychometric properties. *J Am Med Dir Assoc* 2010; 11(5):344-355.

| | | | |
|---|--|-------|------------------|
| B1 Physical components | | | |
| 11. | Do you feel physically healthy? | 0 yes | 0 no |
| 12. | Have you lost a lot of weight recently without wishing to do so? (a lot is: 6 kg or more during the last six months, or 3 kg or more during the last month) | 0 yes | 0 no |
| Do you experience problems in your daily life due to: | | | |
| 13. |difficulty in walking? | 0 yes | 0 no |
| 14. |difficulty maintaining your balance? | 0 yes | 0 no |
| 15. |poor hearing? | 0 yes | 0 no |
| 16. |poor vision? | 0 yes | 0 no |
| 17. |lack of strength in your hands? | 0 yes | 0 no |
| 18. |physical tiredness? | 0 yes | 0 no |
| B2 Psychological components | | | |
| 19. | Do you have problems with your memory? | 0 yes | 0 sometimes 0 no |
| 20. | Have you felt down during the last month? | 0 yes | 0 sometimes 0 no |
| 21. | Have you felt nervous or anxious during the last month? | 0 yes | 0 sometimes 0 no |
| 22. | Are you able to cope with problems well? | 0 yes | 0 no |
| B3 Social components | | | |
| 23. | Do you live alone? | 0 yes | 0 no |
| 24. | Do you sometimes miss having people around you? | 0 yes | 0 sometimes 0 no |
| 25. | Do you receive enough support from other people? | 0 yes | 0 no |

Fig. 1. The Tilburg Frailty Indicator (determinants of frailty are not printed). Gobbens et al. [14].

(SD = 2.6). As the TFI was validated for a population 75 aged and over, we created a group aged 75 or older and a group aged between 60 and 74 years. As can be seen in Table 1, the mean TFI score for the 75+ group is 4.36, which is slightly lower than in the validation study of the TFI [14]. Finally, it was found that the total score of the CFAI and the TFI is the highest in the age group 75+.

3.1.2. Correlation between the Comprehensive Frailty Assessment Instrument and Tilburg Frailty Indicator

The Spearman correlation coefficient between the CFAI and the TFI was found to be 0.590 ($P=0.000$), which is above 0.30 as suggested by Reid [21], pointing to the fact that both scales correlate well.

3.1.3. Internal consistency of the subscales of the Comprehensive Frailty Assessment Instrument

The subscales internal consistency were 0.788 for the physical domain (CFAI_Physical), 0.746 for the psychological domain (CFAI_Psychological), 0.816 for the emotional domain (CFAI_Emotional), 0.836 for the social domain (CFAI_Social), 0.710 for the environmental domain (CFAI_Environment) and 0.350 for the social support domain (CFAI_Social Support). This latter score is rather low, but comparable with the Cronbach's α of 0.340 found for the social subscale of the TFI [14]. Consequently, the subscores of the CFAI were calculated and are printed in Table 1. Next, the subscales of the TFI, the physical (TFI_Physical), psychological (TFI_Psychological) and social (TFI_Social) subscales were also calculated and are printed

Table 1

Mean scores and standard deviation of the Comprehensive Frailty Assessment Instrument (CFAI) and the Tilburg Frailty Indicator (TFI) and the respective subscales.

| | Total sample | Aged < 75 | Aged ≥ 75 |
|---|--------------|-----------|-----------|
| CFAI | | | |
| CFAI (range 19–97) | 38.73 | 36.22 | 41.01 |
| ±SD | 10.80 | 9.20 | 11.55 |
| CFAI_Physical (range 4–12) | 6.45 | 6.06 | 6.80 |
| ±SD | 2.64 | 2.59 | 2.65 |
| CFAI_Psychological (range 5–20) | 7.40 | 7.32 | 7.48 |
| ±SD | 2.69 | 2.35 | 3.01 |
| CFAI_Social (range 3–15) | 5.23 | 5.16 | 5.32 |
| ±SD | 2.83 | 2.87 | 2.87 |
| CFAI_Emotional (range 3–15) | 6.27 | 5.99 | 6.52 |
| ±SD | 3.58 | 3.43 | 3.70 |
| CFAI_Social Support Network (range 0–10) | 5.09 | 5.36 | 4.77 |
| ±SD | 2.32 | 2.52 | 2.12 |
| CFAI_Environment (range 5–25) | 7.83 | 7.27 | 8.31 |
| ±SD | 3.69 | 3.17 | 3.98 |
| TFI | | | |
| TFI (range 0–15) | 3.84 | 3.28 | 4.36 |
| ±SD | 2.59 | 2.44 | 2.65 |
| TFI_Physical (range 0–8) | 1.75 | 1.20 | 2.30 |
| ±SD | 1.69 | 1.38 | 1.80 |
| TFI_Psychological (range 0–4) | 1.03 | 1.07 | 0.96 |
| ±SD | 1.03 | 1.01 | 0.99 |
| TFI_Social (range 0–3) | 1.05 | 1.00 | 1.09 |
| ±SD | 0.86 | 0.94 | 0.77 |

in Table 1. All these scores were calculated according to the guidelines of the authors [14].

Our sample shows comparable scores for the TFI subscales with those from the validation study of the TFI [14]. We found slightly lower means for the TFI_Physical (2.30 against 2.50 in the validation study), for the TFI_Social (1.09 against 1.30 in the validation study) and a comparable mean for the TFI_Psych (0.96 against 1.00 in the validation study).

With regard to the CFAI, this trend continues for all subscales except for social support, where those aged below 75 demonstrate higher scores. For the TFI, the score of the psychological domain is lower in the aged 75+.

3.1.4. Convergent and divergent validity

Construct validity was assessed through examination of the Spearman correlation coefficients between the subscales of the CFAI and TFI and is presented in Table 2. Positive and significant correlations were interpreted as evidence for construct validity. In the first three columns, the Spearman correlation coefficients between the subscales of the CFAI and TFI are printed for the whole sample. In the next three columns, the correlation coefficients can be found for the population younger than 75 and in the latter three columns for those being 75 years or older.

For the total sample, it was demonstrated that the physical domain score of the CFAI (CFAI_Physical) correlated well and significantly with the TFI_Physical ($r = 0.560$, $P = 0.000$) and correlated weakly with the TFI_Psychological ($r = 0.152$, $P = 0.045$) and TFI_Social ($r = 0.066$, $P = 0.384$). The CFAI score of the psychological domain (CFAI_Psychological) correlated well with the TFI_Psychological ($r = 0.502$, $P = 0.000$). Emotional and social scores of the CFAI (CFAI_Emotional and CFAI_Social) showed a correlation of respectively 0.553 ($P = 0.000$) and 0.311 ($P = 0.000$) with the TFI_Social. The scores of the environmental domain of the CFAI (CFAI_Environment) showed weak correlations with all the TFI subscales. Finally, the social support scores of the CFAI (CFAI_Social Support) showed a correlation of 0.390 ($P = 0.000$) with the TFI_Social.

The same tendency can be found for the correlations in the sample aged between 60 and 74 years. For those aged 75 and over, this tendency continues except for the correlation between CFAI_Social where we found the highest correlation with the TFI_Psychological.

4. Discussion

The CFAI was developed in order to detect frailty in community-dwelling older persons. The CFAI consists of four domains; physical, psychological, social and environmental. Although the CFAI showed good model fit indices and good reliability on a sample of 33,629 respondents, it was not yet validated against another scale aiming to capture frailty. In this study, we choose the Tilburg Frailty Indicator (TFI) as validation instrument as both instruments are based on the same conceptual model.

This study shows that the CFAI is a valid instrument for the detection of community-dwelling frail older persons. The internal consistency was found to be good on the total scale and the subscales of the CFAI, which confirms the results of the previous validation study on the CFAI [12]. Moreover, although the physical, psychological and social domain of frailty are measured differently in the CFAI and the TFI, the scores of the subscales of the CFAI correlated well with the respective subscales of the TFI. Also, the correlations between different scales of the CFAI and TFI, for example CFAI_Physical with TFI_Social, were weak pointing to good construct validity of the CFAI. The novelty of the CFAI is the introduction of the environmental domain, which is important because older people will highly depend on their environment when ageing in place. The internal consistency of this subscale showed to be good and the correlation between this subscale score (CFAI_Environment) and the TFI subscales was low, which demonstrates that the environmental domain measures something different. The total scores of the CFAI and TFI showed a correlation of 0.590, indicating that both scales correlate well.

The CFAI has some advantages over most other quantitative instruments detecting frailty. The scale comprises 23 items capturing four different domains of frailty in the aged. Thereby the CFAI changes the vision on frailty like suggested by Walston et al. [22], Levers et al. [23], Hogan et al. [24] and Markle-Reid and Brown [10]. The major strength of the CFAI was the validation of the instrument in a large sample size ($n = 33,629$) upon which our validation results are based [12]. In this contribution, the sample size was appropriate for the study as well ($n = 178$). The CFAI showed a comparable internal consistency as in the validation study, indicating that the CFAI is a valid and reliable instrument.

Despite these strengths of the present study and the methodological approach, some limitations have to be considered. First, as convenience sampling is used, a selection bias might be possible, although the internal consistency of the CFAI and its subscales showed to be good except for the social support subscale. The internal consistency of the CFAI_Social Support was low and this in contrast with the validation study. This can point to the

Table 2
Spearman rho correlation coefficients between the subscales of Comprehensive Frailty Assessment Instrument (CFAI) and the Tilburg Frailty Indicator (TFI).

| | Total sample | | | Aged < 75 years | | | Aged ≥ 75 years | | |
|----------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | TFI_Physical | TFI_Psychological | TFI_Social | TFI_Physical | TFI_Psychological | TFI_Social | TFI_Physical | TFI_Psychological | TFI_Social |
| CFAI_Physical | | | | | | | | | |
| rho | 0.560 ^b | 0.152 ^a | 0.066 | 0.589 ^b | 0.247 ^a | 0.120 | 0.465 ^b | 0.131 | −0.031 |
| sig | 0.000 | 0.045 | 0.384 | 0.000 | 0.020 | 0.262 | 0.000 | 0.245 | 0.782 |
| n | 174 | 174 | 174 | 89 | 89 | 89 | 81 | 81 | 81 |
| CFAI_Psychological | | | | | | | | | |
| rho | 0.326 ^b | 0.502 ^b | 0.246 ^b | 0.434 ^b | 0.443 ^b | 0.235 ^a | 0.314 ^b | 0.535 ^b | 0.220 ^a |
| sig | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.026 | 0.004 | 0.000 | 0.047 |
| n | 176 | 176 | 176 | 89 | 89 | 89 | 82 | 82 | 82 |
| CFAI_Emotional | | | | | | | | | |
| rho | 0.268 ^b | 0.297 ^b | 0.553 ^b | 0.370 ^b | 0.283 ^b | 0.586 ^b | 0.212 | 0.269 ^a | 0.481 ^b |
| sig | 0.000 | 0.000 | 0.000 | 0.000 | 0.007 | 0.000 | 0.053 | 0.013 | 0.000 |
| n | 178 | 178 | 178 | 89 | 89 | 89 | 84 | 84 | 84 |
| CFAI_Social | | | | | | | | | |
| rho | 0.157 ^a | 0.221 ^b | 0.311 ^b | 0.093 | 0.168 | 0.376 ^b | 0.198 | 0.307 ^b | 0.213 |
| sig | 0.036 | 0.003 | 0.000 | 0.388 | 0.115 | 0.000 | 0.070 | 0.004 | 0.052 |
| n | 178 | 178 | 178 | 89 | 89 | 89 | 84 | 84 | 84 |
| CFAI_Social Support | | | | | | | | | |
| rho | 0.196 ^a | 0.187 ^a | 0.390 ^b | 0.208 | 0.226 | 0.470 ^b | 0.167 | 0.191 | 0.306 ^b |
| sig | 0.019 | 0.026 | 0.000 | 0.086 | 0.062 | 0.000 | 0.167 | 0.113 | 0.010 |
| n | 143 | 143 | 143 | 69 | 69 | 69 | 70 | 70 | 70 |
| CFAI_Environment | | | | | | | | | |
| rho | 0.262 ^b | 0.189 ^a | 0.261 ^b | 0.344 ^b | 0.223 ^a | 0.293 ^b | 0.083 | 0.193 | 0.196 |
| sig | 0.000 | 0.012 | 0.000 | 0.001 | 0.037 | 0.006 | 0.457 | 0.082 | 0.078 |
| n | 175 | 175 | 175 | 88 | 88 | 88 | 82 | 82 | 82 |

^a Correlation is significant at the 0.05 level (2-tailed).^b Correlation is significant at the 0.01 level (2-tailed).

moderate sample size in this study ($n = 178$) or to the higher mean age of the sample. When ageing, an individual's social network decreases. The rather low internal consistency can also be caused by sampling issues, as the reliability in the previous study showed to be much better. Yet, all other subscales showed good internal consistencies. This matter needs to be addressed in future research.

Second, the CFAI_Social showed a moderate correlation of 0.311 with the TFI_Social. This could be due to several reasons. Both instruments use different indicators and are scored in different ways. For the TFI, the propositions can be answered by ticking yes, no or sometimes. In the CFAI, a 5-point Likert scale is used. Moreover, the internal consistency of the CFAI_Social is good (0.836). In the validation study of Gobbens et al. [14], the internal consistency of TFI_Social was 0.340.

Third, there are no cut-off points determined. Future research could offer more insight in this matter. Fourth, cognitive problems are not assessed in the CFAI and this in contrast with the TFI. Further research could focus on this matter.

Finally, only Dutch speaking older persons living in Belgium were included in this study. Cross-validating the CFAI by including international samples would of course enrich the external validity of this measurement instrument.

This study provides support for using the CFAI as a measurement instrument of frailty in community-dwelling older persons. In order to get more insight in frailty, further research could uncover individual and contextual determinants of frailty.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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