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### Towards tailored elderly care

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## Measurement properties of the Groningen Frailty Indicator in home-dwelling and institutionalized elderly people

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## ABSTRACT

**Objectives** To enable prevention of poor outcome in elderly people a valid instrument is required to detect individuals at high risk. The concept frailty is a better predictor than age alone. The Groningen Frailty Indicator (GFI) has been developed to identify frailty. We assessed feasibility, reliability and construct validity of the self-assessment version of the GFI.

**Design** Cross-sectional.

**Setting** Community-based.

**Participants** Home-dwelling and institutionalized elderly persons were included in the study ( $n=353$ ) who met the following inclusion criteria: persons 65 years of age and over who were able to fill out questionnaires.

**Measurements** The feasibility of the GFI was assessed by determining the proportion of missing values per item. The internal consistency reliability of the GFI was established by calculating the KR-20. Mann-Whitney and Kruskal-Wallis tests were applied to assess discrimination between specific subgroups (known group validity). Convergent and discriminant validity was assessed using Spearman Rank correlations between GFI and diseases and disorders, case complexity and healthcare needs (INTERMED), life satisfaction (Cantril's Ladder of Life), activities of daily living (Katz), quality of life (EQ-5D) and mental health (SF-36). Finally, we used multivariate regression analyses to evaluate the cut off score of the GFI ( $<4$  versus  $\geq 4$ ).

**Results** A total of 296 (84%) of the participants completed all items of the GFI; and the internal consistency was 0.68. The GFI yielded statistically significant GFI-scores for subgroups (known group validity). The correlations for the convergent (range 0.45 to 0.61) and discriminant validity (range 0.08-0.50) were also as hypothesized. In contrast with non-frail participants, frail older persons had higher levels of case complexity, disability, and lower quality of life and life satisfaction.

**Conclusions** This study supports the feasibility, reliability and validity of the self-assessment version of the GFI in home-dwelling and institutionalized elderly people.

## 2.1 INTRODUCTION

Since the introduction of the concept of frailty several instruments have been developed to determine the level of frailty among elderly people<sup>1</sup>. Although researchers disagree on a precise definition, it is commonly accepted that frailty indicates a state of vulnerability regarding the future occurrence of poor health outcomes like mortality, hospitalization, institutionalization, chronic conditions, and/or loss of function in one or more domains (i.e. the physical, psychological, cognitive and social domains)<sup>2-5</sup>. Frailty is not only associated with quality of life and life satisfaction of individuals but also has an effect on healthcare demands as the numbers of frail elderly people in our ageing population will increase<sup>6,7</sup>. A valid screening tool to identify frailty is essential from both a clinical and social perspective. Without such an instrument tailoring preventative interventions for elderly people who are at risk of adverse events will be difficult to attain. The current instruments differ in their perspective on frailty, and as a consequence different domains are included to measure the construct<sup>1,4,5,8-15</sup>.

More recently frailty is considered as a multidimensional construct comprising several domains (e.g. physical, psychological, social and cognitive domains)<sup>1,8,16</sup>. Several multidimensional frailty instruments have been developed, including the Tilburg Frailty Indicator (TFI)<sup>17</sup>. However, major drawbacks of most of these instruments are that they (1) aim to assess frailty in specific elderly populations only (e.g. home-dwelling), (2) do not comprise both a professional and a self-assessed version, (3) do not comprise items that assess disability that could predict poor outcome and (4) do not allow for grades of frailty to be identified. The Groningen Frailty Indicator (GFI) is an instrument which includes all these domains and meets the drawbacks of other instruments<sup>18</sup>. The GFI is widely used in clinical practice (i.e. geriatric centers, nursing homes, emergency departments, traumatology, pulmonology, rheumatology, and surgical medicine), in outpatient settings, and in clinical studies<sup>4,18-21</sup>.

Some of these studies assessed the psychometric properties of the professional or self-report version of the GFI. The internal consistency of the professional version of the GFI was considered to be good and the calculated KR-20/ Cronbach's alpha ranged from 0.71-0.77<sup>18,19</sup>. Positive indications were also found for its validity since – in contrast with non-frail elderly people – frail older participants showed lower scores on quality of life and higher scores on psychological distress<sup>18</sup>. Another study found that higher scores on the GFI were associated with less self-management abilities<sup>19</sup>. Only one study – in community-dwelling older persons only – assessed the psychometric properties of the self-report version of the GFI<sup>22</sup>. In this study, the internal consistency was 0.73

(Cronbach's alpha) and the construct validity of the GFI was also supported since it had substantial to high correlations with two other frailty instruments: the Sherbrooke Postal Questionnaire (SPQ) and the TFI (convergent validity)<sup>22</sup>. Secondly, as with the TFI, the GFI-scores were significantly higher for females, older persons with higher age, persons with lower education, and people with lower incomes (known group validity)<sup>22</sup>.

We conclude that a comprehensive psychometric evaluation of the self-report version of the GFI is still lacking in home dwelling elderly and elderly living in assisted-living residences, homes for the elderly and nursing homes. Accordingly, the aim of the present study was to assess feasibility, reliability, and validity, of the self-report version of the GFI in a heterogeneous population of elderly people.

## 2.2 METHODS

From June 2008 until February 2010, a cross-sectional study was conducted among individuals residing in the Northern provinces of the Netherlands. We recruited 359 elderly people who met the following inclusion criteria: persons 65 years of age and over who were able to fill out questionnaires. We excluded elderly people who had severe cognitive dysfunction and/or were very ill. The exclusion of severe cognitive dysfunction during the home interview was based on the professional judgment of comprehensively trained research nurses. This type of non-intrusive observational study does not require ethical committee approval under Dutch legislation. For a later study involving the same instruments and - moreover - including follow-up measurements, the ethics review board of our institution provided a waiver it was not an experimental study with test subjects as meant in the Medical Research Involving Human Subjects Act (WMO). Trained research nurses identified eligible elderly people who lived independently, in assisted-living residences or institutionalized (nursing homes or homes for the elderly). Respondents were identified with help from a geriatric department of a general hospital, home care organizations and associations for the elderly. Before participation, all elderly people gave their consent to participate in the study. Subsequently, all participants received a postal questionnaire comprising items about demographics, diseases and disorders and in addition instruments to assess frailty (GFI) and life satisfaction (Cantril's Ladder of Life).

The GFI is a 15-item screening instrument to determine the level of frailty which is available in a professional and self-report version<sup>19,22</sup>. It measures the loss of functions and resources in four domains: physical (mobility functions, multiple health problems, physical fatigue, vision, hearing), cognitive (cognitive dysfunction), social (emotional isolation), and psychological (depressed mood and feelings of anxiety)<sup>18</sup>. All answer categories were dichotomized and a score of 1 indicates a problem or dependency. The range of the GFI-score is 0-15. Geriatric experts agreed that a score of four or higher represents moderate to severe frailty<sup>19</sup>. The professional version of the GFI was modified from a patient orientated questionnaire (with items like: "Has the patient recently felt downhearted or sad?") in to an individual orientated questionnaire (with items like "Have you recently felt downhearted or sad?") and as a consequence the formulations of all items were adapted<sup>19,22</sup>. For the purpose of the future evaluation of the predictive validity of the GFI in the longitudinal cohort study Lifelines<sup>23</sup>, 4 psychosocial items were slightly rephrased. For example, the item "Do you sometimes miss people around yourself" was rephrased as: "Do other people pay attention to you?" (see Appendix I).

Life Satisfaction of elderly people was assessed using the validated Cantril's Ladder of Life Scale<sup>24-27</sup>. It assesses the respondents' life satisfaction with three self-report items that indicate life satisfaction in the past, present, and future. The present study is limited to the analyses of present life satisfaction. Ratings are made on a 10-point scale that ranges from best possible life to worst possible life. A higher score indicates better life satisfaction.

After two weeks, the research nurses collected the questionnaire at the elderly homes. They asked the elderly people to indicate GFI items which were difficult to fill out and helped the participants to complete those questions that were skipped. During the interview, the following assessments were performed; case complexity and healthcare needs (INTERMED), activities of daily living (Katz extended ADL)<sup>28</sup>, quality of life (EuroQol-5D)<sup>29</sup>, and psychosocial functioning (SF-36 mental health subscale)<sup>30</sup>.

The INTERMED questionnaire is a valid and reliable assessment method of case complexity and healthcare needs. It provides a biopsychosocial description of the elderly person based on clinically relevant variables<sup>31,32</sup>. It contains a biological, a psychological, a social, and a healthcare domain. All domains comprise five questions and each domain is assessed in a context of time (history, current state, and prognosis). In total, the instrument consists of 20 items and the scores are summed up (range 0-60). A high score indicates high case complexity<sup>33,34</sup>.

The Katz extended Instrumental Activities of Daily Living (Katz) measures the independency in personal and instrumental activities of daily living. This instrument is frequently used in elderly people. It includes six ADL items and four instrumental-ADL items. Each item is scored with a 0 (dependent) or 1 (independent), range 0-10<sup>35</sup>.

The EuroQol-5D (EQ-5D) is a reliable and valid tool for measuring health-related quality of life. The instrument comprises five domains: mobility, self-care, pain, usual activities, and psychological status (answers-categories: no/some/severe problems). An index score was calculated for each respondent's health status<sup>29</sup>.

The SF-36 is a generic health questionnaire, which measures several dimensions of the respondent's health status. For this study, we assessed the mental health subscale (containing 5 items). Scores on the scale ranged from 0-100 with a score of 100 indicating the highest rating of mental health<sup>30</sup>.

### 2.2.1 Sample size

For the calculation of the number or required participants per subgroup we estimated effect sizes based on the conventions of Cohen<sup>36</sup>. Medium effect sizes (0.5 standard deviation difference between subgroups) were considered to be clinically relevant. Because some of the subgroup characteristics comprised 3 categories (e.g. living situation), we decided to recruit at least 52 older persons per subgroup (on the basis of a two-tailed test with  $\alpha=5\%$  and  $1-\beta=80\%$ )<sup>36</sup>.

### 2.2.2 Statistical analyses

Baseline characteristics were analyzed using descriptive statistics. Differences between the study sample and excluded respondents were evaluated with Independent T Tests and Pearson Chi-Square tests, where appropriate. A total GFI-score was calculated if at least 75% of the GFI items were completed<sup>22</sup>. We applied 3 techniques to impute missing values. Missing values were imputed with 0, 1 or the mean score for completed items of the GFI. The different techniques showed similar results and therefore we arbitrarily decided to impute missing values by 0. Standard psychometric methods were used to estimate measurement properties (feasibility, reliability and construct validity) of the GFI.

The feasibility was based upon the proportion of participants who completed at least 75% of the GFI items. In addition, we calculated the non-response rate per item among those participants who completed at least 75% of the GFI items<sup>22</sup>. The internal consistency reliability of the GFI was calculated with the Kuder-Richardson Formula 20 (KR-20), as the items were scored dichotomously<sup>37</sup>. The KR-20 and Cronbach's alpha produce the same results and an Alpha above 0.70 indicates satisfactory internal consistency<sup>38</sup>. The construct validity of the GFI was assessed in terms of known or extreme group validity, convergent validity, and discriminant validity<sup>39</sup>. We hypothesized that the GFI-total scores differ among elderly subgroups and that these would be associated with age, gender, being single, being institutionalized, and having more diseases and disorders<sup>20,22</sup>. This was assessed with Mann-Whitney and Kruskal- Wallis tests (known group validity). To assess the construct validity of the GFI we calculated Spearman Rank correlations between the GFI-total score and concepts that measure similar concepts (convergent validity) and concepts that measure different concepts (discriminant validity)<sup>39</sup>. Frailty means losses of direct resources in several domains of function and these losses are associated with the prevalence of diseases/disorders, case complexity, and dependency of carrying out daily tasks<sup>11,15,19,22,40,41</sup>. Therefore, we assumed higher correlations between the GFI and similar constructs. We assumed lower correlations with total GFI-scores versus different constructs like quality of life and life satisfaction. Finally, we evaluated the cut off score of



the GFI (<4 versus ≥4) using multivariable regression analyses (with adjustments for age, gender and diseases/disorders) and the outcome measures: case complexity, activities of daily living, quality of life, and life satisfaction. All GFI data were analyzed using previously mentioned nonparametric tests as the data were not normally distributed.

All statistical analyses were performed by using SPSS/PASW 18 (spss inc, Chigaco, IL). The level of significance was set at p=0.05.

**Table 1** Baseline characteristics of the included elderly population (n=353)

<b>Sex (n, %)</b>		
Female	228	(65)
<b>Age (mean, SD)</b>	81	(8)
<b>Marital Status (partner/spouse) (n, %)</b>	118	(33)
<b>Living situation (n, %)</b>		
Home-dwelling elderly	168	(48)
Assisted-living residences	61	(17)
Living in home for the elderly or nursing homes	124	(35)
<b>Diseases (n, %)<sup>1</sup></b>		
Degenerative joint disease	190	(54)
Cardiovascular disease	156	(44)
Diabetes Mellitus	71	(20)
Pulmonary disease	65	(18)
Stroke	54	(15)
<b>Cognitive dysfunction</b>		
No cognitive dysfunction	309	(88)
Some cognitive dysfunction	44	(12)
<b>Assessments (mean, SD)</b>		
Frailty (GFI)	4.5	(2.8)
Case complexity and healthcare needs (INTERMED)	14.8	(6.3)
Life satisfaction current (Cantril's Ladder of Life)	7.0	(1.5)
Quality of life (EQ-5D) <sup>2</sup>	0.7	(0.4)
ADL (Katz) <sup>2</sup>	4.5	(2.8)
Mental Health (SF-36) <sup>2</sup>	71.8	(19.6)

<sup>1</sup> The selected diseases showed the highest prevalence in the population

<sup>2</sup> n=260

## 2.3 RESULTS

A total of 359 elderly persons consented to participate in the study and filled out a postal questionnaire. All included elderly persons participated in the home interviews for the assessment of case complexity (INTERMED) and life satisfaction (Cantril's Ladder of Life). During the study period the assessment of ADL (Katz), quality of life (EQ-5D) and mental health (SF-36) were added to the interview. For the majority of the included elderly people ( $n=260$ ) all instruments mentioned previously were assessed. Based on the research nurses' professional experience in geriatric care no participant had to be excluded because of severe cognitive impairment. The data of  $n=353$  were analyzed as they filled out at least 75% of the GFI items (see paragraph below on feasibility). The average age of the elderly was 81 years and 65% of the participants were female (see Table 1). The elderly people had a median GFI-score of 4 (interquartile range 2-7). Sixty percent of the elderly ( $n=211$ ) had a total GFI- score of 4 or higher and were considered to be frail. None of the elderly people scored the maximum total score of 15 and 7% ( $n=23$ ) scored the minimum GFI-score.

### 2.3.1 Feasibility

During the home visit the research nurses assisted 69 elderly persons with the completion of items in the postal questionnaire, comprising the GFI and other measures. Six (2%) of the 359 elderly people were excluded from the analyses because they completed 11 or fewer items of the GFI. Of those who were included in the analyses, 84% ( $n=296$ ) filled out all 15 items of the GFI. The 6 excluded older persons did not differ from those who were included, with regard to gender ( $p=0.92$ ), age ( $p=0.60$ ), marital status ( $p=0.06$ ), diseases and disorders ( $p=0.26$ ), or cognitive dysfunction ( $p=0.75$ ); however, more frequently elderly people who lived in assisted-living residences had missing values as compared with those who lived independently or in a home for the elderly or nursing home ( $p=0.001$ ). We also compared the demographic characteristics and cognitive functioning of the included elderly persons who completed all items ( $n=296$ ) versus those who omitted at least one item ( $n=57$ ). Participants who were older ( $p=0.05$ ), were single ( $p=0.05$ ), lived in a home for the elderly or nursing home ( $p=0.01$ ) or who had some cognitive dysfunction ( $p=0.03$ ) had more missing values. The average number of missing values per participant was 0.2. Of the 59 elderly persons who omitted at least one GFI item, 16 participants had 20 questions with regard to GFI items that they found difficult to fill out, especially the items of the psychosocial domains and the item 'mark physical fitness'. This corresponds with the higher proportions of missing values on the same items (see Table 2).

**Table 2** Proportions of missing values on the separate GFI items

GFI items	Proportion of missing values	
	<i>n</i>	(%)
<b>Physical domain</b>		
1. Shopping	10	(3%)
2. Walking around outside	5	(1%)
3. Dressing and undressing	1	(0%)
4. Going to the toilet	2	(1%)
5. Mark Physical fitness	14	(4%)
6. Experience problems due to poor vision	2	(1%)
7. Experience problems due to poor hearing	1	(0%)
8. Lost weight	3	(1%)
9. Prescription of 4 or more medicines	2	(1%)
<b>Cognition domain</b>		
10. Complaints about memory	0	(0%)
<b>Social domain</b>		
11. Part of social network	13	(4%)
12. Attention other people	3	(1%)
13. Help other people	9	(3%)
<b>Psychological domain</b>		
14. Calm and relaxed	9	(3%)
15. Nervous or downhearted	4	(1%)

### 2.3.2 Reliability

The internal consistency of the GFI was 0.68.

### 2.3.3 Construct validity

Table 3 shows the statistical differences on the median total GFI-scores between elderly subgroups based on demographic and diseases/disorders characteristics (known group validity). The GFI-total scores differed between subgroups as hypothesized: higher GFI-scores were found in the oldest-old, elderly people who were single, who were institutionalized, who had a higher number of diseases/disorders and in women (though the last difference was not statistically significant).

The correlations between the GFI-total score and its physical and psychological domains, versus comparable constructs were higher, as expected, and ranged from 0.45-0.61 (convergent validity; Table 4). With the exception of life satisfaction, lower correlations were found between the GFI and different concepts: 0.08-0.50 (discriminant validity). The current cut off score of the GFI (<4 versus  $\geq 4$ ) in multivariate regression analyses with adjustments for age, gender, and diseases/disorders showed that – as compared with non-frail older adults – frail elderly persons scored higher on case complexity, had higher levels of dependency in carrying out activities of daily living (ADL), and had lower quality of life and lower life satisfaction rates (see Table 5).

**Table 3** GFI-scores and proportions of frailty in elderly subgroups

	GFI median (interquartile range)	Proportion frailty GFI-total score $\geq 4$ (%)
<b>Gender</b>		
Men (n=125)	4 (2-6)	52
Woman (n=228)	5 (3-7)	64
<b>Age<sup>1</sup></b>		
65-82 years (n=178)	4 (2-6)	52
$\geq 82$ years (n=175)	5 (3-7)	68
<b>Marital Status<sup>1</sup></b>		
Partner/Spouse (n=118)	3 (2-6)	47
Single/Widow (n=235)	5 (3-7)	66
<b>Living situation<sup>2</sup></b>		
Home-dwelling elderly (n=168)	3 (1-5)	46
Assisted-living residences (n=61)	4 (3-6)	62
Living in home for the elderly or nursing homes (n=124)	6 (4-8)	77
<b>Diseases and disorders<sup>2</sup></b>		
0-1 disease/disorder (n=110)	2 (1-4)	29
2 diseases/disorders (n=99)	4 (3-6)	61
$\geq 3$ diseases/disorders (n=144)	6 (4-8)	83

<sup>1</sup> Mann-Whitney test  $p \leq 0.001$

<sup>2</sup> Kruskal-Wallis test  $p \leq 0.001$

**Table 4** Convergent and discriminant validity of the GFI-total score, GFI physical domain, and GFI psychological domain<sup>1</sup>

	Total GFI score	GFI domain physical	GFI domain psychological
<b>Convergent validity</b>	r <sup>1</sup>	r <sup>1</sup>	r <sup>1</sup>
Diseases and disorders	0.51	0.45	-
Case complexity (INTERMED)	0.56	0.49	-
Activities of daily living (Katz)	0.50	0.61	-
Mental health (SF-36)	-	-	0.57
<b>Discriminant validity</b>			
Quality of life (EQ-5D)	0.26	0.28	0.13
Life satisfaction (Cantril's Ladder of Life)	0.50	0.35	0.48
Activities of daily living (Katz)	-	-	0.08
Mental health (SF-36)	-	0.15	-

<sup>1</sup> Correlations are in absolute values (high scores on the instruments - i.e. good quality of life, high life satisfaction, independent with activities of daily living, and good mental health - are associated with low scores on the GFI - i.e. low frail).

**Table 5** Multivariate regression analyses to assess the associations between dichotomized total scores on the GFI (<4 versus ≥4) and case complexity, activities of daily living, quality of life and life satisfaction

Dependent variables	Multivariate GFI model <sup>1</sup> B
Case complexity (INTERMED)	4.88 (3.66 to 6.11) <sup>2</sup>
Activities of daily living (Katz)	2.54 (1.83 to 3.25) <sup>2</sup>
Quality of Life (EQ-5D)	-0.16 (-0.26 to -0.07) <sup>2</sup>
Life Satisfaction (Cantril's ladder of life)	-1.01 (-1.33 to -0.69) <sup>2</sup>

<sup>1</sup> Adjusted for age, gender, and diseases/disorders

<sup>2</sup> p < 0.05

## 2.4 DISCUSSION

This study collaborates the feasibility, reliability and validity of the self-report version of the GFI in home-dwelling and institutionalized elderly people.

The feasibility of the self-report version of the GFI in the present study was good, which supports the results of a previous study<sup>22</sup>. Most of the elderly persons 84% ( $n=296$ ) had no difficulty completing the GFI, a minority 16% ( $n=57$ ) skipped at least one item on the GFI. Persons who had at least one missing value were older in age, single, lived institutionalized or had mild to moderate cognitive dysfunction.

The internal consistency of the GFI in the present study (0.68) was slightly lower than the range of a satisfactory scale ( $>0.70$ ) and also lower than the reliability found in a previous study (i.e. 0.73)<sup>22</sup>. However, it is not unusual to see a variation in internal consistency of a scale across data sets. Also, while developing the GFI our aim was a feasible and short questionnaire as an indicator of frailty with items from different domains. Such an approach has clearly advantages for the use of the instrument in clinical practice but may have compromised internal consistency.

With regard to construct validity the results of the known group validity showed that overall the GFI discriminates between subgroups with different demographics and diseases/disorders characteristics. Our results were consistent with previous work showing that age has a statistically significant association with GFI-scores<sup>20,22</sup>. However, in contrast with one previous study we did not find a significant association between gender and GFI-scores<sup>20</sup>. The correlations of the GFI with diseases/disorders and other instruments showed evidence for both its convergent and its discriminant validity. As expected, we found higher correlations between the GFI and related concepts. Except for life satisfaction, lower correlations were found between the GFI and different concepts. The moderate correlations between case complexity (INTERMED) and the GFI were consistent with previous results, although in this study the professional version of the GFI was assessed<sup>4</sup>. The substantial correlation between instrumental activities of daily living (Katz) and the GFI in the present study was comparable to the results in a previous study in which the Groningen Activity Restriction Scale was used<sup>22</sup>.

The correlation between GFI and life satisfaction was moderate and therefore higher than expected. A previous study, which used a different life satisfaction instrument, also showed a moderate correlation between frailty and life satisfaction<sup>21</sup>. Even though frail older persons experience substantial loss of function, they may maintain a certain level of satisfaction with their lives by adjusting their subjective criteria for success and failure in life<sup>21</sup>.

The strength of the present study was the recruitment of a heterogeneous elderly population, which supports the generalizability of the results of the GFI. Though some researchers and clinicians have the opinion that frailty is a pre-disability state, others like Fried disagree<sup>12</sup>. We think that frailty is a distinctive concept from, but overlapping with disability. Therefore the GFI comprises some disability items and we decided to recruit the previously mentioned heterogeneous elderly population, including some elderly persons with significant disabilities.

The limitations of the study were related to the data collection. Firstly, we do not have demographic data from those who declined participation, which prohibited comparisons between nonparticipants and participants. Additionally, for practical reasons the items of the sociopsychological domain were slightly rephrased. Secondly, not all elderly people filled out the Katz, SF-36 and EQ-5D as the data collection of these instruments were not performed directly from the beginning of the study. Nevertheless, overall the proportion of missing data appears limited, i.e., does not compromise our findings. The final limitation is related to the GFI instrument itself: it does not (yet) differentiate between grades of fitness, mild, and pre-frailty since non-frail older persons have GFI-scores on a limited range of 0-3. Future research should explore the meaning of low scores (e.g. 0-1 versus 2-3) and also higher scores on the GFI. For example, individuals with a score just above the cut-off are likely to differ from individuals with scores over 10.

We have the following recommendations for future studies: Firstly, we recommend further psychometric evaluations on the GFI to assess the inter- and intra-rater reliability. Second, the present study indicated that the current used cut off score of the GFI is satisfactory to differentiate frail versus non-frail older people. However future longitudinal studies are recommended to assess the optimal cut off point. This cut off point may vary and depend on factors like the setting (e.g. independent versus institutionalized living older persons) and the predicted poor outcome. Our third recommendation is to investigate the current weighing of the GFI, in fact a simple addition of factors present or not may be optimized. Still, a brief questionnaire like the GFI appears very useful because it explains a lot of variance within groups. Importantly, as a standalone instrument for in prediction of individual risk in clinical practice current instruments may lack the precision required. Finally, we recommend that other independent research groups also assess the psychometric properties of the GFI, preferable against a second frailty instrument.

In the current literature there is some evidence of the predictive validity of the professional version of the GFI<sup>4,42-44</sup>. However, there is scarce evidence of the predictive validity of the self-report version of the GFI<sup>45,46</sup>. Therefore we will perform longitudinal studies in different populations and with different outcome variables to clarify the

predictive performance of the self-report version of the GFI in both clinical practice and in home dwelling elderly.

#### **2.4.1 Conclusion**

We conclude that the results of this cross sectional study showed evidence that confirms the feasibility, reliability and validity of the self-report version of the GFI in a heterogeneous elderly population.

#### **2.4.2 Acknowledgments**

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## Response to the letter from Hoogendijk and Van Hout

Lilian L. Peters, Han Boter, Erik Buskens, Joris PJ Slaets

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To the editor,

Hoogendijk and Van Hout dispute that we performed a comprehensive evaluation of the self-assessment version of the Groningen Frailty Indicator (GFI)<sup>1</sup>. Clearly, we recognize that previous studies also evaluated its psychometric properties<sup>2,3</sup>. However, the present study was much more extensive through the inclusion of also institutionalized older adults. Additionally, discriminant validity of the GFI was assessed. The feasibility of the GFI was based on the number of missing values after (assisted) self-assessment. It is obvious that a postal version may yield different results. However, the relevance of such a remark remains questionable for institutionalized individuals. Metzelthin et. al. used postal questionnaires and reported that in 532 community-dwelling older people the average number of missing values were only 2.4 per GFI item<sup>2,3</sup>. This was considerably less than observed for the other frailty measures assessed.

In addition to our own suggestions for future studies, we do agree that the measurement properties of translated versions of the GFI should be assessed as well. Likewise test-retest reliability of the GFI may be studied.

In conclusion, one may argue over the phrase 'comprehensive', yet we maintain that we presented important new support for the feasibility, reliability, and validity of the self-assessment version of the GFI in home-dwelling and institutionalized elderly people. Using a consensus based COSMIN checklist may be helpful to complete the picture<sup>4</sup>.

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