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Towards a more effective strategy to detect community-dwelling frail older adults: validation of risk factors

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Abstract

Purpose – In the context of early detection of frail older people, prior research found several risk factors of multidimensional frailty. The current study aims to validate these risk factors.

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Ethical committee: The ethical committee of the Vrije Universiteit Brussel approved the study protocol (B.U.N. 143201111521). A detailed description of the BAS and the interview-design can be found in the methodological paper

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Design/methodology/approach – Two data sets, Belgian Ageing Studies and Detection, Support and Care for older people: Prevention and Empowerment (BAS and D-SCOPE), in three Belgian municipalities (Ghent, Knokke-Heist and Thienen) were used and compared. The BAS data set ($N = 1496$) is a representative sample of community-dwelling older adults (60+), while the recruitment of the D-SCOPE sample (validation sample, $N = 869$) is based on risk factors (e.g. age, marital status, moved in the past 10 years). Frailty was measured with the comprehensive frailty assessment instrument (CFAI). The validity was examined by means of prevalence rates, distribution and the odds rates within both data sets.

Findings – The validation sample had an increase in the percentage of elderly who were mildly and highly frail for physical frailty (men: +17.0 percent point, women: +20.7 percent point), for psychological frailty (men: +13.4 percent point, women: +13.7 percent point), for social frailty (men: +24.8 percent point, women: +4.8 percent point) and environmental frailty (men: +24.2 percent point, women: +6.8 percent point). The present results indicate that the risk of being mildly or highly frail was higher in the validation sample in comparison with the BAS data.

Originality/value – The present study proved the validity of aforementioned risk factors. Selecting older people based on these risk factors proved to be an effective strategy for detecting frail older people.

Keywords Detection, Frailty, Older adults, Risk factors, Validity

Paper type Research paper

Introduction

The world's population has aged considerably over the last few decades (United Nations, 2013). In line with this development, the number of older adults with a high need for care and support has continued to increase (Fairhall *et al.*, 2015), though ageing in place is stimulated from a policy perspective in order to reduce the high costs of institutionalization (Scharlach, 2012). Moreover, it is also the wish of most older people to stay at home as long as possible (Wiles *et al.*, 2012). One of the conditions that is associated with ageing is frailty described as a dynamic state affecting an individual who experiences losses in one or more domains of human functioning, which increases the risk of adverse outcomes such as a higher number of admissions to long-term care facilities (Gobbens *et al.*, 2010; Vermeiren *et al.*, 2016). Therewith, the desire to age in place is threatened for frail older people (Gobbens *et al.*, 2012). To prevent frailty and its adverse negative (health) outcomes such as institutionalization, as well as to tackle their unmet needs in care and support in general, (frail) older adults are visited proactively by a nurse or a social worker in many countries (van Hout *et al.*, 2011). However, it is often unknown which older adults are at risk of adverse outcomes and thus should be visited. Consequently, preventive home visits on a large scale can be inefficient and expensive. In some places, the decision to visit an older person proactively is based on age. However, older people are a heterogeneous group, so (merely) focussing on people of a certain age does not seem to be the most effective way to detect people in need of care and support (De Bruin *et al.*, 2016; Looman *et al.*, 2018; Van den Berg and Schoemaker, 2010). Therefore, a more targeted approach is needed to identify frail older people in need of care and support (Feng *et al.*, 2017; Ferrucci *et al.*, 2004). In the light of a more targeted approach, focussing on specific groups seems to be more promising than early detection initiatives in the general population (De Bruin *et al.*, 2016).

In response to this, Dury *et al.* (2017) used the Belgian Ageing Studies data set ($N = 28\,049$) to determine risk factors for four different domains of frailty (i.e. physical, social, environmental and psychological frailty), stratified by gender. Sociodemographic risk factors were age, marital status and country of birth. Socioeconomic risk factors were net household income and education (Dury *et al.*, 2017). A last risk factor is "relocated the previous 10 years". These risk factors differ depending on the frailty domain and gender (Table 1). In literature, frailty is described as a dynamic state which can deteriorate but also improve (Gobbens *et al.*, 2010). Previous research has shown that frailty in an early state is reversible. Therefore, a timely detection of frailty is important. A strategy to detect frailty is with use of risk factors. Nonetheless, currently, it is not yet clear if selecting older people

based on these risk factors is indeed an effective way of identifying frail older people by means of preventive home visits. Therefore, the present study aimed to validate the aforementioned risk factors for frailty. The following research question is examined: can a larger number of frail older adults be detected by means of preventive home visits by using the risk factors as developed by Dury *et al.* (2017)?

Method

Two data sets that were collected in three Belgian municipalities (Knokke-Heist, Ghent and Tienen) were used and compared.

The first data set, using a representative sample, was the "*Belgian Ageing Studies*" (BAS). The BAS is a large-scale survey in Belgian municipalities collecting information in community-dwelling older people by means of a highly structured survey. The questionnaire has over 80 questions regarding for example demographic information, housing, civic participation and frailty (De Donder *et al.*, 2014). The BAS uses a participatory peer-research methodology; older volunteers administer the survey. Data collection started in 2004 and is still ongoing in new municipalities. For the current study, BAS data that were collected in the aforementioned municipalities were used. This sample was collected in 2011 in Ghent, in 2013 in Knokke-Heist and in 2009 for Tienen (using a proportional sample, stratified for age and gender). The respondents were assured of their privacy and of their right to refuse to participate or answer a question. The ethical committee of the Vrije Universiteit Brussel approved the study protocol (B.U.N. 143201111521). A detailed description of the BAS and the interview-design can be found in the methodological paper of De Donder *et al.* (2014).

The second data set, labelled as the validation sample, was gathered within the *D-SCOPE* project (Detection, Support and Care for older people: Prevention and Empowerment). D-SCOPE investigated strategies for the proactive detection of potentially frail, community-dwelling older people in order to guide them towards the right support and/or care. The respondents were selected through the census records, based on the risk factors for frailty (Dury *et al.*, 2017). Consequently, the sample was not representative but over represented older citizens having a higher risk of being frail. Participants were free to participate in the project. The survey was administered by researchers and older volunteers. Data collection started in March 2017 and lasted until September 2017. The ethical committee of the Vrije Universiteit Brussel approved the study protocol (B.U.N. 143201630458) and written informed consent was obtained from all participants. The details of the data collection method can be found in the protocol paper (Lambotte *et al.*, 2018).

Participants

In both studies, participants were community-dwelling older adults aged 60 years and over. Participants were excluded from the study in the case of hospitalization, when the participant

	Physical frailty		Psychological frailty		Social frailty		Environmental frailty	
	Men	Women	Men	Women	Men	Women	Men	Women
Older age	x	x	x		x	x		
Marital status			x	x	x	x	x	x
Country of birth							x	x
Moved the previous ten years	x	x	x	x	x	x		x (not moved)
Lower education	x	x	x	x		x	x	x
Lower income	x	x	x	x	x	x	x	x

Note(s): In case of environmental frailty, moved in the previous 10 years is a protective factor

Table 1. Risk factors per frailty domain and sex (Dury *et al.*, 2017)

or the informal caregiver indicated that the older adult was unable to participate, or when the interviewer noted that the older participant was unable to provide adequate answers (e.g. not being able to answer questions due to physical exhaustion or distraction).

Concerning the D-SCOPE sample ($N = 869$), the researchers determined that older adults had to meet at least three risk factors to be included in the analysis of the present study. The study of Dury *et al.* proposed several risk factors; however, no clear cut-offs were suggested. Therefore, the cut-off criteria for age, marital status, education and income were determined using a ROC curve (using sensitivity and specificity rates). The cut-off inclusion groups were: 70 and older (versus 60–69) for age; living alone (versus living with a partner) for marital status; no schooling to lower secondary (versus higher secondary to university degree) for education; 500–1499 euro (versus 1500 euro or more) for income; relocated in the previous ten years yes (versus no) and country of birth in Belgium versus elders.

In the BAS sample ($N = 1496$), the recruitment of older adults was representative, and not based on the risk factors. Therefore, BAS was used as the gold standard for prevalence.

Measurement of frailty

Since the aim was to identify strategies for proactive detection community-dwelling older people at risk of frailty, and to guide them towards the proper support and/or care, with a focus on empowerment and ageing well in place, a multidimensional approach to frailty is needed. Therefore, frailty was in both studies, BAS and D-SCOPE, measured using the comprehensive frailty assessment instrument (CFAI) (De Witte *et al.*, 2013a, b). The CFAI is a self-reported survey, which includes four domains of frailty: physical, social, psychological and environmental frailty. The survey section on the physical domain (4 items) assesses an older adult's functionality. The psychological domain (8 items) includes questions about mood disorders (5 items) and emotional loneliness (3 items). The social domain comprises social loneliness (3 items) and the potential social support network (10 items). Finally, the environmental domain (5 items) covers the suitability of the physical housing environment. Scores on all sub-scales range from 0 to 100, with higher scores indicating more severe levels of frailty. The total score (i.e. for "overall" frailty) on the CFAI is calculated by summing the scores on each domain divided by the number of domains. The CFAI was previously validated with a second-order confirmatory factor analysis (De Witte *et al.*, 2013a, b). Moreover, a previous study determined the presence of three natural groups within the sample: no-low frail, mildly frail and highly frail (De Witte *et al.*, 2018). The cut-offs of the domains and a detailed description of the CFAI can be found in Appendix.

Statistics

The validity was tested by measuring (1) the prevalence of mildly and highly frail older adults meeting the risk factors per domain and gender in the BAS and D-SCOPE study; (2) the congruence of the distribution of frailty in older adults meeting the risk factors (D-SCOPE data) and the distribution of frailty in the "representative sample" (i.e. the BAS data as gold standard) by means of a Mann-Whitney *U* test; (3) the mean differences of the frailty domains between the BAS and D-SCOPE sample using independent sample *t*-tests; (4) the odds' ratio between the levels of frailty per frailty domain and gender; and (5) the sensitivity, specificity, positive predicted value (PPV), negative predicted value (NPV) and accuracy. Since we were mainly interested to detect frailer older adults, only the results of the no-low group versus mildly or highly frail group were discussed in the results. All analyses were performed in SPSS 22 (IBM Corp., Armonk, NY, USA).

Results

Table 2 presents the sociodemographic and socioeconomic variables of the BAS and the D-SCOPE sample (i.e. only older adults with the presence of at least three risk factors). In the

Table 2. Sample characteristics BAS dataset (whole sample) and D-SCOPE (at least 3 risk factors) stratified according to domain and sex

	BAS		D-SCOPE physical 3 risk factors		D-SCOPE psychological 3 risk factors		D-SCOPE social 3 risk factors		D-SCOPE environmental 3 risk factors	
	Men $N = 683$	Women $N = 813$	Men $N = 105$	Women $N = 157$	Men $N = 176$	Women $N = 155$	Men $N = 153$	Women $N = 226$	Men $N = 55$	Women $N = 158$
Age (years) %										
60–69	51.5	43.2	1.9	3.8	4.0	14.2	2.6	9.7	12.7	19.0
70 and above	48.5	56.8	98.1	96.2	96.0	85.8	97.4	90.3	87.3	81.0
Marital status %										
Partner	80.5	59.8	18.1	13.4	10.8	1.9	2.6	9.3	3.6	6.3
Single	19.5	40.2	81.9	86.6	89.2	98.1	97.4	90.7	96.4	93.7
Country of birth %										
Belgium	93.2	95.8	96.2	94.9	96.6	92.9	96.7	94.7	87.3	90.5
In Europe	4.6	2.8	2.9	3.8	2.8	4.5	2.6	3.5	7.3	5.7
Out Europe	2.2	1.4	1.0	1.3	0.6	2.6	0.7	1.8	5.5	3.8
Relocated previous 10 years %										
Yes	21.1	18.2	77.1	75.2	75.6	74.2	80.4	65.0	56.4	39.2
Level of education %										
<Lower secondary	44.2	58.6	67.6	75.2	44.9	72.3	36.6	58.4	94.5	74.1
Secondary education or more	55.8	41.4	32.4	24.8	55.1	27.7	63.4	41.6	5.5	25.9
Monthly household income %										
€500-€1499	33.1	45.4	86.7	89.8	60.8	94.2	64.7	81	98.2	93.0
>€1500	66.9	54.6	13.4	10.2	39.2	5.8	35.3	19	1.8	7.0

BAS sample, 51.5% of the men and 43.2% of the women was aged <70 years. In the D-SCOPE sample, this ranged between 1.9% for men physical frailty and 19% for women environmental frailty. The percentage of older adults living together was 80% for men and almost 60% for women in the BAS sample. In the D-SCOPE sample, these percentages ranged from 1.9% for women who were psychologically frail, until 18.1% for men who were physically frail. Approximately, 1 out of 5 participants in the BAS sample had relocated in the previous 10 years, while in the D-SCOPE sample this number ranged between 39.2% for women with environmental frailty, until 80.4% for men with social frailty.

Table 3 presents the prevalence of frailty for each domain, and men and women separately. The D-SCOPE sample had a higher number of mildly and highly frail older adults for physical (men: +17.0% point, women: +20.7% point), psychological (men: +13.4% point, women: +13.7% point), social (men: +24.8% point, women: +4.8% point) and environmental frailty (men: +24.2% point, women: +6.8% point). Moreover, a significant difference in distribution was found for physical (men and women), psychological (men and women), social (men) and environmental frailty (men).

Table 4 presents the mean differences of the average frailty scores per frailty domain. For men, in the D-SCOPE sample there was found a significant difference for each domain, while for women this was only the case for physical and psychological frailty, as in line with the results of Table 3.

Table 5 presents the odds ratios (OR) for each domain, and men and women separately. The risk of being mildly or highly frail was higher in the D-SCOPE sample compared to the BAS data for physical (OR men 2.103, OR women 2.315), psychological (OR men 1.780, OR women 1.749), social (OR men 3.741, OR women 1.234) and environmental frailty (OR men 2.693, OR women 1.316). These results indicate that the risk of being mildly or highly frail was higher in the D-SCOPE sample than in the BAS data.

Table 6 shows that the sensitivity across the domains was varying from 0.12 till 0.27 and the specificity ranged from 0.75 till 0.95. The accuracy ranged from 44% till 84% (see Table 6).

Discussion

The main goal of this study was to validate the risk factors for frailty as developed by Dury *et al.* (2017). The present study proved the validity of these risk factors by examining the prevalence, distribution, mean differences and the odds ratio between the BAS and the D-SCOPE sample (validation sample). The results are characterized by a low sensitivity, but a high specificity. According to the present results, selecting older people based on these risk factors is indeed an effective strategy of identifying frail older people, which could increase efficiency of preventive home visits.

A first key finding is the proven validity of the risk factors. The average scores of the frailty domains and the prevalence of mildly and highly frail older adults is higher in older adults that meet at least three risk factors. Therewith, the odds of identifying people who are mildly or highly frail is higher if one screens people who meet at least three risk factors. The validation of these risk factors indicates that selecting older people based on these risk factors can be an effective way of detecting mildly or highly frail older adults. This affirms prior research showing that age, marital status, a lower level of education, low socioeconomic status and ethnicity are risk factors for frailty (Espinoza and Fried, 2007; Etman *et al.*, 2012; He *et al.*, 2019; Ntanasi *et al.*, 2018; Trevisan *et al.*, 2016). However, it should be noted that the results are characterized by low specificity and high specificity, indicating that the use of these risk factors is mainly helpful for excluding a large group of people in advance. Nonetheless, the frailty status of the remaining group of people should then still be examined further.

Table 3. Level of frailty

	BAS physical		D-SCOPE physical		BAS psychological		D-SCOPE psychological		BAS social		D-SCOPE social		BAS environmental		D-SCOPE environmental	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
No-low	72.2%	57.6%	55.2%	36.9%	69.1%	62.1%	55.7%	48.4%	39.8%	38.0%	15.0%	33.2%	60.6%	56.8%	36.4%	50.0%
Mild	15.5%	24.1%	29.5%	42.0%	24.5%	26.8%	30.7%	32.3%	37.8%	41.0%	54.2%	49.1%	28.1%	29.3%	36.4%	40.5%
High	12.3%	18.3%	15.2%	21.0%	6.4%	11.1%	13.6%	19.4%	22.4%	21.0%	30.7%	17.7%	11.3%	13.9%	27.3%	9.5%
Mann-Whitney			$p < 0.01$	$p < 0.000$			$p < 0.000$	$p < 0.01$			$p < 0.000$	$p > 0.05$			$p < 0.000$	$p > 0.05$

A second key finding is that the identification of frail older people based on risk factors seems to be more effective in men than in women. An explanation might be that the margin to detect frailer older women is smaller. Previous research has shown that being a woman is a risk factor for frailty (Alexandre *et al.*, 2018; Yu *et al.*, 2017), and indeed, in BAS sample, women already had higher (i.e. more severe) frailty levels compared to men. Related hereto, the prevalence of mild and high frailty was higher in women. Another plausible explanation for this finding might be that the women within the BAS sample already met more risk factors compared to men. For instance, only 19.5% of the men were single in BAS sample, while 40.2% of women were single. Consequently, it should be noted that in general, the increase of older people meeting risk factors in the D-SCOPE sample (validation sample) in comparison with BAS was higher in the men group.

A third key finding is that using the risk factors especially seems to increase the detection of mildly frail older adults. Since in BAS most people are no-low frail, a general increase on the CFAI will primarily lead to the detection of a higher proportion of mildly frail older adults.

Limitations

Some limitations of the research should be highlighted. The first limitation is that only older adults who met at least three risk factors could be included for the validation sample. The lack of older adults meeting all risk factors can be a plausible explanation why several analyses did not have significant results. Although, one must be aware that using all risk factors can cause missing out (frail) older people in need of care if they not meet these risk factors.

A second limitation is the uniqueness of each municipality, implying that the risk factors and the importance of risk factors may differ in every municipality. For instance, in Tienen, the number of older adults relocated in the previous 10 years was very low. Consequently, this risk factor was less applicable and assumed less relevant in the detection of frail older adults. Therefore, more in-depth research at the level of the municipality should be done (e.g. multilevel analysis) (Tariman *et al.*, 2012; Vanden Boer *et al.*, 2010).

A third limitation is the small number of older adults with a migration background in our samples. Due to changing societal trends, in the near future, a higher number of older adults will have a migration background (Kristiansen *et al.*, 2016; Warnes and Williams, 2006).

Implications and future research

Several authors define frailty as a dynamic state and potentially reversible or modifiable by interventions (Cameron *et al.*, 2013; Gobbens *et al.*, 2010). However, recent research has shown that the effectiveness of interventions is still inconclusive, and it is suggested that older people can become too frail to be reversible (Van der Elst *et al.*, 2018). Therefore, it is believed that early detection and early intervention is important to delay or even reduce frailty (Lette *et al.*, 2015). The present results show that a case-finding strategy based on risk factors could be helpful in detecting frail older people. This information could be helpful for professionals in the community to detect/screen frail older people with an evidence-based strategy, which is

Table 4.
Mean differences in frailty score BAS versus D-SCOPE (domain and sex)

	BAS		D-SCOPE		*P*-value	
	Male	Female	Male	Female	Male	Female
Physical frailty	24.067 (35.4)	34.625 (38.6)	37.857 (37.9)	48.328 (37.4)	$p < 0.05$	$p < 0.05$
Psychological frailty	15.201 (17.3)	18.978 (20.0)	21.776 (21.6)	26.602 (24.3)	$p < 0.05$	$p < 0.05$
Social frailty	45.543 (21.7)	45.516 (23.1)	56.209 (53.3)	47.577 (18.6)	$p < 0.05$	$p > 0.05$
Environmental frailty	11.589 (18.2)	13.727 (20.9)	20.636 (21.6)	13.861 (17.6)	$p < 0.05$	$p > 0.05$

Note(s): Independent *T*-test

Table 5. The risk of being more frail meeting three risk factors

	D-SCOPE physical		D-SCOPE psychological		D-SCOPE social		D-SCOPE environmental	
	Men OR (CI)	Women OR (CI)	Men OR (CI)	Women OR (CI)	Men OR (CI)	Women OR (CI)	Men OR (CI)	Women OR (CI)
No/low-mild/high	2.10 (1.38-3.20)	2.32 (1.63-3.30)	1.78 (1.27–2.50)	1.75 (1.24–2.47)	3.74 (2.34–5.98)	1.23 (0.90–1.69)	2.69 (1.52–4.77)	1.32 (0.94–1.85)
No/low/mild-high	1.28 (0.72–2.29)	1.19 (0.78–1.81)	2.29 (1.35–3.89)	1.93 (1.22–3.04)	1.54 (1.04–2.26)	0.81 (0.55–1.18)	2.95 (1.56–5.59)	0.65 (0.37–1.15)
No/low-mild	2.49 (1.53–4.03)	2.72 (1.84–4.01)	1.56 (1.07–2.27)	1.54 (1.04–2.28)	3.81 (2.33–6.22)	1.37 (0.97–1.91)	2.16 (1.13–4.10)	1.57 (1.09–2.27)
Mild-high	0.65 (0.33–1.27)	0.66 (0.41–1.05)	1.69 (0.94–3.03)	1.45 (0.87–2.43)	0.96 (0.63–1.44)	0.70 (0.47–1.05)	1.87 (0.91–3.84)	0.49 (0.27–0.90)

Note(s): Odds ratio. CI = confidential interval

	D-SCOPE physical		D-SCOPE psychological		D-SCOPE social		D-SCOPE environmental	
	Male	Female	Male	Female	Male	Female	Male	Female
No/low-middle/high								
Sensitivity	0.20	0.22	0.27	0.21	0.24	0.23	0.12	0.18
Specificity	0.89	0.89	0.83	0.87	0.92	0.80	0.95	0.85
PPV	0.45	0.63	0.44	0.52	0.85	0.67	0.64	0.50
NPV	0.72	0.58	0.69	0.62	0.40	0.38	0.61	0.57
Accuracy	0.69	0.58	0.64	0.60	0.48	0.44	0.61	0.56
No/low/middle-high								
Sensitivity	0.16	0.18	0.35	0.25	0.24	0.19	0.16	0.12
Specificity	0.87	0.84	0.81	0.85	0.83	0.78	0.94	0.83
PPV	0.15	0.21	0.14	0.19	0.31	0.18	0.27	0.09
NPV	0.88	0.82	0.94	0.89	0.78	0.79	0.89	0.86
Accuracy	0.78	0.72	0.77	0.78	0.69	0.66	0.84	0.74
No/low-middle								
Sensitivity	0.23	0.25	0.24	0.19	0.24	0.25	0.09	0.21
Specificity	0.89	0.89	0.83	0.87	0.92	0.80	0.95	0.85
PPV	0.35	0.53	0.36	0.40	0.78	0.60	0.50	0.45
NPV	0.82	0.70	0.74	0.70	0.51	0.48	0.68	0.66
Accuracy	0.76	0.68	0.66	0.65	0.56	0.51	0.67	0.62
Middle-high								
Sensitivity	0.16	0.18	0.35	0.25	0.24	0.19	0.16	0.12
Specificity	0.77	0.75	0.76	0.81	0.76	0.75	0.91	0.79
PPV	0.34	0.33	0.31	0.38	0.36	0.26	0.43	0.19
NPV	0.56	0.57	0.79	0.71	0.63	0.66	0.71	0.68
Accuracy	0.51	0.52	0.66	0.64	0.56	0.57	0.68	0.59

Note(s): PPV = positive predicted value, NPV = negative predicted value

Table 6. Statistical measurements: sensitivity, specificity, PPV, NPV and accuracy

more *efficient*. Since early detection is important for the dynamic state of frailty, this might also imply that the efforts made by the professionals (i.e. extra care and support) could be more *effective* (Cameron *et al.*, 2013; Van der Elst *et al.*, 2018). However, one must be aware that not all (frail) older people at risk of adverse outcomes fit in these risk profiles, and some people in need of more support and care will be missed using this case finding strategy. Therefore, the case finding strategy as presented in this article should be seen as a part of a larger policy. Moreover, professional healthcare services should be aware of changing demographics, such as increased number of older people who divorce (Spijker and Solsona, 2012), and an increased number of older adults with a birth country outside Europe (Kristiansen *et al.*, 2016; Warnes and Williams, 2006). These changes in demographics should be taken into account; because it might be needed to "update" these risk factors. In addition, professional health care services should consider that every municipality is unique and that risk factors may differ among municipalities. Therefore, as said before, more in-depth research at the level of the municipality should be done.

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Appendix
The comprehensive frailty assessment instrument (CFAI)

The Appendix file is available online for this article.

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