ORIGINAL RESEARCH

PREVALENCE OF FRAILTY IN NURSING HOME RESIDENTS ACCORDING TO VARIOUS DIAGNOSTIC TOOLS

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Abstract: *Background:* Although the theoretical foundations of frailty are well established in the literature, it remains an evolving concept lacking any unique definition or diagnostic criteria for use in clinical practice and epidemiological research. No consensus exists about the accurate prevalence rates of frailty. The various operational definitions of frailty can at least partly explain such discrepancies. *Objective:* To compare the prevalence of frailty, measured with different diagnostic tools, among elderly nursing home residents. *Design:* This is an analysis of baseline data collected among the SENIOR (Sample of Nursing home Elderly *Individuals:* an Observational Research) cohort. *Setting:* Nursing homes. *Population:* A total of 662 volunteer subjects from 28 nursing homes were included in this analysis. Among them, the mean age was 83.2 ± 8.99 years and 484 (72.5%) of them were women. *Measurement:* The percentages of frail and non-frail subjects were calculated according to 10 different definitions. *Results:* Prevalence of frailty varies from 1.70% (Frailty Index) to 76.3% (Groningen Frailty Indicator) depending on the tool used. *Conclusions:* The prevalence of frailty is highly dependent on the diagnostic tool used. It would be necessary to reach a consensus on which diagnostic tools to use if one wishes to have comparable data obtained in epidemiological studies.

Key words: Diagnostic tool; epidemiology; frailty; nursing homes; prevalence..

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Introduction

With an ageing population, there is a growing interest in frailty. It may be regarded as a multidimensional geriatric syndrome of decreased resilience and resistance to stressors, resulting from cumulative decline across multiple physiological systems, causing vulnerability to adverse health outcomes such as falls, hospitalisation, institutionalisation and mortality (1). These adverse health effects in turn contribute to an increased demand for medical and social care and are associated with increased financial costs (2). Thus, one of the major challenges of geriatric medicine is to recognise these conditions as soon as possible and to halt (or slow) the downward spiral of increasing comorbidity and frailty. Although the theoretical foundations of frailty are well established in the literature, and the concept almost universally accepted, the practical effects and solutions remain controversial (3, 4). It remains an evolving concept lacking any unique definition or diagnostic criteria for use in clinical practice and epidemiological research (4). Multiple tools have been developed in recent years in order to diagnose this geriatric syndrome (5) and some of these tools have been widely used in epidemiological studies. Taking account of all such studies, the prevalence of frailty seems to increase with age, appears to be greater in women than in men and would appear to be more prevalent in people with any combination of lower education or income, poorer health and higher rates of comorbid chronic disease and disability. However, no consensus exists about the accurate prevalence rates of frailty (6, 7). The various operational definitions of frailty used in these studies can at least partly explain such discrepancies (8). However, and to the best of our knowledge, no single study has investigated the impact of all these definitions of frailty on its prevalence in the same population. In nursing home populations, some studies have suggested that the prevalence of frailty is high, compared with non-institutionalised subjects (6, 7). The prevalence of frailty also depends on the countries (9). Indeed, a recent survey of 7510 community-dwelling older adults in 10 European countries found that the prevalence of frailty, according to frailty phenotype defined by Fried, was higher in southern than in northern Europe consistent with an unexplained north-south health risk gradient (10). African Americans are more likely to be frail than Caucasians (11). For these reasons, it is difficult to compare the results obtained in different studies, given the difference observed in the prevalence of frailty, which can be due to the inclusion of people living in different places, with different degrees of dependence or a different age range. However, it should be acknowledged that there is no specific operational definition of frailty validated for nursing home residents. To the best of our knowledge, all existing tools to assess frailty have not been tested in this specific population. Indeed, only a few tools such as the frailty phenotype (12) or Clinical frailty Scale (13) have sometimes been used in studies performed in nursing homes, but a comparison between various tools has never been

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carried out. Therefore, the aim of this study was to compare the prevalence of frailty with regards to different diagnostic tools among elderly nursing home residents. Moreover, the differences in demographic and clinical characteristics of subjects diagnosed as frail according to the various definition of frailty are poorly understood and were also investigated in the present study.

Methods

Study design

This is an analysis of baseline data collected among the SENIOR (Sample of Elderly Nursing home Individuals: an Observational Research) cohort. The protocol was approved by the Ethics Committee of the University Teaching Hospital of Liège, under the number 2013/178.

Study subjects and setting

Residents of 28 nursing homes in the area of Liège, Belgium, were eligible for the study if they agreed to participate (i.e. informed consent). Subjects disoriented or unable to stand and walk (authorised technical support) were excluded from this research.

Data collection

Assessment of frailty

For each subject, frailty was measured using the 10 different diagnostic tools described below:

A) Clinical Frailty Scale (CFS) (14): this is based on a clinical evaluation in the domains of mobility, energy, physical activity and function, using descriptors and figures to stratify elderly adults according to their level of vulnerability. The score ranges from 1 (robust health) to 7 (complete functional dependence on others).

To measure the prevalence of frailty, all persons included in categories "terminally ill", "very severely frail", "severely frail", "moderately frail" and "mildly frail", were considered as "frail".

B) Edmonton Frail Scale (EFS) (15): this samples 8 domains (Cognitive impairment, health attitudes, social support, medication use, nutrition, mood, continence, functional abilities). A score range between 0-3 is a robust state, 4-5 is a slightly frail state, 6-8 is a moderately frail state and 9-17 is a severely frail state.

All persons included in categories "severely frail", "moderately frail" and "slightly frail" were considered as "frail".

C) Frail Scale Status (16): this has 5 components: Fatigue, Resistance, Ambulation, Illness, and Loss of weight. Scores range from 0-5 and represent frail (3-5), pre-frail (1-2), and robust (0) health states.

D) Frailty index (17): this is expressed as a ratio of deficits present to the total number of deficits considered. Frailty index includes 40 variables and the calculation was performed on the maximum number of deficits collected. Thus, participants were considered as frail when the ratio of deficits present to the total number of deficits considered was 0.25 (i.e. lowest quartile) or more (18, 19).

E) Frailty phenotype (7): this is a deficit across five domains. Thus, phenotype of frailty was identified by the presence of three or more of the following components: shrinking, weakness, poor endurance and energy, slowness and a low level of physical activity. The presence of one or two deficits indicates a pre-frail condition, and a total of three or more deficits indicates frailty while the absence of deficits indicates a robust state.

F) Groningen Frailty Indicator (GFI) (20): this consists of 15 self-report items and screens for loss of functions and resources in four domains: physical, cognitive, social, and psychological. Scores range from zero (not frail) to fifteen (very frail). A GFI score of 4 or higher was regarded as frail.

G) Sega grid (21): this establishes a risk profile of frailty and provides

reporting of problems and factors that may influence functional decline, including age, provenance, drugs, mood, perceived health, history of falls, nutrition, comorbidities, IADL, mobility, continence, feeding and cognitive functions. A score of 0, 1 or 2 is given for each item and a total over 11 points indicates a "very frail" condition, a score between 8 and 11 points indicates a frail condition while a score below 8 is a slightly frail condition.

All persons included in categories "frail" and "very frail" were considered as "frail".

H) Share Frailty Instrument (Share-FI) (22): Using the five SHARE frailty variables (fatigue, loss of appetite, grip strength, functional difficulties & physical activity), D-Factor scores (DFS) were determined using the SHARE-FI formula and based on the DFS value, the subject could then be categorised as non-frail, pre-frail, or frail.

I) Strawbridge questionnaire (23): this defines frailty as difficulty in two or more functional domains (physical, cognitive, sensory, and nutritive). A score greater than or equal to 3 in more than one domain is considered vulnerable.

J) Tilburg Frailty Indicator (TFI) (24): The TFI consists of 2 parts. Part A contains 10 questions on determinants of frailty and diseases (multimorbidity); part B contains 3 domains of frailty (quality of life, disability, and healthcare utilisation) with a total of 15 questions on components of frailty. The threshold above which the participant is considered as frail is 5 points.

The objectives and the validation criteria of these various tools are shown in Appendix 1.

Other data collected

Other variables collected were socio-demographic data such as age or sex, anthropometric measurements such as weight, height, from which body mass index (BMI) was calculated, abdominal circumferences, type of institution, technical

Table 1
Baseline characteristics of the population (n=662)

Characteristics		Mean± SD	Median (P25-P75)	Number	Frequency (%)
Age (years)		83.2 ± 9.0			
Sex	Women			480	72.5
Setting	Nursing home			467	70.5
	Nursing home and care			195	29.5
Body Mass Index (kg/m²)		25.9 ± 5.5			
Waist circumference (cm)		110.7 ± 15.7			
Walking aid	None			291	44.2
	Stick			117	17.7
	Frame			195	29.5
	Crutch			8	1.22
	Wheelchair			34	5.16
	Arm			7	1.07
	Other			8	1.22
Drug consumed (number)		10.4 ± 6.6			
Medical history (number)			5.0 (3.0-8.0)		
MMSE (score) /30		24.1 ± 4.5			
Minnesota questionnaire (kcal/day)		853 ± 826			
MNA	Normal nutritional status			439	69.9
	Risk of malnutrition			175	27.9
	Malnutrition proved			14	2.20
EQ-5D		0.6 ± 0.2			
EQ-VAS (%)		69.6 ± 17.4			
SF-36					
Physical function (%)		52.4 ± 13.9			
Social functioning (%)		88.3 ± 20.6			
Role limitation due to physical Problems (%)		85.8 ± 32.7			
Role limitation due to physical Problems (%)		92.6 ± 25.0			
Mental health (%)		62.8 ± 21.4			
Vitality (%)		47.8 ± 29.4			
Bodily Pain (%)		78.3 ± 17.6			
General health		64.9 ± 18.9			
Katz (points)		11.4 ± 4.6			
Scale comorbidities CIRS-G	Overall score (/56)	6.5 ± 6.6			
	Composite score (/14)	2.8 ± 5.9			
Tinetti score (points) /28		22.4 ± 6.2			
SPPB score (points) /12		5.6 ± 3.2			
Timed Up and Go test (sec)			19.9 (14.2-31.9)		
Gait speed (m/sec)		0.89 ± 4.25			

assistance for walking, drug consumption and medical history. The following clinical measurements were also collected:

- Daily energy expenditure evaluated by the Minnesota Leisure Time Activities Questionnaire;
- Cognitive skills assessed with the Mini Mental State Examination;
- Nutritional status estimated by the Mini Nutritional Assessment;
- Quality of life assessed by both the EQ-5D and the SF-36 questionnaires;
- Activities of Daily Living estimated by the Katz index;
- Comorbidities collected from the CIRS-G questionnaire;
- Gait and body balance assessed using the Tinetti, the "Timed Up and Go" and the "Short Physical Performance Battery" tests and gait speed

These data were collected during a face-to-face appointment with the patient. The same observer conducted all the tests in all nursing homes. The data were completed using the medical records.

Statistical analyses

Quantitative variables that were normally distributed were expressed as means ± standard deviation (SD), and quantitative variables that were not normally distributed were reported as medians and interquartile ranges (percentile 25, percentile 75). A Shapiro–Wilk test verified the normal distribution for all parameters. Qualitative variables were reported as numbers and frequencies (%). Participantss were defined as frail, or not, according to each of these 10 diagnostic tools. Then, the percentage of frail subjects for each definition was estimated. Afterwards, the degree of concordance between each definition was calculated by Cohen's Kappa coefficient; the closer the value to 1, the better the concordance (i.e. k<0: disagreement, 0-0.2: very low agreement, 0.21-0.40: low agreement, 0.41-0.60: moderate agreement, 0.61-0.80: strong agreement, 0.81-1: excellent agreement). The percentage of pre-frail subjects was also assessed by 3 of these 10 definitions, that propose this intermediate state. The association between the different diagnostic tools and subject characteristics was assessed by multiple regression or logistic regression. All analyses were performed with Statistica 10 software and SAS Statistical package (version 9.3 for Windows). Results were considered statistically significant when 2-tailed p values were less than 0.05.

Results

Baseline characteristics of the population

A total of 662 subjects were included in this study. The mean age of the population was 83.2 ± 8.99 years and the population was predominantly women (72.5%). Participants' demographic and clinical characteristics are shown in Table 1.

Prevalence of frailty according to different definitions

The prevalence of frailty varied from 15.2% (Frail Scale Status) and Frailty Index (83.7%) depending on the definition used. The percentage of pre-frail subjects varied from 28.0% (Clinical Frailty Scale) to 60.8% (Frailty phenotype) according to the definitions which propose this intermediate state. (Table 2).

Concordance between the different definitions of frailty

Table 3 presents the concordance between definitions. The concordance between the definitions was low (Overall Kappa Coefficient: 0.014 (-0.057 – 0.085)), with a Cohen's Kappa coefficient which ranged from -0.77 (-0.85- -0.69), observed between Frailty Index and Sega gird, to 0.67 (0.61-0.73), observed between Frail Scale Status and Clinical Frailty Scale. Thus, participants diagnosed as frail with one definition are rarely diagnosed as frail with another definition. Nevertheless, reporting the Spearman's correlation among the operational definitions without their categorization (i.e. continuous variables), these definitions follow similar patterns of increase in the risk of deficits. The correlations ranged between 0.13 (i.e. Edmonton frail scale and Strawbridge questionnaire) and 0.68 (i.e. Frailty Index and Frailty phenotype) and were all statistically significant

Clinical characteristics of frail subjects

Depending on the tool, clinical characteristics of frail subjects appears to be different.Significant differences are observed regarding the age of participants, their sex, their walking support, their nutritional status evaluated by the Mini Nutritional Assessment, their quality of life assessed by the EQ-5D and by the SF-36, their functional abilities assessed by the Tinetti test, by the SSPB test and by gait speed (p<.0001 for all these data).

Discussion

In this study it was found, as expected, that the prevalence of frailty is highly dependent on the diagnostic tool used. However, the ratios observed differ very widely, ranging from 1.70% to 76.3%, and this could have important consequences for clinicians, researchers and public health decision-makers.

Clearly, the diversity and the breadth of definition of frailty criteria would appear to have contributed to the wide range of prevalence found (6). Indeed, there are two main kinds of definition for frailty (one broad and the other physical) and a recent systematic literature review showed that studies using a physical definition consistently reported lower prevalence of frailty than those using a broad frailty definition (6). Frailty measurements can be grouped into three categories: subjective (i.e. self-reported, reported by participant or by a researcher), objective (i.e. directly measured components) or mixed (i.e. subjective and objective combined) (25). This may also have an impact on the prevalence of frailty.

A systematic review highlighted that the prevalence of

Table 2
Number of frail subjects using the different definitions (n=662)

Diagnostic tools		State		Number (%)
A) Clinical Frailty Scale (30)	Frail		369 (56.9)	
		Terminally ill		1 (0.2)
		Very severely frail		41 (6.3)
		Severely frail		94 (14.5)
		Moderately frail		121 (18.6)
		Mildly frail		112 (17.3)
	Vulnerable		182 (28.0)	
	Managing well		88 (13.6)	
	Fit		8 (1.2)	
	Very fit		2 (0.3)	
B) Edmonton Frail Scale (15)	Frail		488 (73.7)	
		Severely frail		41 (6.2)
		Moderately frail		225 (34.0)
		Slightly frail		222 (33.5)
	Robust		174 (26.3)	
C) Frail Scale Status (16)	Frail		99 (15.2)	
	Pre-frail		370 (56.8)	
	Robust		182 (28.0)	
D) Frailty index	Frail		554 (83.7)	
	Robust		108 (16.3) (98.3)	
E) Frailty phenotype (7)	Frail		166 (25.5)	
	Pre-frail		396 (60.8)	
	Robust		89 (13.7)	
F) Groningen Frailty Indicator (20)	Frail		497 (76.3)	
	Robust		154 (23.7)	
G) Sega grid (21)	Little frail		494 (76.9)	
	Frail		148 (23.1)	
		Frail		138 (21.5)
		Very frail		10 (1.6)
H) Share Frailty Instrument (22)	Frail		292 (45.1)	
	Pre-frail		237 (36.6)	
	Robust		118 (18.2)	
I) Strawbridge questionnaire (23)	Frail		391 (60.1)	
	Robust		259 (39.9)	
J) Tilburg Frailty Indicator (24)	Frail		292 (45.0)	
	Robust	357 (55.0)		

Table 3
Concordance between definitions of frailty, estimated by Kappa Cohen's coefficient (95% CI)

	A	B	C	D	E	F	G	H	I	J
A		-0.40 (-0.46 – - 0.34)	0.67 (0.61 – 0.73)	0.67 (0.61- 0.73)	-0.080 (-0.13 – -0.024)	-0.10 (-0.15 – -0.054)	-0.43 (-0.50 – -0.36)	-0.083 (-0.15 – -0.02)	-0.099 (-0.15 – -0.045)	-0.11 (-0.17 – -0.043)
B			-0.69 (-0.75– -0.63)	-0.069 (-0.75- -0.63)	-0.087 (-0.13 – -0.043)	0.055 (-0.015 – 0.12)	0.76 (0.71 – 0.81)	-0.027 (-0.10 – 0.048)	0.15 (0.069 – 0.22)	-0.076 (-0.15 – -0.0027)
C				1	-0.0080 (-0.068– 0.052)	-0.097 (-0.15 – -0.042)	-0.77 (-0.85 – -0.69)	-0.065 (-0.13 – 0.0085)	-0.11 (-0.18 – -0.046)	-0.03 (-0.10 – 0.044)
D					-0.008 (-0.068 - 0.052)	-0.097 (-0.15- -0.042)	-0.77 (-0.85 – -0.69)	-0.065 (-0.14 – 0.00085)	-0.11 (-0.18- -0.046)	-0.031 (-0.11-0.043)
E						0.053 (0.033 – 0.073)	0.004 (-0.029 – 0.037)	0.14 (0.093 – 0.20)	0.021 (-0.017 - 0.059)	0.11 (0.062 – 0.16)
F							0.14 (0.062 – 0.22)	0.19 (0.13 – 0.25)	0.28 (0.21 – 0.35)	0.33 (0.27 – 0.38)
G								0.061 (-0.0081-0.13)	0.13 (0.054 – 0.21)	0.019 (-0.049 – 0.086)
H									0.23 (0.16 – 0.30)	0.28 (0.21 – 0.36)
I										0.31 (0.24 – 0.38)

A= Clinical Frailty Scale; B = Edmonton frail Scale, C= Frail Scale Status, D= Frailty Index, E= Frailty phenotype, F= Groningen Frailty Indicator, G= Sega Grid, H= Share Frailty Instrument, I= Strawbridge questionnaire, J= Tilburg Frailty indicator

frailty in community-dwelling elderly adults varied from 4.0% to 59.1% according to the diagnostic tool used (6). Contrary to the systematic review that compared various tools but in different populations, the present study evaluates the differences in prevalence of frailty using the different operational definitions within the same population. The results presented in the review are somewhat different from those obtained in this study, which could be explained by the difference in the populations studied. Nevertheless, the results presented here are more consistent with a recent meta-analysis which showed that the mean prevalence of frailty in nursing homes differed widely from study to study, ranging from 19.0% to 75.6% (26). One study, published in 2015, compared how different frailty measures predict short-term adverse outcomes (27). The results highlighted that, over a time interval of 10 months and among a sample of community-dwelling elderly individuals, the Groningen Frailty Index predicted an increase in IADL disability, and the Tilburg Frailty Indicator predicted a decline in quality of life. Actually, no study has yet investigated the predictive value, in a nursing home setting, of different operational definitions of frailty for the occurrence of different adverse health outcomes, and, to our knowledge, no operational definition of frailty has been validated among institutionalised people. And yet this would seem to be an important aspect to be explored in prospective studies to identify the best operational definition adapted to this particular population. This definition could then be considered as the gold standard among nursing home residents and could be used in clinical practice and research to make studies more comparable. It is also important to point out that gait speed at usual pace was found to be a consistent risk factor for disability, cognitive impairment, institutionalisation, falls, and/or mortality. (28) In the population under study here, gait speed seemed significantly different according to different operational definitions of frailty used. It would be interesting to clarify the predictive value of this variable in future prospective studies in a nursing home setting.

In the present study, the prevalence of pre-frailty was between 28% and 60.8% and similar with other studies (6). It is important to note that people included in this study were volunteers, not disoriented and had to be able to move. Because of this selection, the most frail people have probably not been included in the study and, therefore, the prevalence of frailty in this study may be underestimated. Anyway, it is important to identify pre-frail people because preventive intervention programs can be implemented, thus modifying the rates of associated events (9).

Otherwise, the agreement between the definitions was very low. This means that the people diagnosed as frail are different depending on the diagnostic tool used. Nevertheless, the definitions seem to be correlated with each other. This means that the frailest subjects, according one definition, are also the frailest ones, according to the other definitions; but the threshold between frail and robust is different depending on the operational definition used. Moreover, significant differences were found regarding the clinical characteristics of frail subjects diagnosed according to these 10 definitions. Indeed, depending on the diagnostic tool used, it seems that significant differences are observed concerning the age of the participants. Also, nutrition status is different depending on the definition used, and this could be explained because the different definitions do not evaluate systematically nutritional status or,

at best, do it differently (anamnesis, weight loss). In addition, the quality of life of frail subjects according to the different tools seems different. This can also be explained because the quality of life is not always considered in the various diagnostic tools for frailty or based on a simple question.

Investigators use multiple scales to assess frailty, all of which count deficits in health. Frailty scales differ in the nature and number of deficits they count, which could explain the heterogeneity of frail persons according to different definitions. Because the characteristics of frail subjects are different depending on the tools used for the diagnosis of frailty, the long-term clinical consequences of frailty may also differ. Therefore therapeutic strategies will not be easily evaluated and implemented as long as studies do not use the same diagnostic tool.

Consensus does not yet exist regarding the component element of frailty (29) and there is no validated operational definition for nursing home residents. From a clinical and Public Health point of view, further investigations identifying the best model of frailty in this specific population are needed in order to obtain comparable data in epidemiological studies. In clinical practice, it would improve the management of frailty. An unambiguous definition of frailty is of great importance for clinicians to identify those at an increased risk of adverse health outcomes, but also for policy makers to make cost-effective decisions in health care. In conclusion, the prevalence of frailty is highly dependent on the definition used. In addition, the concordance between the different modalities of diagnosis is low and this research reveals that the clinical characteristics of frail subjects diagnosed with varied definitions are different. As long as no consensus has been reached about the operationalisation of frailty, clinicians and policy-makers should be aware that differences between definitions exist and that it should have important consequences, at least in epidemiological research.

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