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## Original Study

## Prediction of the Incidence of Falls and Deaths Among Elderly Nursing Home Residents: The SENIOR Study

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## A B S T R A C T

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**Objective:** The objective of this study was to evaluate, among nursing home residents, the extent to which the various operational definitions of frailty predict mortality and falls at 1 year.

**Methods:** We studied 662 participants from the Sample of Elderly Nursing home Individuals: An Observational Research (SENIOR) cohort aged  $83.2 \pm 8.99$  years, including 484 (72.5%) women and living in nursing homes. Among this cohort, 584 and 565 participants, respectively, were monitored over 12 months for mortality assessment and for occurrence of falls (ie, by mean of their medical records). Each patient was subjected to a clinical examination at baseline, during which many original clinical characteristics were collected. Stepwise regression analyses were carried out to predict mortality and falls.

**Results:** Among the participants included in the study, 93 (15.9%) died and 211 (37.3%) experienced a fall during the 1-year of follow-up. After adjustment, none of the definitions of frailty assessed predicted the 1-year occurrence of negative health outcomes. When comparing the clinical characteristics of deceased participants and those still alive, being a man (OR = 1.89; 95% CI: 1.19–3.01;  $P = .002$ ) and being diagnosed with sarcopenia (OR = 1.7; 95% CI: 1.1–2.92;  $P = .03$ ) were independent factors associated with 1-year mortality. Other independent factors that were significantly associated with the 1-year occurrence of falls were the results obtained with the Tinetti test (OR = 0.93; 95% CI: 0.87–0.98;  $P = .04$ ), with the grip strength test (OR = 0.95; 95% CI: 0.90–0.98,  $P = .03$ ), and with the isometric strength test of elbow extensors (OR = 0.93; 95% CI: 0.87–0.97;  $P = .04$ ).

**Conclusions:** Within the operational definitions of frailty assessed, none is sufficiently sensitive to predict the occurrence of falls and deaths at 1 year among nursing home residents. Globally, the frequency of undesirable health outcomes seems to be higher among participants with lower muscle strength and mobility. Medical strategy or adapted physical activity, with the aim of improving specific isometric muscle strength and mobility could potentially, but significantly, reduce the occurrence of falls and even deaths.

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Causes of morbidity and mortality are major public health problems in modern societies with aging populations and the increase in the number of institutionalized persons.<sup>1</sup> Previous studies have shown

that 20% to 24% of deaths occur in nursing homes.<sup>2</sup> Falls are also prevalent among nursing home residents, affecting 30% to 50% of the population, with approximately 1.5 falls occurring per nursing home bed per year.<sup>3</sup>

Whereas the concept of frailty is quite well established in the scientific literature, there is no consensual operational definition.<sup>4,5</sup> A recent systematic review identified 67 operational definitions of frailty<sup>6</sup> and, currently, only one of these has been validated in the specific population of nursing home residents, the FRAIL-Nursing Home scale (FRAIL-NH).<sup>7</sup> It is acknowledged that frailty increases the likelihood of developing negative health outcomes, including falls

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and deaths<sup>8</sup>. According to the recent meta-analysis published by Vermeiren et al,<sup>8</sup> frail participants have a risk of mortality increased by 2.55 [odds ratio (OR) = 2.55; 95% confidence interval (CI): 1.76–3.70], and the risk of falls increased by 2.06 (OR = 2.06; 95% CI: 1.28–3.34). An interesting operational definition of frailty, to use in the nursing home setting, could be the one that best predicts the occurrence of these negative health outcomes.

Other intrinsic risk factors for falls are generally recognized, such as age, functional abilities, chronic diseases, gait disturbances, and fear of falling.<sup>9–12</sup> These factors have been identified among community-dwelling older people or among hospitalized patients, but very few studies have been performed in a nursing home setting. In a previous prospective study conducted in nursing homes, we have shown that very few factors were independently associated with the incidence of falls.<sup>13</sup> In this study, a low body mass index (BMI) was the only variable significantly associated with a 2-year risk of mortality. Because our previous study included a small number of residents and few confounding variables in the analysis, it is important to confirm and to complete these observations.<sup>13</sup>

On the basis of these findings, the present study aimed to identify the most predictive operational definition of frailty for mortality and falls, after 1-year of follow-up, among nursing home residents, taking into account intrinsic risk factors for such negative health outcomes.

## Methods

### Study Design

The analysis was based on the data from the Sample of Elderly Nursing home Individuals: an Observational Research (SENIOR) cohort, which is a prospective longitudinal study of Belgian nursing home residents, in which participants are evaluated each year.<sup>14</sup> The present analysis is focused on data collected at baseline and on negative health outcomes occurring during the first year of follow-up. The study was approved by the Ethics Committee of the University Teaching Hospital of Liège under number 2013/178.

### Population

The sample comprised participants from the SENIOR cohort, living in 28 nursing homes in the Province of Liège and who have been monitored over 1 full year. The selection criteria for the population were (1) to be oriented (ie, to get informed consent), (2) to be able to stand and walk (ie, walking technical assistance allowed), and (3) to be a volunteer.

### Data Collected

#### Diagnosis of frailty

At baseline, all participants received a diagnosis of frailty based on 11 different operational definitions.

**Clinical frailty scale.**<sup>15</sup> 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).

**Edmonton frail scale.**<sup>16</sup> This samples 8 domains (cognitive impairment, health attitudes, social support, medication use, nutrition, mood, continence, functional abilities). A score range from 0 to 3 is a robust state, 4 to 5 is a slightly frail state, 6 to 8 is a moderately frail state, and 9 to 17 is a severely frail state.

**Frail scale status.**<sup>17</sup> This has 5 components: fatigue, resistance, ambulation, illness, and loss of weight. Scores range from 0 to 5

and represent frail (3–5), prefrail (1–2), and robust (0) health states.

**Frailty index.**<sup>18</sup> 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 (ie, lowest quartile) or more.<sup>19,20</sup>

**Frailty phenotype.**<sup>21</sup> This is a deficit across 5 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 1 or 2 deficits indicates a prefrail condition, and a total of 3 or more deficits indicate frailty whereas the absence of deficits indicates a robust state.

**Groningen frailty indicator.**<sup>22</sup> This consists of 15 self-reported items and screens for loss of functions and resources in 4 domains: physical, cognitive, social, and psychological. Scores range from 0 (not frail) to 15 (very frail). A Groningen Frailty Indicator score of 4 or higher was regarded as frail.

**Sega grid.**<sup>23</sup> 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, instrumental activities of daily living, 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.

**Share frailty instrument.**<sup>24</sup> Using the 5 share frailty instrument variables (fatigue, loss of appetite, grip strength, functional difficulties, and physical activity), D-factor scores were determined using the share frailty instrument formula and, based on the D-factor score value, the participant could then be categorized as nonfrail, prefrail, or frail.

**Strawbridge questionnaire.**<sup>25</sup> This defines frailty as difficulty in 2 or more functional domains (physical, cognitive, sensory, and nutritive). A score greater than or equal to 3 in more than 1 domain is considered vulnerable.

**Tilburg frailty indicator (TFI).**<sup>26</sup> 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 utilization) with a total of 15 questions on components of frailty. The threshold above which the participant is considered as frail is 5 points.

**FRAIL-NH score.**<sup>7</sup> This score covers 8 areas (F = fatigue, R = resistance, A = ambulation, I = incontinence (version 1) or polypharmacy (version 2), L = weight loss, N = nutritional approach, H = help with dressing). The sum score ranged from 0 to 14. The FRAIL-NH has a suggested cut-off value of 7 for frailty.<sup>27</sup>

### Clinical Characteristics Collected

Other sociodemographic and clinical data were collected at baseline: age, sex, anthropometric measurements, BMI, technical assistance for walking, drug consumption, and the patient’s medical history. In addition, the following evaluations were carried out: daily energy expenditure evaluated by the Minnesota Leisure Time Activities Questionnaire,<sup>28</sup> cognitive skills assessed with the Mini-Mental State Examination,<sup>29</sup> Nutritional status estimated by the Mini-Nutritional Assessment,<sup>30</sup> quality of life assessed by both the EQ-5D<sup>31</sup> and the Short Form Health Survey (SF-36) questionnaires,<sup>32</sup> activities of daily living estimated by the Katz index,<sup>33</sup> gait and body balance assessed using the Tinetti,<sup>34</sup> the Timed Up and Go,<sup>35</sup> and the

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