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Hierarchical components of physical frailty predicted incidence of dependency in a cohort of elderly women

Isabelle Carrière[a,*], Alain Colvez[a], Francois Favier[b], Claude Jeandel[c], Hubert Blain[c]; for the EPIDOS study group[1]

[a]*INSERM Unité 500, 39 avenue Charles Flahault, 34093 Montpellier Cedex, France*
[b]*INSERM CIC-EC, Groupe Hospitalier Sud Réunion, 97410 Saint Pierre, France*
[c]*Department of Internal Medicine and Geriatrics, Montpellier University Hospital, 34295 Montpellier Cedex 5, France*

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Abstract

Objective: To identify the most important predictors of early disability incidence and devise a simple score of physical frailty.

Methods: A cohort of 545 high-functioning women aged 75 years and older was followed for 7 years. Every year, the self-reported loss of at least one instrumental activity of daily living was chosen as definition of disability. An extension of the logistic regression for repeated responses, the random-effect model, was used to assess the effects of baseline predictors. The regression coefficients of the final multivariate model were scaled and rounded to create a practical score.

Results: The proportion of women reporting disability increased from 22.1% to 52.1% throughout the follow-up. In the multivariate model, increasing age, lower performances in mobility and balance tests, bad perceived health, lower muscle strength, higher body mass index, lower educational level, and lower reported physical activity were strong predictors of disability. Evaluating the predictive value of the simplified predictive score on an independent cohort gave a *c*-statistic equal to .71.

Conclusion: The use of a powerful fitting method allows to establish a hierarchy between the components of physical frailty and to provide a predictive score with substantial practical value for clinicians and public health professionals.

Keywords: Longitudinal studies; Logistic models; Random-effects models; Disability evaluation; Frail elderly

1. Introduction

One important public health goal for an aging society is to minimize the impact of chronic diseases and impairments on the health status of older adults, to prevent dependency, and to improve their quality of life. If progress in medical care, together with better life conditions, account for a longer life span, the counterpart is that the number of very old people at risk of becoming disabled is increasing. Several studies suggest that the prevalence of moderate disability has declined in elderly population, but conflicting results exist about the trend for more severe stages [1], and the overall prevalence remains very high: 20% of older U.S. adults have chronic disabilities.

Fortunately, older age is not uniformly associated with decline of performance [2], indicating the potential for effective interventions to promote more successful aging. The results of the few intervention programs designed to prevent functional decline in older people show that participants with relatively good functional status or moderate frailty are those who benefit the most of these programs [3], suggesting that interventions targeted early in the process of functional decline is potentially very effective. A concept of *frail subjects* is sometimes used to define this target population [4]. Until now, only minor attention has been paid to primary prevention of progressive disability among nondisabled old people. It seems useful to better characterize this early state of physical frailty associated with later disability.

Many risk factors are involved in the disability process [5] and so a valid estimation of the weight of each factor is not straightforward. Most findings have come from cross-sectional studies. Longitudinal studies are far more informative; however, the analysis of repeated outcomes with possible recovery throughout time requires the use of

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* Corresponding author. Tel.: +33-499-614691; fax: +33-499-614579.

E-mail address: carriere@montp.inserm.fr (I. Carrière).

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nonclassical models that have only recently become available in statistical packages.

The first aim of the present study was to identify the most important baseline predictors of the decline in instrumental activities of daily living (IADL) during a seven-year follow-up in a group of nondisabled women aged 75 years and over.

The second aim was to devise an indicator of physical frailty, in order either to select healthy women at risk of becoming disabled within the next few years and liable to benefit from an intervention program, or to evaluate the global risks in populations.

2. Materials and methods

2.1. Subjects

This report is based on a cohort of 545 high-functioning women aged 75 years and older, selected from 1,547 women recruited in Montpellier, one of the five participating centers of the French EPIDOS study on the risk of hip fracture [6]. In this center, the follow-up was extended to 7 years. To ensure that the selected women have not already begun the IADL disability process, we considered only those independent in IADL both at inclusion and at the 1st year of follow-up—that is, performing light or heavy housework, laundry, shopping for groceries or personal items, preparing meals, using a telephone, taking public transport, managing money, and taking medication without assistance [7].

In addition, the data from the EPIDOS center of Toulouse were used to test the predictive value of our indicator. This independent sample consisted of 807 women free of disability at inclusion and followed for 4 years.

2.2. Baseline evaluation

The baseline evaluation was done in the local clinical center by trained doctors and nurses, and included a questionnaire, a physical examination, a functional assessment, and measurements of whole-body bone mineral density (BMD) and body composition with lean mass (bone mineral excluded) and fat mass.

Educational level was assessed by a dichotomous variable: obtaining or not obtaining the old French Certificate of Elementary Education, generally taken at the age of 14 years.

Current physical activity was estimated by questions concerning physical exercise (walking, gymnastics, cycling, swimming, gardening) and heavy housework. The time spent for each activity was converted into metabolic equivalents (MET) by week, and then the overall total was calculated.

Physical performance was assessed by a series of standard tests: quantitative measurements of grip and quadriceps strength and calf circumference; time taken to stand up and sit down five times with arms across the chest (chair stands); time taken to tap one foot back and forth 10 times between two circles placed 30 cm apart in a sitting position (foot tapping). Subjects were asked twice to walk 6 m at normal pace to determine gait speed and step length.

Standing balance was assessed by timed maintenance of balance in progressively more challenging positions: side-by-side position, semitandem position, and tandem position. Dynamic balance was assessed by testing the ability to walk with the heel of the front foot touching the big toe of the rear foot (tandem walk).

Corrected binocular visual acuity was measured at a distance of 5 m with a Snellen letter test chart (decimal scale).

2.3. Binary outcome variable

Every year, women filled out a mail questionnaire in which they were asked whether they were able to do the eight basic IADLs without assistance. Women were scored on a dependence scale equivalent to the number of activities for which they needed assistance. Our variable of interest is a repeated binary outcome, taking the value 1 if the yearly IADL score is positive and otherwise 0. Other cutoff points (score $\geqslant 2$; score $\geqslant 3$) were also investigated, to check if the same risk factors were found again.

2.4. Statistical analysis

The analysis included six steps. (1) The sample was described and compared to the group of women with no IADL evaluation during the follow-up or with missing data for at least one baseline covariable, using Student's *t*-test or Wilcoxon's test for quantitative variables and chi-square test for qualitative variables. (2) A comprehensive analysis was conducted to identify the baseline factors linked to the outcome variable of IADL decline. Every potential factor was tested in a univariate model, adjusted on time since inclusion and age at inclusion. (3) Predictors that were significant in the previous step were grouped into categories according to their source and availability in a typical clinical setting. Five categories of factors were used in our analysis: mobility, standing and dynamic balance, grip and quadriceps strength, body composition, perceived health. Several factors were not grouped: self-reported physical activity, visual acuity, educational level, and body mass index (BMI) change since the age of 30 years. The predictors within each category were entered groupwise into a multivariate model. (4) The remaining significant predictors from each model were entered into a global multivariate model and the final selection of the covariables was done using a descending step-by-step method. (5) The regression coefficients of the final model were scaled and rounded to integers, to create a score easy to implement. Optimal scaled and rounded coefficients were calculated using the algorithm proposed by Cole [8]. This algorithm