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### ► To cite this version:

Jonathan Sicsic, Bastian Ravesteijn, Thomas Rapp. Are frail elderly people in Europe high-need subjects? First evidence from the SPRINTT data. *Health Policy*, 2020, 124 (8), pp.865-872. 10.1016/j.healthpol.2020.05.009 . halshs-02949571

**HAL Id: halshs-02949571**

**<https://shs.hal.science/halshs-02949571>**

Submitted on 25 Sep 2020

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# Are frail elderly people in Europe high-need subjects? First evidence from the SPRINTT data<sup>1</sup>

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## Abstract

Physical frailty and sarcopenia (PF&S) has received growing attention in empirical models of health care use. However, few articles focused on objective measures of PF&S to assess the extent of care consumption among the frail population at risk of dependency. Using baseline data from the SPRINTT study, a sample of 1,518 elderly people aged 70+ recruited in eleven European countries, we analyse the association between various PF&S measures and health care / long term care (LTC) use. Multiple health care and LTC outcomes are modelled using linear probability models adjusted for a range of individual characteristics and country fixed effects. We find that PF&S is associated with a significant increase in emergency admissions and hospitalizations, especially among low-income elders. All PF&S measures are significantly associated with increased use of formal and informal LTC. There is a moderating effect of income on LTC use: poor frail elders are more likely to use any of the formal LTC services than rich frail elders. Our results are robust to various statistical specifications. They suggest that the inclusion of PF&S in the eligibility criteria of public LTC allowances could

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<sup>1</sup> Pre-proof version of the article published in Health Policy :

<https://doi.org/10.1016/j.healthpol.2020.05.009>

contribute to decrease the economic gradient in care use among the elderly community-dwelling European population.

**Key words:** Frailty; Sarcopenia; Long-term care; Health care use, SPRINTT trial

**Acknowledgements:** The research leading to these results has received support from the Innovative Medicines Initiative Joint Undertaking under *grant agreement* n° 115621, resources of which are composed of financial contribution from the European Union' Seventh Framework Programme (FP7 / 2007-2013) and EFPIA companies' in kind contribution. The authors wish to thank Nicolas Sirven, François Béland, Brigitte Santos Eggimann, and participants of the SPRINTT consortium for providing helpful comments during the preparation of this article. All errors remain ours.

**Conflicts of interest:** none.

## 1. Introduction

European countries face important economic and policy challenges associated with the ageing of their populations. It is estimated that the number of Europeans aged 65+ will almost double over the next 50 years, which will dramatically increase the demand for long-term care (LTC) services [1]. In 2016, European countries devoted on average 1.7% of their GDP to LTC spending, including the health and social components (e.g., home care), while the annual growth in expenditures in real terms has been large (4.6% on average) over the past decades [1]. Predictions show that by 2070, LTC spending in the European Union may increase by almost 70% in the best-case (healthy ageing) scenario [2].

Understanding which factors are associated with the use of care is therefore crucial to prepare an efficient organization of services. More specifically, in light of health care resource allocations problems, it is important to have accurate measures of the determinants of current use of health care and home care in order to integrate them in future projections of health utilization and spending [3].

Health status is an important driver of care use and costs in the elderly population.. Different measures of health have been used in the literature to model health care and LTC use, most often included in the same model: the number of chronic diseases or comorbidities [4–8], self-reported health [7,9], impairments or limitations in (instrumental) activities of daily living (ALDs/ IADLs) [8,10–12], and/or mental health [9,13,14].

In addition to these health factors, physical frailty is a key variable to consider when modelling the determinants of health care use in the elderly population. Frailty is a geriatric syndrome resulting from age-related cumulative declines across multiple physiologic systems, with reduces capacity of the organism to withstand stress, thus increasing vulnerability to adverse health outcomes including falls, hospitalisation, institutionalisation, and mortality [15–17]. It is considered as a separate health dimension, distinct from disability, chronic

diseases, and functional limitations [18]. However, there is a paucity of evidence in the literature exploring the association between frailty and LTC use. Our study aims at further investigating the role of frailty as a more comprehensive measure as compared to ADLs to assess the need for LTC services.

A growing empirical literature has explored the correlation between physical frailty and health care use. Empirical evidence from European data suggest that frailty is positively associated with ambulatory care use [4,14], and that frailty transitions are strong predictors of hospitalization use [9]. Results suggest that frail elders are more likely to use LTC services provided at home [4,19] or in institution [20–22]. This increased use of care is likely to be associated with greater costs [23]. In France, it was estimated that frailty had an incremental effect on ambulatory spending of about €1,500 per frail individual [24]. In Germany, estimates of the difference in total costs between frail and non-frail participants was €1,917 (4 or 5 symptoms according to Fried’s measure) and €680 (3 symptoms) [23].

Despite its key contribution to a better understanding of care use in the elderly population, prior work faces several limitations. First, evidence regarding the correlation between frailty and LTC arrangements in the general community dwelling population is rather limited [4,19,23], while prior work shows that frail elderly people mostly need LTC services and support [25]. Second, in the majority of studies, frailty has been operationalized using self-reported measures, which may suffer from reporting bias and measurement errors. In other words, there is need for studies using objective and accurate measures of frailty. Third, there is little or no evidence regarding the extent to which economic conditions may affect the relationship between frailty and LTC use. This topic is important because economic resources should positively affect the consumption of formal LTC services (which are considered as normal goods in standard economic model) [26,27] but there is little evidence on the extent to which the effect varies according to the type of LTC services used [28].

This study aims to address these limitations, by exploring the association between frailty measures and LTC use, and by using clinical measures to characterise elderly people's physical status: loss of muscle mass and muscle quality, which are referred to as sarcopenia [29]. In practice, frailty and sarcopenia are closely related, and it may be difficult to empirically distinguish these concepts [30]. Indeed, frailty and sarcopenia overlap; most frail older people exhibit sarcopenia, and some older people with sarcopenia are also frail [31]. Therefore, we focus on the concept of physical frailty and sarcopenia (PF&S) [32], using validated measures of frailty and / or sarcopenia. We first explore the association between PF&S and several outcomes measuring health care use (hospital, emergency care, ambulatory care), and LTC use (provided either formally by professional helpers or informally by relatives) among European 70+ elders. Our second objective is to assess which PF&S indicator is most strongly associated with health care and LTC use, and whether the relationship is affected (moderated) by individual's economic conditions.

We use original baseline data from the "Sarcopenia and Physical Frailty in Older People: Multicomponent Treatment Strategies" (SPRINTT) project [33,34]. We consider five different measures of PF&S, and assess the moderating effect of economic conditions on the relationship between PF&S, health care, and LTC use. The next section describes the data, variables and methods used.

## **2. Data and methods**

### **2.1. SPRINTT trial: sample & recruitment**

We use cross-sectional baseline data from the SPRINTT study, collected before an intervention aimed at reducing PF&S was randomly assigned (ClinicalTrials.gov identifier: NCT02582138). The SPRINTT sample consists of 1,518 elderly people aged 70+ who were

recruited in eleven European countries (Austria, Czech Republic, Finland, France, Germany, Iceland, Italy, Netherlands, Poland, Spain and United-Kingdom) between 2015 and 2017. The inclusion criteria were being older than 70, having a score on the Short Physical Performance Battery (SPPB) test higher than 3/12 (i.e., excluding disabled individuals) and lower than 9/12 (i.e., excluding robust subjects), having completed the 400 meters walk test within 15 minutes, presence of low muscle mass based on the results of a dual energy X-ray absorptiometry (DXA) scan, according to the cut-points indicated by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project [35], and having a score at the Mini Mental State Evaluation (MMSE) higher than 24/30 (i.e., excluding subjects who are likely to have cognitive impairment or dementia). Further details concerning the study objectives, design and methodology are provided in previous publications [33,34]. Inclusion of 70+ years elders is justified because this population is at increased risk of mobility disability and are expected to have a sufficiently long life expectancy for justifying the participation in a 3-year preventive trial [36]. The sample was restricted to those individuals with complete information (no missing values) to all dependent and independent variables. The final sample comprises 1,351 observations. All clinical research has been conducted to GCP standards and according to local legislation [36].

## 2.2. Outcome variables

### *Health care use*

We use five binary self-reported health care utilization outcomes as dependent variables in our models, each coded as having any visit (1/0). All outcomes denote health care use *within the previous 6 months* and distinguishes 1) emergency admission, 2) hospitalization, 3) GP visit, 4) specialist visit, and 5) nurse practitioner visit.

### *Long-term care use*

We use five binary self-reported LTC use outcomes in our models, each coded as having any visit (1/0). All LTC outcomes denote use *within the last month* and distinguishes: 1) home nurse visit, 2) paid home help visit, 3) meal-on-wheels visit, 4) use of publicly-funded transportation, and 5) unpaid assistance from a caregiver (hereafter, informal care).

## 2.3. Independent variables

### 2.3.1. Physical frailty and sarcopenia (PF&S)

We use five PF&S measures. All measures are coded such as higher scores indicate more frail individuals. The definition and coding strategies for all measures are summarized in Table A.1 (Appendix A). First, we use two generic multidimensional scales: the SARC-F, and the Short Physical Performance Battery (SPPB) test. The SARC-F has been developed as a possible rapid diagnostic test for PF&S and is composed of 5 dimensions: strength, assistance with walking, rise from a chair, climb stairs, and falls [36]. The scores range from 0 to 10, with 0 to 2 points assigned for each component (0= “no difficulty”, 1= “some difficulty”, 2= “a lot or unable”). The internal consistency and predictive performance of the SARC-F have been validated in different settings [37,38]. A score equal or greater than 4 is predictive of sarcopenia and poor outcomes [36]: this cut-off was used to discriminate frail individuals in our data. The SPPB was designed to evaluate physical performance and includes three subtests evaluating standing balance, gait speed over a short distance (i.e., 8 feet), and ability to rise from a chair [31]. A lower score indicates poorer health. Specifically, a threshold of 7 is commonly used, such that individuals whose SPPB is strictly lower than 7 are regarded as particularly frail individuals [32,39]. We used the same threshold (SPPB <7) to identify the frailest participants.



Second, we use three specific objective measures: low muscle strength (measured by handgrip dynamometer), low muscle mass (i.e., low appendicular lean mass measured through DXA ray), and slow walking speed (based on the 400 m walk test). We use the cut-off points defined by the FNIH to categorize individuals whose health status is frailer than the others: males whose grip strength is lower than 26 kg, and females whose grip strength is lower than 16 kg, are categorized in the “low grip strength” category [35]. Similarly, males with a local appendicular lean mass (aLM) lower than 19.75 kg and females with an aLM lower than 15.02 kg are in the “low aLM local” category [40]. Finally, we use the inverse of walking speed (interpreted as the number of seconds to walk one meter) denoting slowness, by assuming that an increase in slowness is associated with higher risk of PF&S [41]. This variable is standardized (z-score: mean=0, standard deviation=1) to ease interpretation.

### 2.3.2. Control variables

All models are adjusted for potential confounders of the relationship between PF&S and health care or LTC use: age, gender, body mass index (BMI), BMI squared, education level, income (in quintiles), having children, and country fixed effects. These variables are considered as ‘good’ (exogenous) controls [42], because likely predetermined before frailty. Other potential control candidates include living alone, the number of comorbidities, and mental health. However, it is difficult to assess whether these controls are causes or consequences of frailty. On the one hand, including endogenous (‘bad’ [42]) control variables that are consequences of frailty may block the causal pathway and lead to biased estimates of both the total and direct effect of frailty [42,43]. On the other hand, if these variables exert a causal impact on frailty, then excluding them from the model would lead to an omitted variable bias. In our main analyses, we only include predetermined (exogenous) controls, but results of models including potentially endogenous variables are provided as robustness

analyses in Appendix B (Tables B.1 and B.2). In Appendix B, we further discuss the potential bias associated with inclusion / exclusion of these potentially endogenous covariates.

#### 2.4. Statistical analyses

All outcome variables are modelled using ordinary least squares (OLS) regressions, using standard errors robust to heteroskedasticity [44]. We test the robustness of results to functional misspecifications of the linear models by estimating probit models (results are provided in Appendix C). Separate models are estimated by including each of the five PF&S on at a time in different models, in order to avoid multicollinearity. A 5% threshold is used to assess statistical significance but 10% and 1% significance levels are also reported. Differences in the impact of each PF&S measures on health care / LTC use are graphically assessed by comparing 95% confidence intervals (CIs) around point estimates. When the 95% CIs overlap but one of the 95% CIs does not contain the point estimate from the other PF&S indicator, we perform a student test of equality of coefficients to assess whether the differences are statistically significant [45]. Then, for each outcome variable, we investigate the moderating effects of income by including interaction effects between income category (low, middle, high) and each PF&S indicator.

### 3. Results

#### 3.1. Descriptive statistics

In our sample: 16% of participants used emergency care, 7% were hospitalized, 78% had a GP consultation, 67% had a specialist consultation, and 21% had a nurse practitioner consultation (Table A.2). The proportion of elders using LTC services is distributed as

follows: home nurse visit (3%), paid home help visit (20%), meal-on-wheel visit (2%), publicly funded transport (4%) and informal care (18%).

The shares of patients defined as frail according to each PF&S diagnosis instrument were the followings : SARC-F (36%), SPPB (37%), grip strength (38%), aLM (61%). The fifth PF&S measure - slowness - is considered as continuous, and no cut-off is used to discriminate frailest subjects. In terms of socio-demographic characteristics: 72% of the sample were females, the mean age was 78 years (min=70, max=98), the mean BMI was 28.7, the mean number of comorbidities was 1.63, and the mean MMSE score was 27.9.

### 3.2. Main statistical analyses

#### 3.2.1. Association between PF&S and health care use

The results of the main effects models assessing the impact of each PF&S indicator on health care use are summarized in Figure 1 (exact estimates displayed in Table B.1). For each categorical PF&S indicator (i.e., all indicators except slowness), the base category is 0, indicating absence of frailty or sarcopenia diagnosis according to the associated measure (e.g., SARC-F). For instance, PF&S<sub>SARC-F</sub> denote presence (versus absence) of sarcopenia symptoms according to the SARC-F instrument.

#### *[1] Emergency visits*

Two PF&S measures (PF&S<sub>SARC-F</sub> and PF&S<sub>slowness</sub>) are significantly associated with a higher probability and number of emergency admissions. For instance, a one standard deviation increase in slowness (i.e., an increase of 0.37 seconds to walk on meter) is associated with a 3.1% points increase in the probability of emergency admissions. The average marginal effect (AME) of the other PF&S measures are not statistically different from that of PF&S<sub>SARC-F</sub> and PF&S<sub>slowness</sub> at the 5% level. There are significant interactions effects between PF&S and

income (Table 1). While PF&S<sub>grip strength</sub> is significantly associated with a higher probability of emergency admissions among low-income elders (+ 8.9% points), the probability of emergency admissions decreases significantly among moderate-income (-10.3% points) and high-income (-16.8% points) elders. Income thus plays a protecting role on the impact of PF&S on emergency admissions.

Slowness was also included in quartiles to investigate non-linearities of its effect on health care use (results available in Table B.1, Appendix B). The positive effect of PF&S<sub>slowness</sub> on emergency admissions is increasing with slowness but at a decreasing rate: elders in the third quartile of slowness (i.e., between 1.20 and 1.51 s/m) are those at highest risk of emergency admission.

### *[2] Hospitalization*

One PF&S indicator - the SARC-F - is significantly associated with a higher probability of hospitalizations (+ 3.4% points). PF&S<sub>SARC-F</sub> has a statistically significant higher association with the probability of hospitalizations compared with the PF&S<sub>SPPB</sub> instrument (p-value=0.036). However, the differences are not statistically different with the other PF&S instruments. Furthermore, slowness is significantly associated with higher probability of hospitalization (+ 12.4% points for a one standard deviation increase in slowness) only among low-income elders.

### *[3,4,5] Ambulatory care visits*

Overall, none of the PF&S measures is significantly associated with a higher probability of GP, specialist, or nurse visit. However, PF&S<sub>SARC-F</sub> (respectively, PF&S<sub>grip strength</sub>) is significantly associated with higher probability of GP visit (respectively, specialist visit) only among high-income elders (>€25,000 per year).

[insert Figure 1 and Table 1]

### 3.2.2. Association between PF&S and LTC use

The results of the main effects models assessing the impact of each PF&S indicator on LTC use are shown in Figure 2 (exact estimates displayed in Table B.2).

#### *[1] Home nurse visit*

Only PF&S<sub>grip strength</sub> has a significant effect on the probability of home nurse visit (+ 2.9% points). The effects are not significantly different across PF&S measures.

#### *[2] Paid home help visit*

All the PF&S measures (except PF&S<sub>aLM</sub>) are significantly associated with a higher probability of paid home help visit. The average marginal effect (AME) is higher for the SARC-F and grip strength measures (AME > 10% points) compared to the effects of SPPB and slowness (AME ≈ 5% points), but the differences are only significant at the 10% level. The impact of PF&S on paid home help visits further varies by income, with low-income frail elders more likely to use paid home help visits (e.g., AME<sub>grip strength</sub> = 16.5% points) compared to moderate-income (AME<sub>grip strength</sub> = 3.3% points) or high-income (AME = -0.6% points) elders.

#### *[3] Meal-on-wheels visit*

PF&S<sub>grip strength</sub> is significantly associated with a higher probability of meal-on-wheels visits (+ 2.5% points), as well as PF&S<sub>slowness</sub> (+ 1.5% points for every one standard deviation increase in slowness). The impact of PF&S on meal-on-wheels visits further varies by income, with

low-income frail elders being more likely to use meal-on-wheels visit (Table 2), the effect being non significant among moderate or high-income elders.

#### *[4] Publicly financed transport*

Only PF&S<sub>SARC-F</sub> is significantly associated with a higher probability of using publicly financed transport (+ 4.7% points). In addition, PF&S<sub>slowness</sub> is significantly associated with a higher probability of transport use only among low-income elders (+ 10.9% for every one standard deviation increase in slowness).

#### *[5] Informal care*

Three PF&S measures (PF&S<sub>SARC-F</sub>, PF&S<sub>SPPB</sub>, PF&S<sub>slowness</sub>) are significantly associated with a higher probability of informal care use. Although the differences are not statistically significant on average, the association tends to be stronger among low-income elders (Table 2).

[insert Figure 2 and Table 2]

### 3.3. Robustness checks

#### *Robustness of results to the inclusion of potentially endogenous covariates*

The main effect of the model excluding (Model 1) and of the model including (Model 2) the potentially endogenous controls are displayed in Appendix B (Tables B.1 and B.2). Regarding health care use, we note the impact of PF&S is consistent but smaller in Model 2 compared to Model 1. For instance, the effect of PF&S<sub>SARC-F</sub> on hospitalization become significant only at the 10% level, and the effect of PF&S<sub>slowness</sub> loses statistical significance. Concerning the

models of LTC use, the results hardly change (in terms of magnitude and statistical significance) between Model 1 and Model 2.

#### *Robustness of results to functional misspecification*

The results of the probit models are shown in Appendix C (Tables C.1 and C.2). Regarding probit versus OLS estimates, the results are consistent for all health care and LTC use outcomes. We note the marginal effects are slightly higher using the probit specification, thus our estimates based on OLS could be conservative.

## **4. Discussion**

This paper investigates the association between self-reported and objective measures of PF&S on different health care and LTC outcomes in the 70+ community-dwelling European population. Specifically, we compare the effects of the different PF&S measures that have been used (separately) in the literature and namely: the SARC-F (self-reported) the SPPB (objective, multidimensional), grip strength (objective), muscle mass (objective), and slowness (objective). We explored the independent impact of each of these measures on various health care and LTC use outcomes. To our knowledge, it is the first study to explore the correlation between muscle mass (measured by dual-energy x-ray absorptiometry scan) and care use.

We found a significant association between two PF&S measures (SARC-F and slowness) and increased risk of emergency visit or hospitalization. These results are consistent with previous work using different European data sources [4,9]. Physical frailty was not independently associated with increased risk of ambulatory care use. We found that PF&S was associated with an increased probability of using formal and informal care. These

results confirm previous studies having shown that frail elders (as assessed using self-reported measures or scales) are more likely to use meals-on-wheels visits [19], home help [4], home care [46] and informal care [47]. We have found that slowness, measured using walking speed on the 400m-walk test, performed best in predicting health care and LTC use outcomes. This result confirms previous findings showing the accuracy of walking speed both in predicting frailty and potential associated adverse outcomes [41,48].

Another contribution of this study to the literature is our exploration of the moderating effect of economic conditions on the relationship between PF&S and care use. Concerning emergency care use and hospitalization, we have found that income plays a protective role, i.e. low-income frail elders have higher risk of emergency admissions or hospitalization compared with high-income frail elders. In the same vein, we found that LTC use was higher for low-income elders compared to high-income elders, especially regarding formal care use (e.g., meal-on-wheels, public transport, or home help visit). These last results are consistent with previous studies showing a significant pro-poor concentration in LTC use (especially, home care utilization) among the Dutch population [49] or the European population [50]. Note that the supply of LTC services is usually very fragmented. Therefore, one could assume that wealthier people use different types of services that are not captured in our data.

We have assessed the robustness of our results to i/ inclusion or exclusion of potentially endogenous controls (which could be caused by frailty, see Appendix B) and ii/ specification of a linear- or non-linear-in-probability model (see Appendix C). We have found that our results were partially affected inclusion of potentially endogenous controls for the models of healthcare use (the effects of PF&S were lower in magnitude in these models), and perfectly robust in the models of LTC use. Moreover, our results were perfectly robust to different functional specifications (i.e., linear or probit model).



A specificity of our study comes from the nature of the data used for the analyses. Our sample was selected with very strict inclusion criteria: the study participants were physically and mentally autonomous. At inclusion, they received a full clinical assessment, including all potential comorbidity screening. The fact that our sample is composed on non-disabled elders allows use understanding the drivers of LTC needs in a pre-disabled population. However, one drawback of the SPRINTT sample is that it is difficult to compare our PF&S prevalence estimates with other studies, which have focused, for the majority, on middle-aged population (e.g., 50-64 years), whereas the SPRINTT population is older (mean age =79 years). Thus, we find higher frailty prevalence estimates in the SPRINTT sample (between 36 and 39% according to the PF&S measure used) compared to other studies with frailty (or sarcopenia) prevalence ranging from 8% to 28% [41,51–53]. This discrepancy can also be explained by the fact that functional impairment was more severe among SPRINTT candidates, as reflected by the lower average SPPB score (6.7 vs. 7.4 in the Lifestyle Interventions and Independence for Elders (LIFE) study (Pahor et al., 2014)). This finding is explained by the higher proportion of participants with SPPB<8 targeted by SPRINTT [34]. The fact that a higher proportion of respondents are considered frail decreases mechanically the proportion of the control group (non-frails) and our ability to detect significant differences in terms of health care or LTC use.

Our study has other limitations. Our estimates of the impact of PF&S on health care cannot be considered as causal, as we are using non-experimental cross-sectional data. In particular, we cannot rule out reverse causality and omitted variable bias. For instance, hospitalization and emergency admissions can have adverse effects on health and increase the PF&S status. In general, unobserved shocks (e.g., loss of a relative, falls, etc.) can simultaneously affect PF&S and care use. In this case, our results may overestimate the net impact of frailty on care use. Further analyses are needed to better understand the impact of

PF&S on care use, for instance using longitudinal data. Second, our sample is limited, and did not allow for stratified analysis per country. Finally, our outcomes variables were self-reported, and may be thus subject to reporting or memory bias in this ageing sample. However, we think that having considered care use at the extensive margin (i.e., the probability of event) – rather than at the intensive margin (i.e., the number of events) – together with the fact that LTC use was during the last month (or the last six months for health care use) may limit the memory bias.

## **5. Conclusions and policy recommendations**

In conclusion, using more accurate measures with respect to previous studies, we confirm that PF&S is a strong predictor of health care and in particular, of LTC use in the 70+ community-dwelling European population. Our results have important health policy implications. They suggest that European frail elders are patients in high need for LTC services. Most European countries do not use PF&S measures to determine eligibility to LTC benefits. Indeed, prior work shows that most LTC systems use activities of daily living limitations scales to define LTC benefit eligibility. This is for instance the case in Austria, Belgium, Czech Republic, France, Germany, Italy, and Spain [54]. While prior work shows that in Europe frailty and ADL can overlap, it is likely that an important proportion of the frail elderly population is not eligible to public benefits, while our results show that they actually have a greater risk of using LTC services. In countries where LTC benefits depend on pre-defined levels of dependency (like for instance France), frail elders are out of range of LTC insurance policies, while our results suggest that the poorest PF&S elders are more likely to use LTC services. Assuming that LTC services provided to the frail elders are appropriate, our results suggest that the inclusion of PF&S in the eligibility criteria of public LTC allowances could contribute to decrease the economic gradient in care use among the elderly

community-dwelling European population. Our interpretation is driven by the idea that eligibility rules that include frailty criteria would help mitigating equity in LTC access issues among elderly people. This is a reasonable assumption given the fact that LTC allowances are provided after an evaluation of elders' care needs (thus reducing the potential for moral hazard issues). In countries where benefits are individualised (United Kingdom, Germany), and/or predefined by care needs (Netherlands), our results show that PF&S is likely to be a relevant indicator of care needs. For instance, walking speed (or slowness) could be a simple – yet powerful and discriminant – indicator to include, as this measure was one of the most correlated (in terms of magnitude and statistical significance) with health care and LTC use in our study.

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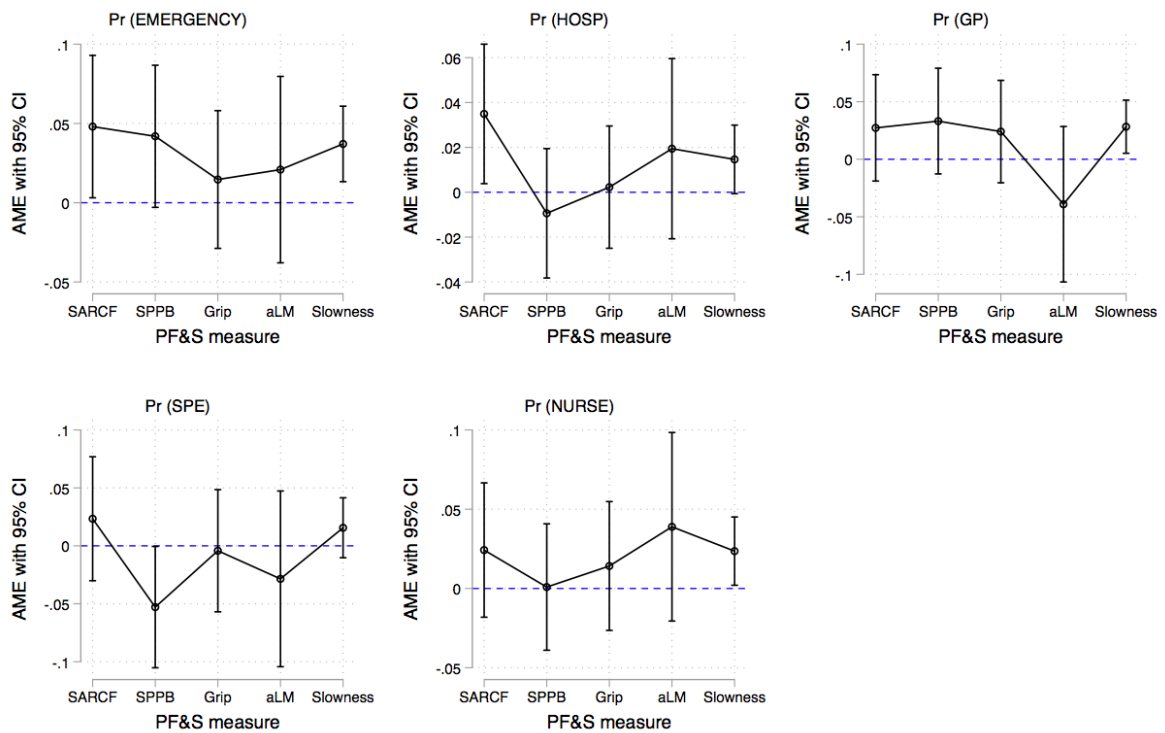
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# Figures

**Figure 1.** Effect of PF&S on health care use. SPRINTT baseline data (N=1351)

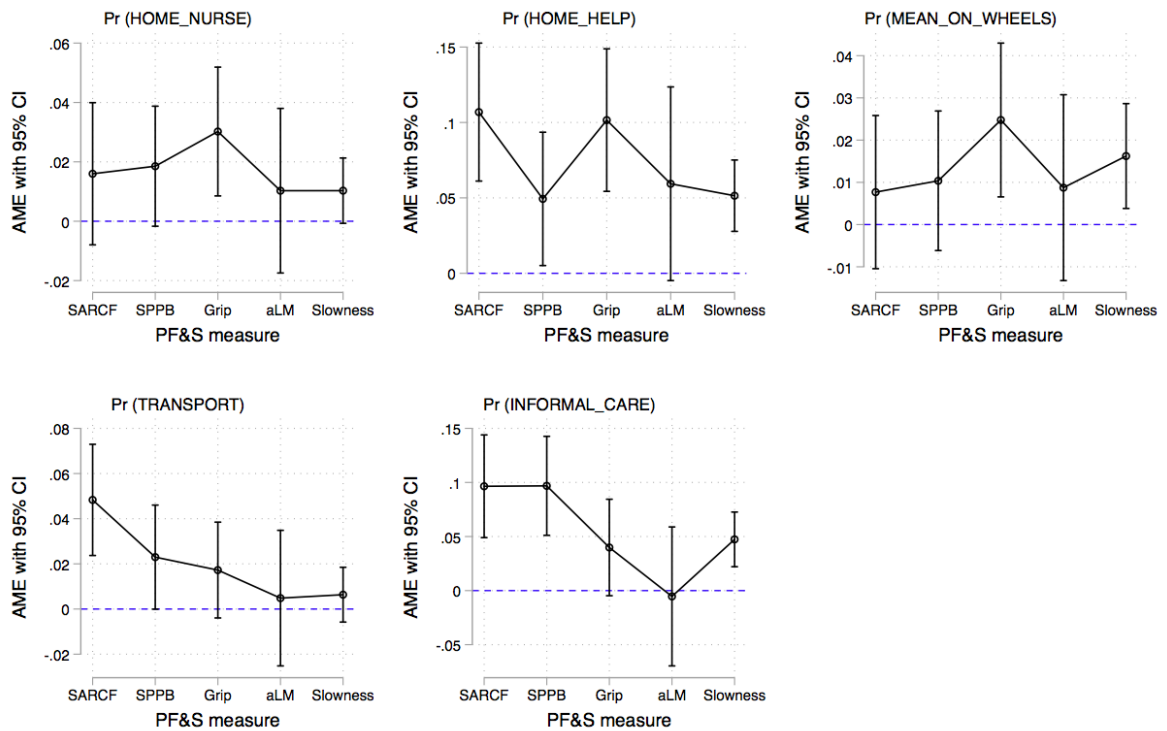


Note: results of linear probability models are adjusted for country, age, gender, BMI, educational level, income, and having children.

Legend. AME: average marginal effects. 95%CI: Confidence intervals at the 95% level. Pr: probability. EMERGENCY: emergency visit. HOSP: hospitalization. GP: General practitioner visit. SPE: specialist visit.

The base category (reference) for each categorical PF&S measure is as follows: SARCF: 0 if SARCF < 4; SPPB: 0 if SPPB > 6; Grip strength: 0 if maximum reading  $\geq 26$  (for males) or  $\geq 16$  (for females); aLM: 0 if DXA scan result  $\geq 19.75$  (for males) or  $\geq 15.02$  (for females).

**Figure 2.** Effect of PF&S on LTC use. SPRINTT baseline data (N=1351)



Note: results of linear probability models are adjusted for country, age, gender, BMI, educational level, income, and having children.

Legend. AME: average marginal effects. 95% CI: Confidence intervals at the 95% level.

The base category (reference) for each categorical PF&S measure is as follows: SARCF: 0 if SARCF < 4; SPPB: 0 if SPPB > 6; Grip strength: 0 if maximum reading  $\geq 26$  (for males) or  $\geq 16$  (for females); aLM: 0 if DXA scan result  $\geq 19.75$  (for males) or  $\geq 15.02$  (for females).



**Table 1.** Linear probability models of the impact of PF&S on health care use: interaction effects. SPRINTT baseline data.

Health care use	Pr (EMERGENCY)		Pr (HOSP)		Pr (GP)		Pr (SPE)		Pr (NURSE)	
	<i>Est</i>	<i>(Std Err)</i>	<i>Est</i>	<i>(Std Err)</i>	<i>Est</i>	<i>(Std Err)</i>	<i>Est</i>	<i>(Std Err)</i>	<i>Est</i>	<i>(Std Err)</i>
<b>A. PF&amp;S = SARC-F (1/0)</b>										
SARC-F ( <i>ref = Low income: &lt;9,999€</i> )	-0.034	(0.046)	0.015	(0.034)	-0.019	(0.043)	-0.024	(0.051)	0.051	(0.041)
SARC-F * Moderate income (10,000-24,999€)	0.086	(0.059)	0.037	(0.043)	0.046	(0.055)	0.046	(0.067)	0.007	(0.053)
SARC-F * High income (>25,000€)	0.098	(0.068)	0.007	(0.048)	0.147**	(0.069)	0.107	(0.080)	-0.087	(0.062)
<b>B. PF&amp;S = SPPB (1/0)</b>										
SPPB ( <i>ref = Low income: &lt;9,999€</i> )	-0.022	(0.045)	0.015	(0.033)	0.073*	(0.038)	0.003	(0.048)	0.003	(0.040)
SPPB * Moderate income (10,000-24,999€)	0.091	(0.056)	-0.029	(0.041)	-0.094*	(0.052)	-0.050	(0.065)	0.010	(0.052)
SPPB * High income (>25,000€)	0.100	(0.065)	-0.016	(0.043)	0.003	(0.067)	-0.036	(0.078)	-0.027	(0.059)
<b>C. PF&amp;S = low grip strength (1/0)</b>										
Low grip ( <i>ref = Low income: &lt;9,999€</i> )	0.089**	(0.045)	0.040	(0.032)	0.055	(0.045)	-0.037	(0.051)	0.069	(0.046)
Low grip * Moderate income (10,000-24,999€)	-0.103*	(0.057)	-0.046	(0.041)	0.027	(0.057)	0.064	(0.066)	-0.056	(0.056)
Low grip * High income (>25,000€)	-0.168***	(0.062)	-0.038	(0.043)	-0.093	(0.075)	0.165**	(0.080)	-0.076	(0.064)
<b>D. PF&amp;S = low aLM (1/0)</b>										
Low aLM ( <i>ref = Low income: &lt;9,999€</i> )	0.025	(0.045)	0.017	(0.036)	-0.043	(0.047)	-0.055	(0.055)	0.061	(0.040)
Low aLM * Moderate income (10,000-24,999€)	0.004	(0.054)	-0.015	(0.042)	0.075	(0.054)	0.045	(0.064)	-0.029	(0.050)
Low aLM * High income (>25,000€)	-0.060	(0.060)	0.050	(0.041)	-0.060	(0.067)	0.052	(0.075)	-0.024	(0.059)
<b>E. PF&amp;S = slowness (s/m)</b>										
Slowness ( <i>ref = Low income: &lt;9,999€</i> )	0.080	(0.060)	0.124**	(0.050)	0.067	(0.058)	0.140**	(0.065)	0.036	(0.054)
Slowness * Moderate income (10,000-24,999€)	0.014	(0.078)	-0.109*	(0.060)	-0.015	(0.076)	-0.115	(0.085)	0.024	(0.069)
Slowness * High income (>25,000€)	0.033	(0.094)	-0.058	(0.067)	0.020	(0.102)	-0.005	(0.103)	0.024	(0.090)
N	1351		1351		1351		1351		1351	

Note: All models are adjusted for country, age, gender, BMI, BMI-squared, educational level, income, having children.

Interpretation: Low grip strength is associated with a 8.9 percentage point increase in the probability of emergency admission among low income elders, versus a 7.9 (8.9-16.8 = -7.9) percentage point decrease in the probability of emergency admission among high income elders.

Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%

**Table 2.** Linear probability models of the impact of PF&S on long-term care use: interaction effects. SPRINTT baseline data.

Long-term care use	Pr (HOME NURSE)		Pr (HOME HELP)		Pr (MEAL-ON-WHEELS)		Pr (TRANSPORT)		Pr (INFORMAL CARE)	
	<i>Est</i>	<i>(Std Err.)</i>	<i>Est</i>	<i>(Std Err.)</i>	<i>Est</i>	<i>(Std Err.)</i>	<i>Est</i>	<i>(Std Err.)</i>	<i>Est</i>	<i>(Std Err.)</i>
<b>A. PF&amp;S = SARC-F (1/0)</b>										
SARC-F ( <i>ref = Low income: &lt;9,999€</i> )	0.001	(0.023)	0.115***	(0.044)	0.002	(0.022)	0.078***	(0.027)	0.083	(0.053)
SARC-F * Moderate income (10,000-24,999€)	0.030	(0.028)	-0.003	(0.056)	0.005	(0.024)	-0.042	(0.032)	-0.003	(0.065)
SARC-F * High income (>25,000€)	-0.004	(0.029)	-0.064	(0.072)	0.002	(0.030)	-0.031	(0.036)	-0.029	(0.072)
<b>B. PF&amp;S = SPPB (1/0)</b>										
SPPB ( <i>ref = Low income: &lt;9,999€</i> )	0.001	(0.021)	0.165***	(0.041)	0.051**	(0.024)	0.044	(0.027)	0.180***	(0.048)
SPPB * Moderate income (10,000-24,999€)	0.037	(0.028)	-0.132**	(0.054)	-0.048*	(0.026)	-0.018	(0.031)	-0.113*	(0.061)
SPPB * High income (>25,000€)	-0.015	(0.029)	-0.171**	(0.068)	-0.073**	(0.030)	-0.026	(0.035)	-0.101	(0.069)
<b>C. PF&amp;S = low grip strength (1/0)</b>										
Low grip ( <i>ref = Low income: &lt;9,999€</i> )	0.010	(0.022)	0.128***	(0.044)	0.076***	(0.028)	0.060**	(0.029)	0.059	(0.050)
Low grip * Moderate income (10,000-24,999€)	0.053*	(0.030)	-0.044	(0.057)	-0.076**	(0.030)	-0.040	(0.035)	-0.018	(0.061)
Low grip * High income (>25,000€)	-0.017	(0.030)	-0.069	(0.076)	-0.052	(0.038)	-0.057	(0.038)	0.016	(0.072)
<b>D. PF&amp;S = low aLM (1/0)</b>										
Low aLM ( <i>ref = Low income: &lt;9,999€</i> )	0.014	(0.023)	0.024	(0.047)	0.034	(0.026)	0.006	(0.030)	-0.038	(0.049)
Low aLM * Moderate income (10,000-24,999€)	0.011	(0.028)	0.077	(0.052)	-0.024	(0.028)	-0.001	(0.033)	0.056	(0.060)
Low aLM * High income (>25,000€)	0.004	(0.029)	0.035	(0.066)	-0.048	(0.032)	-0.017	(0.036)	0.054	(0.065)
<b>E. PF&amp;S = slowness (s/m)</b>										
Slowness ( <i>ref = Low income: &lt;9,999€</i> )	0.050	(0.035)	0.272***	(0.059)	0.108**	(0.043)	0.109***	(0.042)	0.220***	(0.074)
Slowness * Moderate income (10,000-24,999€)	-0.042	(0.041)	-0.127	(0.077)	-0.093**	(0.044)	-0.089**	(0.044)	-0.080	(0.089)
Slowness * High income (>25,000€)	-0.027	(0.055)	-0.054	(0.104)	-0.087	(0.054)	-0.050	(0.057)	0.017	(0.110)
N	1351		1351		1351		1351		1351	

Note: All models are adjusted for country, age, gender, BMI, BMI-squared, educational level, income, having children. Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%

# Appendix

**Appendix A.** Definition of dependent / independent variables (Table A.1), and descriptive statistics on the SPRINTT baseline sample (Table A.2).

**Table A.1.** Definition of dependent / independent variables

Variables	Definition	Measurement / coding
<b>Dependent variables</b>		
<b>A. Health care use</b>		
Emergency admission	Emergency room admission during the last 6 months	Probability (1/0)
Hospitalization	Hospital admission (excluding emergency) during the last 6 months	Probability (1/0)
GP visit	General practitioner visit during the last 6 months	Probability (1/0)
Specialist visit	Specialist practitioner visit during the last 6 months	Probability (1/0)
Nurse practitioner	Nurse practitioner visit during the last 6 months	Probability (1/0)
<b>B. Long term care use</b>		
Home nurse visit	Home nurse visit received during the last month	Probability (1/0)
Paid home help visit	Paid home health visit received during the last month	Probability (1/0)
Meal on wheel visit	Meal on wheel visit received during the last month	Probability (1/0)
Transports	Transports (paid from public service) received during the last month	Probability (1/0)
Unpaid assistance	Unpaid assistance from a caregiver received during last month	Probability (1/0)
<b>Independent variables</b>		
<b>A. PF&amp;S measures</b>		
SARC-F	Questionnaire to rapidly diagnose sarcopenia (5 dimensions)	binary (0/1) : coded 1 if SARCF $\geq 4$
SPPB	Short Physical Performance Battery (3 dimensions)	binary (0/1) : coded 1 if SPPB $< 7$
Low grip strength	Dynamometer maximum reading	binary (0/1) : coded 1 if max. reading $< 26$ for males ( $< 16$ for females)
Low muscle mass (aLM)	Appendicular lean mass measured with dual energy x-ray absorptiometry (DXA)	binary (0/1) coded 1 if DXA $< 19.75$ for males ( $< 15.02$ for females)
Low walking speed	inverse of speed in the 400 m walking speed test (s/m)	continuous

B. Control variables		
Country		
Age	Age of respondent	categorical (dummies)
Gender	Gender of respondent	dummy
Education level	Highest diploma obtained (ISCED classification)	categorical
Income	Income from all sources the subject had last year	categorical
Children	Have any children	dummy
Living alone	Do the subject live alone	dummy
# comorbidities*	Total number of comorbidities	continuous
Mental health (MMSE)	Mini mental state evaluation score	categorical

\* In the Sprintt baseline clinical questionnaire (CRF), information was collected on 14 health disorders (comorbidities) for the following locations: heart, vascular, hematopoietic, respiratory, eyes/ears/nose/throat, upper GI, lower GI, liver, renal, genitourinary, musculoskeletal, neurological, endocrine/metabolic & breast, psychiatric. The variable # *comorbidities* count the number of such symptoms that were diagnosed by a doctor at inclusion.

**Table A.2.** Descriptive statistics of dependent and independent variables. SPRINTT baseline data (N=1351)

Variables	Mean	SD	Min	Max
<b>Dependent variables</b>				
A. Health care use				
Emergency admission	0.16	0.37	0	1
Hospitalization	0.07	0.25	0	1
GP visit	0.78	0.41	0	1
Specialist visit	0.67	0.47	0	1
Nurse practitioner	0.21	0.41	0	1
B . Long term care use				
Home nurse visit	0.03	0.17	0	1
Paid home help visit	0.20	0.40	0	1
Meal on wheel visit	0.02	0.15	0	1
Transports	0.04	0.19	0	1
Unpaid assistance from caregiver	0.18	0.38	0	1
<b>Independent variables</b>				
A. PF&S measures				
SARC-F ( $\geq 4$ )	0.36	0.48	0	1
SPPB ( $\leq 6$ )	0.37	0.48	0	1
Low grip strength*	0.38	0.48	0	1
Male	0.36	0.48	0	1
Female	0.39	0.49	0	1
Low aLM (kg)*	0.61	0.49	0	1
Male	0.38	0.49	0	1
Female	0.70	0.46	0	1

Slowness (s/m)	1.31	0.37	0.62	2.24
<b>B. Control variables</b>				
Sex (female)	0.72	0.45	0	1
Age	78.91	5.83	70	98
Education level				
Elementary school	0.23	0.42	0	1
Secondary school	0.25	0.43	0	1
High school	0.19	0.39	0	1
Technical school (not college)	0.11	0.32	0	1
University diploma	0.18	0.39	0	1
None	0.04	0.20	0	1
Total income (all sources)				
<9,999€	0.22	0.41	0	1
10,000-24,999€	0.37	0.48	0	1
>25,000€	0.21	0.41	0	1
Non response	0.20	0.40	0	1
Having children (yes)	0.86	0.34	0	1
Living alone (yes)	0.51	0.50	0	1
Body mass index (BMI)	28.66	5.69	16.10	58.60
# Comorbidities	1.63	1.53	0	8
Mental health (MMSE) score	27.94	1.82	24	30

Legend: \* Low grip strength: grip strength < threshold (i.e., 26 kg for males; 16 kg for females). Low aLM(kg): aLM < threshold (i.e., 19.75 kg for males; 15.02 kg for females)

## **Appendix B.** Results of models adjusted for potentially endogenous controls

We distinguish between good and bad control variables [42]. The purpose of controlling for confounders is to purge the estimator of the coefficient of our regressor of interest, in our case the frailty indicator, from omitted variable bias: if variables such as age and gender are correlated with frailty, but also with the error term in our regression equation excluding these variables, our estimator suffers from omitted variable bias. Age and gender are preceding (good) control variables, in the sense that they cannot be influenced by frailty: age and gender precede frailty on the causal pathway, and can independently influence health care use.

Intervening (bad) control variables are variables that are themselves functions of the regressor of interest, which is frailty in this case. In our setting, variables such as cohabiting status, comorbidities, and mental health are potentially on the causal pathway between frailty and health care use. While these variables can influence frailty, causality potentially also goes in the opposite direction. Controlling for these bad control variables, that are potentially both preceding and intervening in the causal pathway between our regressor of interest, can have three separate consequences. First, like good controls, controlling for these variables can remove the bias that results from omitted variables that precede frailty in a causal sense. Second, if these endogenous variables are consequences of frailty (positive correlation), they will capture part of the correlation between frailty and health care use, such that controlling for these variables is likely bias downward the effect of frailty.[42,43]. Third, if the intervening control variable is correlated with the error term, for example because an omitted variable affects both the intervening control and the outcome, this leads to additional asymptotic bias of the estimator of the coefficient of interest [42].

Results of models excluding (M1) and including (M2) potentially endogenous controls are displayed in Tables B.1 and B.2. Note that BMI may be potentially endogenous, but we decided to include it in the main analyses (M1) because the interplay between obesity and sarcopenia is complex, and BMI may be an important confounder.

**Table B.1.** Linear regressions models of health care use with / without endogenous health controls. SPRINTT baseline data.

Health care use	Pr (EMERGENCY)		Pr (HOSP)		Pr (GP)		Pr (SPE)		Pr (NURSE)	
	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>
<b>PF&amp;S measure</b>										
SARC-F (1/0)	0.044** (0.023)	0.026 (0.023)	0.034** (0.016)	0.028* (0.016)	0.035 (0.023)	0.012 (0.024)	0.026 (0.027)	0.013 (0.028)	0.022 (0.021)	0.013 (0.022)
SPPB (1/0)	0.039* (0.023)	0.016 (0.022)	-0.012 (0.015)	0.008 (0.014)	0.029 (0.023)	0.032 (0.023)	-0.050* (0.026)	-0.051* (0.027)	0.000 (0.020)	-0.006 (0.021)
Low grip strength (1/0)	0.016 (0.022)	0.016 (0.022)	0.003 (0.014)	0.008 (0.014)	0.027 (0.023)	0.032 (0.023)	-0.000 (0.027)	0.002 (0.027)	0.014 (0.021)	0.015 (0.021)
Low aLM (1/0)	0.041* (0.021)	0.048** (0.022)	0.013 (0.015)	0.012 (0.016)	0.011 (0.024)	0.012 (0.025)	0.006 (0.027)	0.002 (0.027)	0.028 (0.021)	0.015 (0.021)
Slowness* (s/m)	0.031*** (0.012)	0.020 (0.012)	0.013* (0.007)	0.009 (0.008)	0.022* (0.012)	0.021* (0.012)	0.014 (0.013)	0.008 (0.013)	0.020* (0.011)	0.016 (0.011)
Slowness in quartiles ( <i>ref</i> = '1.03 s/m')										
1.03 s/m < slowness <= 1.20 s/m	0.051* (0.025)	0.037 (0.026)	0.018 (0.017)	0.019 (0.018)	0.039 (0.031)	0.046 (0.031)	-0.055 (0.036)	-0.059 (0.037)	0.011 (0.028)	0.001 (0.028)
1.20 s/m < slowness <= 1.51 s/m	0.096*** (0.029)	0.071* (0.029)	0.038* (0.018)	0.040* (0.019)	0.010 (0.032)	0.010 (0.033)	-0.020 (0.037)	-0.015 (0.037)	0.005 (0.028)	-0.004 (0.029)
Slowness > 1.51 s/m	0.085** (0.030)	0.052 (0.031)	0.046* (0.021)	0.035 (0.022)	0.075* (0.031)	0.075* (0.032)	-0.001 (0.037)	-0.019 (0.038)	0.036 (0.029)	0.021 (0.030)
<b>Control variables</b>										
Exogenous controls§	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Potentially endogenous controls	no	yes	no	yes	no	yes	no	yes	no	yes
N	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351

\*Slowness: inverse of walking speed, interpreted as the number of seconds needed to walk on meter in the 400 m walk test.

Model 1 (*M1*) includes only *a priori* exogenous controls (country, age, gender, BMI, educational level, income, having children)

Model 2 (*M2*) additionally controls for potentially endogenous controls (living alone, number of comorbidities, mental health)

Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%

**Table B.2.** Linear regressions models of long-term care use with / without endogenous health controls. SPRINTT baseline data.

Long-term care use	Pr(HOME NURSE)		Pr(HOME HELP)		Pr(MEAL-ON-WHEELS)		Pr(TRANSPORT)		Pr(INFORMAL CARE)	
	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>	<i>M1</i>	<i>M2</i>
<b>PF&amp;S measure</b>										
SARC-F (1/0)	0.016 (0.012)	0.016 (0.012)	0.108*** (0.023)	0.109*** (0.024)	0.007 (0.009)	0.005 (0.009)	0.047*** (0.012)	0.042*** (0.013)	0.098*** (0.024)	0.085*** (0.024)
SPPB (1/0)	0.018* (0.010)	0.017 (0.011)	0.052** (0.023)	0.054** (0.023)	0.010 (0.008)	0.010 (0.008)	0.022* (0.012)	0.016 (0.012)	0.097*** (0.023)	0.093*** (0.023)
Low grip strength (1/0)	0.029*** (0.011)	0.031*** (0.011)	0.105*** (0.024)	0.102*** (0.024)	0.025*** (0.009)	0.021** (0.009)	0.017 (0.011)	0.018 (0.011)	0.035 (0.023)	0.038* (0.023)
Low aLM (1/0)	0.000 (0.010)	-0.001 (0.010)	0.020 (0.022)	0.016 (0.023)	0.007 (0.008)	0.006 (0.008)	-0.000 (0.011)	-0.001 (0.011)	-0.017 (0.023)	-0.019 (0.024)
Slowness* (s/m)	0.010* (0.006)	0.010* (0.006)	0.051*** (0.012)	0.051*** (0.012)	0.015** (0.006)	0.014** (0.006)	0.006 (0.006)	0.003 (0.006)	0.048*** (0.013)	0.039*** (0.013)
Slowness in quartiles ( <i>ref</i> = '1.03 s/m')										
1.03 s/m < slowness <= 1.20 s/m	0.017 (0.012)	0.019 (0.012)	0.045 (0.028)	0.037 (0.028)	0.010 (0.008)	0.007 (0.008)	-0.005 (0.013)	-0.010 (0.014)	0.072** (0.027)	0.067* (0.027)
1.20 s/m < slowness <= 1.51 s/m	0.009 (0.011)	0.013 (0.012)	0.077** (0.029)	0.082** (0.029)	0.004 (0.008)	0.002 (0.008)	0.016 (0.016)	0.011 (0.016)	0.038 (0.027)	0.036 (0.028)
Slowness > 1.51 s/m	0.039* (0.015)	0.039* (0.016)	0.151*** (0.032)	0.150*** (0.033)	0.032* (0.014)	0.029* (0.014)	0.014 (0.016)	0.004 (0.017)	0.176*** (0.033)	0.149*** (0.033)
<b>Control variables</b>										
Exogenous controls§	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Potentially endogenous controls	no	yes	no	yes	no	yes	no	yes	no	yes
N	1351	1351	1351	1351	1351	1351	1351	1351	1351	1351

\*Slowness: inverse of walking speed, interpreted as the number of seconds needed to walk on meter in the 400 m walk test.

Model 1 (*M1*) includes only *a priori* exogenous controls (country, age, gender, BMI, educational level, income, having children)

Model 2 (*M2*) additionally controls for potentially endogenous controls (living alone, number of comorbidities, mental health)

Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%



### **Appendix C.** Robustness checks to functional misspecification

When modelling binary dependent variables, it is difficult to assess which of a linear or non-linear specification is best (as noted by Angrist and Pischke, 2009, logit and probit models also rest on restrictive and un-testable assumptions concerning the distribution of the error terms) and in practice, this choice may depend on the data and study objectives. We choose to estimate linear probability models over non-linear (e.g., logit or probit) models for the following reasons: we were mainly interested in computing average marginal effects (AMEs), which necessitate *a posteriori* approximations and additional parametric assumptions in the logit/probit model, and we were also interested in computing interaction effects between covariates, which are difficult to interpret in non-linear models.

Tables C.1 and C.2 provide the results of the comparison between ordinary least squares (OLS) and probit regressions of health care use (C.1) and LTC use (C.2). Our robustness checks show that the difference between the LPM regression coefficients (OLS) and probit estimated average marginal effects is negligible. Our conclusions do not change significantly from one specification to the other.

**Table C.1.** Probit and OLS estimates of marginal effects for health care use outcomes. SPRINTT baseline data.

Health care use	Pr(EMERGENCY)		Pr(HOSP)		Pr(GP)		Pr(SPE)		Pr(NURSE)	
	<i>OLS</i>	<i>Probit</i>	<i>OLS</i>	<i>Probit</i>	<i>OLS</i>	<i>Probit</i>	<i>OLS</i>	<i>Probit</i>	<i>OLS</i>	<i>Probit</i>
<b>PF&amp;S measure</b>										
SARC-F (1/0)	0.044** (0.023)	0.046** (0.021)	0.034** (0.016)	0.033** (0.014)	0.035 (0.023)	0.020 (0.023)	0.026 (0.027)	0.025 (0.027)	0.022 (0.021)	0.018 (0.020)
SPPB (1/0)	0.039* (0.023)	0.039* (0.020)	-0.012 (0.015)	-0.013 (0.015)	0.029 (0.023)	0.028 (0.023)	-0.050* (0.026)	-0.047* (0.026)	0.000 (0.020)	-0.002 (0.020)
Low grip strength (1/0)	0.016 (0.022)	0.014 (0.021)	0.003 (0.014)	0.004 (0.015)	0.027 (0.023)	0.031 (0.023)	-0.000 (0.027)	-0.001 (0.027)	0.014 (0.021)	0.013 (0.020)
Low aLM (1/0)	0.041* (0.021)	0.041* (0.022)	0.013 (0.015)	0.017 (0.015)	0.011 (0.024)	0.015 (0.023)	0.006 (0.027)	0.005 (0.027)	0.028 (0.021)	0.025 (0.020)
Slowness* (s/m)	0.031*** (0.012)	0.035*** (0.011)	0.013* (0.007)	0.012* (0.007)	0.022* (0.012)	0.023* (0.012)	0.014 (0.013)	0.016 (0.014)	0.020* (0.011)	0.018* (0.010)
Slowness in quartiles ( <i>ref</i> '1.03 s/m')										
1.03 s/m < slowness <= 1.20 s/m	0.051* (0.025)	0.052* (0.025)	0.018 (0.017)	0.019 (0.017)	0.039 (0.031)	0.032 (0.030)	-0.055 (0.036)	-0.051 (0.034)	0.011 (0.028)	0.010 (0.027)
1.20 s/m < slowness <= 1.51 s/m	0.096*** (0.029)	0.094*** (0.027)	0.038* (0.018)	0.039* (0.017)	0.010 (0.032)	0.009 (0.032)	-0.020 (0.037)	-0.017 (0.035)	0.005 (0.028)	-0.004 (0.026)
Slowness > 1.51 s/m	0.085** (0.030)	0.084** (0.029)	0.046* (0.021)	0.042* (0.019)	0.075* (0.031)	0.072* (0.032)	-0.001 (0.037)	0.002 (0.036)	0.036 (0.029)	0.031 (0.028)
<b>Control variables</b>										
Exogenous controls§	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Potentially endogenous controls	no	no	no	no	no	no	no	no	no	no
N	1351	1349	1351	1344	1351	1349	1351	1346	1351	1349

OLS: ordinary least squares.

Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%.

**Table C.2.** Probit and OLS estimates of marginal effects for long-term care use outcomes. SPRINTT baseline data.

Long-term care use	Pr(HOME NURSE)		Pr(HOME HELP)		Pr(MEAL-ON-WHEELS)		Pr(TRANSPORT)		Pr(INFORMAL CARE)	
	OLS	Probit	OLS	Probit	OLS	Probit	OLS	Probit	OLS	Probit
<b>PF&amp;S indicator</b>										
SARC-F indicator (1/0)	0.016 (0.012)	0.018* (0.011)	0.108*** (0.023)	0.108*** (0.021)	0.007 (0.009)	0.007 (0.011)	0.047*** (0.012)	0.056*** (0.014)	0.098*** (0.024)	0.095*** (0.021)
SPPB indicator (1/0)	0.018* (0.010)	0.020* (0.011)	0.052** (0.023)	0.052** (0.021)	0.010 (0.008)	0.016 (0.011)	0.022* (0.012)	0.029** (0.013)	0.097*** (0.023)	0.094*** (0.020)
Low grip strength (1/0)	0.029*** (0.011)	0.030*** (0.011)	0.105*** (0.024)	0.099*** (0.021)	0.025*** (0.009)	0.027** (0.012)	0.017 (0.011)	0.020 (0.013)	0.035 (0.023)	0.037* (0.022)
Low aLM (1/0)	0.000 (0.010)	0.002 (0.012)	0.020 (0.022)	0.021 (0.023)	0.007 (0.008)	0.014 (0.012)	-0.000 (0.011)	0.001 (0.014)	-0.017 (0.023)	-0.018 (0.022)
Slowness* (s/m)	0.010* (0.006)	0.013** (0.006)	0.051*** (0.012)	0.051*** (0.011)	0.015** (0.006)	0.016*** (0.005)	0.006 (0.006)	0.007 (0.006)	0.048*** (0.013)	0.045*** (0.011)
Slowness in quartiles ( <i>ref</i> '=1.03 s/m')										
1.03 s/m < slowness <= 1.20 s/m	0.017 (0.012)	0.017 (0.011)	0.045 (0.028)	0.043 (0.026)	0.010 (0.008)	0.013 (0.012)	-0.005 (0.013)	-0.007 (0.015)	0.072** (0.027)	0.080** (0.026)
1.20 s/m < slowness <= 1.51 s/m	0.009 (0.011)	0.012 (0.011)	0.077** (0.029)	0.079** (0.028)	0.004 (0.008)	0.007 (0.011)	0.016 (0.016)	0.024 (0.019)	0.038 (0.027)	0.047 (0.026)
Slowness > 1.51 s/m	0.039* (0.015)	0.049** (0.015)	0.151*** (0.032)	0.157*** (0.032)	0.032* (0.014)	0.042** (0.015)	0.014 (0.016)	0.018 (0.017)	0.176*** (0.033)	0.180*** (0.032)
<b>Control variables</b>										
Exogenous controls§	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Potentially endogenous controls	no	no	no	no	no	no	no	no	no	no
N	1351	1121 <sup>a</sup>	1351	1353	1351	1011 <sup>b</sup>	1351	1103 <sup>c</sup>	1351	1350

*Note:* <sup>a</sup>Finland predicts failure perfectly (140 obs. dropped) ; <sup>b</sup>Poland, Spain and UK predict failure perfectly (345 obs. dropped) ; <sup>c</sup>Spain and UK predict failure perfectly (253 obs. dropped).

Statistical significance: \*: 10% ; \*\*: 5% ; \*\*\*: 1%.