Ability of self-reported frailty components to predict incident disability, falls and all-cause mortality:

results from a population-based study of older British men

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Running title: Self-reported frailty components in older age

Abstract

Background: Frailty is a state of increased vulnerability to disability, falls, and mortality. The Fried frailty phenotype includes assessments of grip strength and gait speed which are complex or require objective measurements and are challenging in routine primary care practice. In this study we aimed to develop a simple assessment tool based on self-reported information on the five Fried frailty components to identify older people at risk of incident disability, falls, and mortality.

Methods: Analyses are based on a prospective cohort comprising older British men aged 71-92 years in 2010-12. A follow-up questionnaire was completed in 2014. The discriminatory power for incident disability and falls was compared to the Fried frailty phenotype using receiver operating characteristic-area under the curve (ROC-AUC); for incident falls it was additionally compared to the FRAIL scale, comprising exhaustion, resistance, ambulation, multimorbidity, and weight loss. Predictive ability for mortality was assessed using age-adjusted Cox proportional hazard models.

Results: A model including self-reported measures of slow walking speed, low physical activity and exhaustion had a significantly increased ROC-AUC (0.68, 95%CI 0.63-0.72) for incident disability compared with the Fried frailty phenotype (0.63, 95%CI 0.59-0.68; p-value of ΔAUC=0.003). A second model including self-reported measures of slow walking speed, low physical activity and weight loss had a higher ROC-AUC (0.64, 95%CI 0.59-0.68) for incident falls compared to the Fried frailty phenotype (0.57, 95%CI 0.53-0.61; p-value of ΔAUC<0.001) and the FRAIL scale (0.56, 95%CI 0.52-0.61; p-value of ΔAUC=0.001). This model was also associated with an increased risk of mortality (Harrell's C=0.73, Somer's D=0.45; linear trend p<0.001) compared to the Fried phenotype (Harrell's C=0.71; Somer's D=0.42; linear trend p<0.001) and the FRAIL scale (Harrell's C=0.71, Somer's D=0.42; linear trend p<0.001).

Conclusion: Self-reported information on the Fried frailty components had superior discriminatory and predictive ability compared with the Fried frailty phenotype for all the adverse outcomes considered and with the FRAIL scale for incident falls and mortality. These findings have important implications for

developing interventions and healthcare policies as they offer a simple way to identify older people at risk

of adverse outcomes associated with frailty.

Introduction

Following a demographic shift observed in several countries, including the UK, the projected number of people aged ≥65 years is expected to rise by over 40% in the next 17 years.[1] From a public health perspective one of the major challenges of population ageing is to reduce the morbidity and disability associated with increasing age. In the UK alone, 40% of those aged 65 years and older have a limiting longstanding illness [1] and 28%-35% experience falls every year.[2]

One of the most commonly recognised risk states for adverse outcomes in the older population is frailty, a clinical condition of increased vulnerability resulting from age-related declines in multiple physiological systems.[3] Numerous prospective studies and meta-analyses have demonstrated significant associations between frailty status and increased risk of disability,[4, 5] falls,[6] and mortality.[4, 7-12] It is, therefore, recognised as one of the greatest challenges for healthcare professionals in countries with ageing populations such as the UK.[13] Frailty also offers potential for preventive management since it has been shown to be preventable or at least amenable to prevention of progression.[3, 14] A review suggested that pre-screening for frailty could serve as a two-step approach to identify individuals who would benefit from further assessments such as the comprehensive geriatric assessment (CGA).[15] The CGA is a recommended component in the care of older patients and includes a detailed evaluation of the individual's functional status, physical health, psychological status including cognitive and affective status and socioenvironmental factors.[16] However, the CGA is time-consuming and, therefore, difficult to implement in routine community care. Consequently, there is a need to develop simple screening tools to identify old people who would benefit from a further detailed assessment followed by appropriate management to prevent adverse outcomes of frailty.[15]

Two models of frailty, the frailty phenotype and the frailty index, have provided the conceptual basis to measure frailty. The Fried frailty phenotype comprises weight loss, physical inactivity, slow walking speed, low grip strength and exhaustion.[7] The frailty index is a cumulative score of a number of symptoms, signs, disease, abnormal laboratory results and disability.[17] Currently, more than 27 indices aiming to screen for

frailty status have been described in the literature.[12-14, 18, 19] The majority of these scales are extensive, for example the 25-item Tilburg Frailty Indicator,[20] the 15-item Groningen frailty indicator,[21] the 70-item frailty index,[22, 23] and the 11-item Edmonton Frail scale.[24, 25] Commonly they also necessitate objective measures of grip strength and/or gait speed, e.g. the Fried frailty component [7] or the SHARE-FI,[26] and are therefore challenging in routine primary care practice. Attempts to develop a simple screening tool for frailty, such as the 5-item FRAIL scale,[14,27,28,29] have shown promising results in terms of their ability to detect frailty among middle-aged and older populations and to predict incident functional loss and mortality.[27,30]

This study in a community-dwelling cohort of older British men aimed to investigate the ability of simple self-reported measures of the Fried frailty components, including weight loss, physical inactivity, slow walking speed, low grip strength and exhaustion to predict incident disability, falls and mortality over a 3-year follow-up period. The discriminative and predictive ability of models including up to three subjective measures was compared with that of the Fried frailty phenotype and with the simpler FRAIL scale.

Methods

Data for this study are based on the British Regional Heart Study (BRHS), a prospective cohort study comprising a socially and geographically representative sample of 7735 men aged 40–59 years from one general practice in each of 24 towns representing all major British regions and who were initially examined in 1978–1980.[31] Surviving study members aged 71-92 years (n=3137) were invited to attend a 30-year re-examination in 2010-2012, of whom 2137 completed a questionnaire (68% response rate) and 1722 attended a physical examination (55% response rate).[32] In 2014 a follow-up postal questionnaire was sent to the cohort and was completed by 1655 participants (64% response rate). In total, 1198 study participants had complete data during the 30-year re-examination and the follow-up questionnaire. Ethical approval was provided by the relevant research ethics committees. All men provided written informed consent to the investigations, which were carried out in accordance with the Declaration of Helsinki.

Physical examination of subjects at age 71-92 years involved anthropometric (height, weight) and physical performance (gait speed, grip strength) assessments, as well as a lung function test. Height was measured with a Harpenden stadiometer to the last complete 0.1 cm and weight with a Tanita MA-418-BC body composition analyser (Tanita, Tokyo, Japan). Body mass index (BMI) was calculated as weight/(height)^2 (kg/m^2). Grip strength (in kilograms) was measured with a Jamar Hydraulic Hand Dynamometer. Walking speed was defined as the time taken, in seconds, to walk 3 meters at normal walking pace. If walking speed was unavailable, self-reported information of slow walking pace ("being unable to walk more than a few steps or <200 yards or difficulty walking across a room") was used. Three measurements were taken for each hand, and the best of six readings was used for the analysis. Forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) were measured using a Vitalograph compact II spirometer with the subject seated.

Subjective assessments of walking speed, grip strength, weight loss, exhaustion and physical activity were derived from the questionnaire completed in 2010-12. They included single-item questions on self-reported a) inability to grip with hands (e.g. opening a jam jar); b) decrease of weight in the last four years; c) slow walking pace; d) not feeling full of energy; and e) being less or much less active compared with a man who spends two hours on most days on activities such as walking, gardening, household chores or DIY projects.

Additional baseline sample characteristics considered included social class, smoking status, and alcohol consumption. For alcohol intake, the men were classified into five groups—none, occasional, light, moderate and heavy. Heavy drinking was defined as drinking >6 units (1 UK unit=10 g) of alcohol daily or on most days. Men were also classified in four groups according to their smoking habits as current smokers, ex-smokers who gave up smoking before or after 1983, and those who never smoked.

Frailty and pre-frailty status based on the 'Fried frailty phenotype' and the FRAIL scale was derived for participants attending the 30-year re-examination of the BRHS using information drawn from the

questionnaire and the physical examination.[33] The Fried frailty phenotype components included a) *unintentional weight loss* defined as ≥ 5% decrease in self- reported weight which was reported to be unintentional; b) *weakness* defined as being in the lowest quintile of the distribution for grip strength; c) *low physical activity* was assessed using self-report questions on being less or much less active than an average man, or participating in active sport and endurance activities; d) *exhaustion* was defined as participants reporting not to be feeling full of energy; and e) *slow walking speed* was defined as being in the lowest quintile of the distribution of walking speed. Scores on the FRAIL scale were computed using information on exhaustion, weight loss, resistance, ambulation, and illnesses. Measurements of e*xhaustion* and *weight loss* were the same for the Fried frailty phenotype and the FRAIL scale. *Ambulation* was computed using information on the ability to walk more than 200 yards. *Resistance* using information on the ability to climb a flight of 12 stairs. Participants were considered to have multiple *illnesses* when they reported having a history of at least 5 out of 11 total illnesses, including hypertension, diabetes, cancer, chronic lung disease, heart attack, heart failure, angina, asthma, arthritis, stroke, and kidney disease. Participants were considered to have a positive history of chronic lung disease when they reported being prescribed bronchodilators (British National Formulary code 3.1) and had $FEV_1/FVC<0.70$.[34] For both, the Fried frailty phenotype and the FRAIL scale, presence of three or more components was defined as frailty, and presence of one or two as pre-frailty.

Outcome measures of disability and falls derived from the questionnaire completed in 2014. Information on all-cause mortality was obtained from death certificates. *Disability* was defined as mobility limitations and measured using information on difficulties going up or down stairs, or walking 400 yards. *Falls* were assessed using self-reported information on whether participants experienced falls during the previous year.

Statistical Analysis

We calculated age adjusted odds ratios (OR) to estimate the relationship of the Fried frailty components and self-reported (subjective) frailty questions with incident disability and falls over the 3-year follow-up period.

Cox proportional hazard models were used to obtain age-adjusted hazard ratios (HR) for mortality. We used ROC-AUC to assess the discriminatory ability of the subjective frailty measures for incident disability and falls. Using the *roccomp* command in Stata we compared the ROC-AUC obtained by the objectively assessed Fried frailty phenotype components and the subjective measures. The subjective measures that produced ROC-AUC comparable to the Fried frailty phenotype for incident falls and disability, were used to create composite indices with up to three variables. We assessed the ROC-AUC of these composite indices and evaluated the improvement in their ability to re-classify falls and disabilities by calculating the Integrated Discrimination Index (IDI). The models that best predicted disability and falls were tested for prediction of mortality using age-adjusted Cox proportional hazard models and were compared with the Fried frailty phenotype using the Harrell's-C statistic. Additionally, we compared our models with the FRAIL scale for falls and mortality, but not for incident disability (mobility limitation), as this was part of the FRAIL scale. All analyses were performed using Stata/SE 14 (Stata Corp., College Station, TX, USA).

Results

Of 1622 subjects who attended the physical examination in 2010-12, complete data on falls or disability in the follow-up questionnaire in 2014 were available for 1198 study members. Of those, 380 (32%) were classified as non-frail, 652 (54%) as pre-frail and 166 (14%) as frail based on the Fried frailty phenotype. In addition, 521 (43%) were classified as non-frail, 580 (48%) as pre-frail and 97 (8%) as frail according to the FRAIL scale. The characteristics of the baseline sample are summarized in Table 1. Over the 3-year follow-up period (mean=2.96 years, SD=0.52), 128 (15%) participants developed incident disability and 163 (16%) reported at least one fall within the previous 12 months. A total of 83 deaths occurred (5%) during this follow-up period with a mean survival time of 1.17 years (mean=1.17 years, SD=1.16).

Table 2 presents the associations of subjectively and objectively assessed frailty components with incident disability, falls, and all-cause mortality over the 3 year follow-up period. After adjustments for age, both objectively and subjectively assessed physical inactivity and slow walking speed were significantly

associated with incident disability, falls and all-cause mortality. Objectively assessed weight loss was significantly associated with a higher risk for mortality only; in contrast, subjectively assessed weight loss was additionally associated with a higher risk for incident falls. Being in the bottom quintile of physical assessments of grip strength was not significantly predictive of any of the considered outcomes. However, self-reported inability to grip with hands was significantly associated with incident disability and falls. Finally, exhaustion was significantly associated with incident disability, but not incident falls or mortality. Based on the Fried frailty phenotype, pre-frail and frail subjects were at a higher risk for incident disability and mortality, but only frail individuals were at a significantly higher risk for incident falls.

Table 3 presents the discriminative ability of the Fried frailty phenotype and the subjective frailty components for incident disability over the 3 year follow-up period. Results of the ROC tests showed moderate ability of the Fried frailty phenotype to discriminate between subjects with and without incident disability (AUC=0.63, 95%CI 0.59-0.68). Of the subjectively measured frailty components, walking speed, physical inactivity, and exhaustion had comparable AUC values to the one obtained by the Fried frailty phenotype, while weight loss and grip strength showed significantly reduced discriminatory ability. Therefore, subjectively measures of walking speed, physical activity and exhaustion were used to identify models predictive of incident disability. Models including any of these two subjective frailty components did not have an appreciably higher AUC than the one obtained for the Fried frailty phenotype (all p-values >0.05). However, the model including slow walking speed, physical inactivity and exhaustion, showed a significant improvement in the discriminative ability for incident disability (AUC=0.68, 95%CI 0.63-0.72 for Model D in Table 3) in comparison to the Fried frailty phenotype (p=0.01). In addition, the significant IDI (IDI=1%, p=0.03) also suggested improvement in the re-classification of cases with incident disability compared to the model which included slow walking speed and physical inactivity only.

Table 4 summarizes the discriminative ability of the Fried frailty phenotype, the FRAIL scale and the subjective frailty components for incident falls over the 3 year follow-up period. Compared to the ROC-AUC

of the Fried frailty phenotype for incident falls (AUC=0.57, 95%CI 0.53-0.61), subjectively assessed gait speed, physical activity, weight loss and grip strength had comparable AUC values, while the ROC-AUC of exhaustion was significantly lower. Therefore, the self-reported frailty components used to build a model for prediction of incident falls included slow walking speed, physical inactivity, weight loss and low grip strength. Of all two-variable models considered, the ones including slow walking speed and physical inactivity (Model A in Table 4), or slow walking speed and weight loss (Model B in Table 4) had a significantly increased ROC-AUC compared to the one obtained by the Fried frailty phenotype. Next, we tested models including combinations of up to three self-reported frailty components. The highest ROC-AUC was obtained for a model including slow walking speed, physical inactivity, and weight loss (AUC=0.64, 95%CI 0.59-0.68; p-value of ΔAUC compared with the Fried frailty status <0.001; Model G in Table 4). An additional model including slow walking speed, physical inactivity, and low grip strength (AUC=0.62, 95%CI 0.57-0.66; Model H in Table 4) also had a significantly increased AUC-value (AUC=0.62, 95%CI 0.57-0.66) compared to the one obtained by the Fried frailty phenotype (p=0.01) while also retaining a significant IDI value (IDI=0.4%, p=0.05). Additionally, both models best predicting incident falls had a significantly increased AUC-value compared to the one obtained by the FRAIL scale (AUC=0.56, 95%CI 0.52-0.61, both p-values of ΔAUC<=0.01).

The model that best predicted disability (self-reported slow walking speed + physical inactivity + exhaustion) was significantly associated with mortality (HR=1.61, 95%CI 1.31-1.98). However, the associated Harrell's C and Somer's D statistics (Harrell's C=0.69; Somer's D=0.38) were lower than that obtained by the Fried frailty phenotype (HR=2.81, 95%CI 1.96-4.05; Harrell's C=0.71; Somer's D=0.42) and the FRAIL scale (HR=2.86, 95%CI 2.04-4.03; Harrell's C=0.71; Somer's D=0.42) suggesting reduced predictive power. The first of the two models that best predicted falls (self-reported slow walking speed + physical inactivity + weight loss) was significantly associated with an increased risk for mortality (HR=2.08, 95%CI 1.68-2.59) and had also increased predictive power (Harrell's C=0.73; Somer's D=0.45) compared with the Fried frailty phenotype and the FRAIL scale. In contrast, the second model that was predictive of incident falls (self-

reported slow walking speed + physical inactivity + low grip strength) also had an increased risk for mortality (HR=1.65, 95%CI 1.34-2.02), but its predictive ability (Harrell's C=0.69; Somer's D=0.39) was lower than that of the Fried frailty phenotype and the FRAIL scale.

Discussion

In this study we demonstrate that self-reported information on walking speed, physical activity, exhaustion and weight loss can be used to identify older people at risk of incident disability, falls and all-cause mortality, which are known adverse outcomes of frailty. When combined, these simple and subjective assessments of frailty components had superior discriminatory and predictive ability compared with the Fried frailty phenotype for all the adverse outcomes considered and with the FRAIL scale for incident falls and mortality. Such measures in community care can offer a simple way of identifying vulnerable older individuals who would benefit from a further intensive assessment such as a CGA [15] without having to rely on more complex and time-consuming assessments.

In particular, single self-reported items on walking speed and physical activity were predictive of incident disability, falls and mortality and their individual and combined discriminative ability for these outcomes was comparable to that of the Fried frailty phenotype. Recent reviews and meta-analyses provide additional evidence that reduced gait speed [35-37] and physical inactivity [38, 39] are key components of at-risk states for disability and falls. Self-reported weight-loss was predictive of incident falls and mortality while exhaustion was associated only with incident disability. Unlike other studies, objectively assessed grip strength was not a significant independent predictor of any of the outcomes considered in our study.[40] Yet, self-reported grip strength was significantly associated with incident disability and falls.

When self-reported information of exhaustion was combined with self-reported walking speed and physical inactivity the discriminative ability for incident disability increased significantly (ROC-AUC=0.68). This finding is in line with results of a study on community-dwelling older adults which has demonstrated the association of fatigue with mobility-related disability.[41] Moreover, the ability of subjective walking speed

and physical activity to predict incident falls increased substantially on including information on self-reported weight loss (ROC-AUC=0.64). The ROC-values observed for incident falls and disability using these self-reported frailty measures were significantly higher compared with the one obtained for the Fried frailty phenotype in this sample. They are also comparable with the absolute AUC values for falls and disability reported in a cohort study of older men that examined both the Fried frailty phenotype and a simpler index comprising weight loss, inability to rise from a chair and poor energy.[42] Combined self-reported information on subjective walking speed, physical activity and weight loss was also significantly better in predicting incident falls and mortality compared to the scores of the FRAIL scale. Nonetheless, the FRAIL scale yielded discriminative and predictive ability for incident falls and mortality that was comparable to that of the Fried frailty phenotype; this also provides evidence for the adequacy of simpler screening tools that do not necessitate complex objective assessments.

One of the main strengths of this study is that it is based on a large prospective population-based study representative of older British men. The cohort has a high follow-up rate of 98% and has enabled very low attrition rates. However, the response rate for the baseline assessment in this study was 55% and therefore the issue of survival bias cannot be overlooked. Frail subjects in particular are likely to have died at a higher rate.[12] Of the 2137 participants who attended the 30-year re-examination of the BRHS, 1722 attended the physical examination which presents an additional selection bias. Moreover, the BRHS includes only white European men and therefore generalizability to women and other ethnic minorities is limited.

Conclusions

This study provides evidence that single self-reported items on weight loss, slow walking speed, physical inactivity and exhaustion are significant predictors of adverse outcomes associated with frailty in older people, including incident disability, falls and all-cause mortality. When combined, these self-reported items can provide a better risk stratification for these adverse outcomes than the Fried frailty phenotype which necessitates standardised objective assessments. Objective assessments required to assess the Fried

frailty phenotype and other frailty indices can be challenging in routine community care because they are more time-consuming. Moreover, the discriminative and predictive ability of self-reported frailty components for incident falls and mortality in our sample was superior to that obtained by the FRAIL scale which further supports the robustness of our findings. The results of this study have important implications for health care policies as they offer a very simple way to identify people at risk of adverse outcomes associated with frailty. The findings of this study could also form the basis of studies developing interventions to target older individuals who would benefit from further detailed assessments, or further management aiming to prevent disabilities and falls in older age.

Conflict of interest: None

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Table 1: Demographic and lifestyle factors according to frailty status in a population-based sample of 1,198 British men age 71-92 years in 2010-2012

Variable	Non-frail (n=380; 32%)	Pre-frail (n=652; 54%)	Frail (n=166; 14%)	Total (n=1,198)	p-value*
Age (years)	76.66 (3.62)	78.27 (4.41)	79.69 (4.88)	77.95 (4.36)	<.001
Body mass index (BMI)	26.69 (3.45)	27.18 (3.55)	28.32 (4.39)	27.18 (3.68)	<.001
Manual social class, n(%)	163 (44%)	277 (44%)	77 (48%)	517 (44%)	0.55
Smoking status/Never smoked, n(%)	163 (43%)	244 (37%)	55 (33%)	462 (39%)	0.07
Moderate/Heavy alcohol consumption, n(%)	7 (2%)	16 (3%)	4 (2%)	27 (2%)	0.79

Continuous variables as shown as mean (Standard Deviation)

*p-value of respective Chi-square test or one-way analysis of variance (ANOVA)

Table 2. Odds ratios and hazard ratios (95% confidence intervals) for incident falls, disability and all-cause mortality according to frailty components and self-report frailty measures over a 3-year follow-up period in a cohort of 1,198 British men aged 71-92 years

		Incident Disability (n=138; 15%)	Incident Falls (n=163; 16%)	Mortality (n=83; 5%)
		n (%) OR (95% CI)	n (%) OR (95% CI)	n (%) HR (95% CI)
Gait Speed				
Fried frailty component	Bottom quintile of walking speed	30 (22%) **3.24 (1.97-5.34)**	38 (23%) **1.99 (1.30-3.04)**	39 (47%) **2.90 (1.84-4.56)**
Single self-report item	Slow walking pace	41 (30%) **3.97 (2.53-6.21)**	55 (34%) **2.27 (1.56-3.32)**	45 (55%) **2.98 (1.91-4.66)**
Physical Activity				
Fried frailty component	Physically Inactive	48 (35%) **2.57 (1.72-3.83)**	60 (37%) **1.80 (1.26-2.58)**	44 (53%) **2.17 (1.40-3.36)**
Single self-report item	Less active or much less active in comparison to other men	43 (32%) **2.63 (1.73-4.00)**	55 (34%) **1.83 (1.26-2.64)**	41 (49%) **2.18 (1.41-3.37)**
Weight Loss				
Fried frailty component	≥5% unintentional weight loss	15 (11%) 1.33 (0.72-2.45)	20 (12%) 1.50 (0.88-2.57)	29 (35%) **3.88 (2.44-6.16)**
Single self-report item	Weight loss in the last four years	31 (22%) 1.44 (0.92-2.26)	43 (27%) **1.84 (1.24-2.74)**	36 (44%) **3.14 (2.02-4.87)**
Grip strength				
Fried frailty component	Bottom quintile of grip strength	30 (22%) 1.18 (0.75-1.86)	39 (24%) 1.48 (0.98-2.22)	28 (34%) 1.22 (0.76-1.97)
Single self-report item	Difficulty or unable to grip with hands	24 (17%) **1.93 (1.16-3.22)**	33 (21%) **1.73 (1.11-2.70)**	24 (30%) 1.51 (0.93-2.46)
Exhaustion				
	Reporting low energy	85 (62%) **2.32 (1.60-3.38)**	81 (50%) 1.04 (0.74-1.46)	56 (67%) 1.56 (0.98-2.49)
Fried frailty phenotype				
	Pre-Frail	81 (59%) **1.85 (1.19-2.89)**	94 (58%) 1.36 (0.91-2.01)	37 (45%) **2.64 (1.11-6.28)**
	Frail	26 (19%) **6.19 (3.29-11.65)**	27 (17%) **2.06 (1.18-3.59)**	40 (48%) **7.60 (3.15-18.31)**
OR: Odds ratio; HR: Hazard ratio; Bold indicates p<0.05; OR and HR are age-adjusted				

Table 3. Discriminative ability of models with up to 3 self-reported frailty components compared with Fried frailty phenotype for incident disability over a 3-year follow-up period in a cohort of 1,198 British men aged 71-92 years

	Incident Disability		
	ROC-AUC (95% CI)	p-value ΔAUC[*]	IDI (p-value[†])
Fried frailty phenotype	0.63 (0.59-0.68)	NA	NA
Self-reported single-variable models			
Slow walking speed	0.61 (0.57-0.65)	**0.44**	NA
Exhaustion	0.61 (0.57-0.66)	**0.25**	NA
Physically inactive	0.59 (0.56-0.64)	**0.09**	NA
Low grip strength	0.54 (0.51-0.58)	<0.001	NA
Weight loss	0.54 (0.50-0.57)	<0.001	NA
Self-reported 2-Variable Models			
Model A Slow walking speed (ref) + Physically inactive	0.65 (0.60-0.69)	0.45	**0.01 (0.03)**
Model B Slow walking speed (ref) + Exhaustion	0.66 (0.62-0.71)	0.12	**0.01 (0.02)**
Model C Physically inactive (ref) + Exhaustion	0.64 (0.59-0.69)	0.58	**0.01 (0.001)**
Self-reported 3-Variable Models			
Model D Model A (ref) + Exhaustion	0.68 (0.63-0.72)	**0.01**	**0.01 (0.03)**

[*]Pairwise comparison of ROC-AUC of each model and the one obtained by the Fried frailty phenotype

[†]p-value of reclassification improvement over the reference category

Bold indicates comparable or significantly increased discriminatory ability compared with the Fried frailty phenotype; Shaded cells indicate the selected model

ROC-AUC: Receiver operating characteristics-area under the curve; IDI: Integrated Discrimination Improvement; NA: Not applicable

Table 4. Discriminative ability of models with up to 3 self-reported Fried frailty components compared with Fried frailty phenotype and the FRAIL scale for incident falls over a 3-year follow-up period in a cohort of 1,198 British men aged 71-92 years

	Incident Falls			
	ROC-AUC (95% CI)	p-value ΔAUC[*]	p-value ΔAUC[†]	IDI (p-value[‡])
Fried frailty phenotype	0.57 (0.53-0.61)	NA	NA	NA
FRAIL Scale	0.56 (0.52-0.61)	NA	NA	NA
Self-reported single-variable models				
Slow walking speed	0.58 (0.55-0.62)	**0.40**	**0.28**	NA
Physically inactive	0.57 (0.53-0.61)	**0.96**	**0.70**	NA
Low grip strength	0.54 (0.51-0.58)	**0.25**	**0.40**	NA
Weight loss	0.55 (0.52-0.59)	**0.61**	**0.74**	NA
Exhaustion	0.52 (0.47-0.56)	0.004	0.001	NA
Self-reported 2-variable models				
Model A Slow walking speed (ref) + Physically inactive	0.61 (0.56-0.65)	**0.04**	**0.04**	0.002 (0.32)
Model B Slow walking speed (ref) + Weight loss	0.62 (0.57-0.66)	**0.04**	**0.03**	0.006 (0.08)
Model C Slow walking speed (ref) + Low grip strength	0.60 (0.56-0.64)	0.14	0.09	**0.005 (0.05)**
Model D Physically Inactive (ref) + Weight loss	0.60 (0.56-0.65)	0.14	0.08	**0.007 (0.03)**
Model E Physically Inactive (ref) + Low grip strength	0.59 (0.54-0.63)	0.43	0.28	**0.005 (0.04)**
Model F Weight loss (ref) + Low grip strength	0.59 (0.55-0.63)	0.38	0.24	0.006 (0.06)
Self-reported 3-Variable Models				
Model G Model A (ref) + Weight loss	0.64 (0.59-0.68)	**<.001**	**0.001**	0.005 (0.09)
Model H Model A (ref) + Low grip strength	0.62 (0.57-0.66)	**0.01**	**0.01**	**0.004 (0.05)**
Model I Model D (ref) + Low grip strength	0.62 (0.58-0.66)	**0.02**	**0.01**	0.004 (0.09)

[*]Pairwise comparison of ROC-AUC of each model and the one obtained by the Fried frailty phenotype

† Pairwise comparison of ROC-AUC of each model and the one obtained by the FRAIL scale

‡p-value of reclassification improvement over the reference category

Bold indicates comparable or significantly increased discriminatory ability compared with the Fried frailty phenotype; Shaded cells indicate the selected model

ROC-AUC: Receiver operating characteristics-area under the curve; IDI: Integrated Discrimination Improvement; NA: Not applicable