CLINICAL INVESTIGATION

Assessing Risk for Adverse Outcomes in Older Adults: The Need to Include Both Physical Frailty and Cognition

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BACKGROUND: Physical frailty is a powerful tool for identifying nondisabled individuals at high risk of adverse outcomes. The extent to which cognitive impairment in those without dementia adds value to physical frailty in detecting high-risk individuals remains unclear.

OBJECTIVES: To estimate the effects of combining physical frailty and cognitive impairment without dementia (CIND) on the risk of basic activities of daily living (ADL) dependence and death over 8 years.

DESIGN: Prospective cohort study.

SETTING: The Health and Retirement Study (HRS).

PARTICIPANTS: A total of 7338 community-dwelling people, 65 years or older, without dementia and ADL dependence at baseline (2006-2008). Follow-up assessments occurred every 2 years until 2014.

MEASUREMENTS: The five components of the Cardiovascular Health Study defined physical frailty. A well-validated HRS method, including verbal recall, series of subtractions, and backward count task, assessed cognition. Primary outcomes were time to ADL dependence and death. Hazard models, considering death as a competing risk, associated physical frailty and CIND with outcomes after adjusting for sociodemographics, comorbidities, depression, and smoking status.

RESULTS: The prevalence of physical frailty was 15%; CIND, 19%; and both deficits, 5%. In unadjusted and adjusted analyses, combining these factors identified older adults at an escalating risk for ADL dependence (no deficit = 14% [reference group]; only CIND = 26%, sub–hazard ratio [sHR] = 1.5, 95% confidence interval [CI] = 1.3–1.8; only frail = 33%, sHR = 1.7, 95% CI = 1.4–2.0; both deficits = 46%, sHR = 2.0, 95%CI = 1.6–2.6) and death (no deficit = 21%; only CIND = 41%, HR = 1.6, 95% CI = 1.4–1.9; only frail = 56%, HR = 2.2, 95% CI = 1.7–2.7; both deficits = 66%, HR = 2.6, 95% CI = 2.0–3.3) over 8-year follow-up. Adding the cognitive measure to models that already included physical frailty alone increased accuracy in identifying those at higher risk of ADL dependence (Harrell's concordance [C], 0.74 vs 0.71; $P < .001$) and death (Harrell's C, 0.70 vs 0.67; $P < .001$).

CONCLUSION: Physical frailty and CIND are independent predictors of incident disability and death. Because together physical frailty and CIND identify vulnerable older adults better, optimal risk assessment should supplement measures of physical frailty with measures of cognitive function. **J Am Geriatr Soc 00:1–7, 2018.**

Key words: cognitive frailty; disability; mortality; community-dwelling older people; interaction

Frailty is a common and feared geriatric syndrome that affects approximately 15% of older adults in the United States.[1] This syndrome is described as depletion of physiologic reserve and inability to cope with stressors that, in turn, increase the vulnerability to several adverse outcomes (ie, institutionalization, disability, and mortality).[2] Many conceptualizations of frailty have focused on the physical domain of this syndrome[3] (eg, the well-known frailty phenotype with five components [weight loss, exhaustion, weakness, slowness while walking, and low

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levels of activity] defined by Fried et al).[2] The frailty phenotype has been proved to be an excellent measure of vulnerability because it identifies currently nondisabled older adults who are at high risk of developing basic activities of daily living (ADL) disabilities.[2,4]

However, some recent studies have explored the role of cognitive impairment without dementia (CIND) in the frailty framework.[5–13] CIND delineates a broader definition of cognitive decline that encompasses individuals without any significant functional disability who meet the criteria for mild cognitive impairment (MCI) as well as others who are cognitively impaired but do not meet all the criteria for MCI.[14–18] This condition affects approximately 19% of older Americans.[17] Although CIND differs from dementia because it is potentially reversible, it is also associated with high-risk adverse outcomes (ie, ADL dependence and mortality).[19,20] Like the components of physical frailty, CIND captures an element of vulnerability that is often present in older persons who are not yet disabled but may make them vulnerable to developing disability in the presence of stressors.[20]

Owing to the potential impact on the population and healthcare systems, the interest in disentangling whether physical frailty and CIND act synergistically in the path toward adverse outcomes in older people is increasing.[3,9,11] Some have suggested that if the frailty syndrome is a vulnerability state in a stress setting (marked by decreased reserve), then a reduced cognitive reserve should confer a risk beyond that identified by a decreased physical reserve.[8,11,12] This has led investigators to include cognitive elements of risk in some frailty instruments.[21,22]

Previous studies have suggested there may be a cumulative impact of frailty and CIND in predicting poor outcomes in older adults, although these studies have had limitations, such as nonrepresentative samples or limited follow-up times.[10–13,23] Furthermore, the extent to which CIND adds prognostic value to physical frailty in identifying nondisabled individuals who are at increased risk for adverse outcomes remains unclear. In addition, studies that investigated the interactions between CIND and physical frailty are extremely limited.[5] Therefore, this study explored previously validated operational definitions of physical frailty and CIND in the Health and Retirement Study (HRS),[16,24,25] a representative sample of older Americans, to estimate the interactions and impact of combining these two geriatric conditions on adverse health outcomes, such as incident disability and mortality, among independent older adults.

METHODS

Design, Setting, and Participants

We used data from the HRS, an ongoing nationally representative cohort of US adults older than 50 years.[24,26] Participants were interviewed by telephone or in person every 2 years about a wide range of information on health, social, and economic circumstances. The HRS is sponsored by the National Institute on Aging and conducted by the University of Michigan. The Health Sciences Institutional Review Board at the University of Michigan approved the HRS data collection. This study was approved by the University of California, San Francisco, Committee on Human Research.

This study comprised independent community-dwelling individuals, 65 years and older, without dementia and ADL dependence at baseline. Since 2004, HRS participants are eligible to participate in enhanced face-to-face interviews if they live in the community and are self-respondents. We combined the 2006 and 2008 waves as the baseline because physical performance measures necessary in this study are collected during enhanced face-to-face interviews, administered to half of the HRS sample every other wave. A total of 8665 participants were eligible for this study. We excluded individuals with missing self-report information (n = 89) or sampling weights (n = 70) at baseline, those who refused to participate in the enhanced interview (n = 497), and those who did not complete the physical measures because of technical difficulties (n = 671), which included unavailable space for the walk or problems with equipment and supplies. Therefore, the final sample consisted of 7338 participants (Supplementary Figure S1).

Operationalization of Physical Frailty and Cognitive Impairment

Physical frailty was assessed according to the five frailty phenotype criteria originally constructed in the Cardiovascular Health Study (CHS).[2] We applied a validated method for using the same five criteria in the HRS.[25] Individuals who met three or more components were classified as physically frail.[2] The presence of each component was defined as follows: (1) unintentional weight loss of 10% or greater in the previous 2 years or body mass index of less than 18.5 kg/m^2; (2) exhaustion, stated by answers "moderate amount of the time" or "most of the time" in the past week for either of these statements: (a) "I felt that everything I did was an effort" and (b) "I could not get going"; (3) muscle weakness measured by grip strength using the CHS cutoff values; (4) slowness while walking, established by gait speed over an 8-ft distance using the CHS cutoff values; and (5) low levels of activity, determined as the lowest 20% (stratified by sex), according to a scale that was calculated on the basis of the intensity (mild, moderate, and vigorous) and frequency of activities performed in daily life.[27]

Cognition was evaluated using an approach for HRS self-respondents.[16,17] The method includes the following cognitive tests: (1) immediate and delayed recall of 10 common nouns, (2) serial subtractions by 7, and (3) a backward count task from 20. The sum of the scores of the three tests results in a 27-point scale, with higher scores indicating better cognitive functioning. This method was validated against an HRS substudy of Alzheimer disease and dementia that used an extended neuropsychological assessment as well as expert clinician adjudication to obtain gold standard diagnoses of normal cognition, CIND, and dementia. In the validation study, the 27-point scale classified individuals as normal cognition (scores, 12–27) and CIND (scores, 7–11). Scores lower than 7 indicated dementia, and these individuals were, therefore, excluded from the present study.[16,18] This method has been used to track national trends on cognitive impairment and dementia in the United States.[17,28]

After classifying older adults according to their physical frailty and cognitive status, participants were also categorized into four groups: (1) no deficit, cognitively normal and nonphysically frail; (2) only cognitively impaired;

Table 1. Baseline Characteristics of the Participants According to Physical Frailty and Cognitive Status[a]

Characteristics	Total (N = 7338)	Not Physically Frail		Physically Frail		*P* Value[b]
		Cognitively Normal (N = 5192)	Cognitively Impaired (N = 1073)	Cognitively Normal (N = 676)	Cognitively Impaired (N = 397)	
Demographics						
Age, mean (SD), y	74.4 (7.0)	73.2 (6.4)	76.4 (7.3)	77.8 (7.6)	79.7 (7.4)	<.001
Women, No. (%)	4098 (54.9)	2853 (53.5)	574 (52.9)	431 (63.8)	240 (62.5)	<.001
Ethnicity, No. (%)						<.001
White	5953 (87.3)	4449 (90.5)	709 (76.6)	554 (88.8)	241 (71.0)	
African American	785 (6.2)	411 (4.4)	228 (12.9)	62 (5.1)	84 (14.3)	
Hispanic	476 (4.6)	255 (3.4)	115 (8.1)	48 (4.8)	58 (11.1)	
Other	124 (1.8)	77 (1.6)	21 (2.5)	12 (1.3)	14 (3.7)	
Married, No. (%)	4576 (59.4)	3483 (64.5)	602 (52.6)	318 (42.5)	173 (40.4)	<.001
Socioeconomic status						
Education less than high school, No. (%)	1487 (18.9)	705 (12.7)	434 (37.5)	159 (22.6)	189 (45.5)	<.001
Net worth (in $1000), median (IQR)	274 (86–637)	341 (124–756)	172 (40–434)	155 (34–419)	71 (5–258)	<.001
Comorbidities, No. (%)						
Stroke	590 (8.3)	338 (6.6)	112 (10.9)	85 (13.5)	55 (14.4)	<.001
Hypertension	4477 (59.7)	3043 (57.2)	670 (60.8)	466 (67.9)	298 (74.7)	<.001
Diabetes	1482 (19.3)	901 (16.7)	245 (21.7)	207 (28.4)	129 (31.8)	<.001
Cancer	1371 (18.9)	946 (18.4)	176 (16.8)	159 (23.3)	90 (23.0)	0.004
Lung disease	741 (10.2)	456 (8.6)	102 (9.8)	124 (19.4)	59 (16.2)	<.001
Heart disease	2100 (29.4)	1,347 (26.2)	307 (30.3)	285 (42.9)	161 (45.1)	<.001
Depression	1268 (17.6)	595 (11.6)	177 (16.7)	287 (44.2)	209 (52.7)	<.001
Behavior measure, No. (%)						
Current smoker	701 (9.7)	456 (9.0)	111 (10.3)	89 (14.2)	45 (9.9)	0.002

[a]Continuous variables with normal distribution are presented as mean (SD); nonnormal variables are reported as median (IQR); categorical variables are expressed as count (frequency).

[b]Comparisons investigated differences among the four groups that resulted from the combination of physical frailty and cognitive status. For continuous variables, we used the one-way analysis of variance (normal distribution) or the Kruskal-Wallis test (nonnormal distribution); and for categorical variables, we used the χ^2 test.

Abbreviation: IQR, interquartile range.

(3) only physically frail; and (4) cognitively impaired and physically frail.

Outcome Measurements

The primary outcomes were time to experiencing incident ADL dependence and time to death. Participants' need for ADL help was assessed during follow-up waves every 2 years. Participants were classified as having incident ADL dependence if they reported needing help in any of these six daily activities: eating, transferring, walking across the room, dressing, toileting, and bathing. Because the exact date of incident ADL disability was unavailable, we considered the date of event as the median time between two waves. Information about death was obtained by combining data from the National Death Index, Medicare files, and HRS surviving family member exit interviews. This method allowed us to determine the exact date of death. Those participants who did not develop disability or die by the 2014 wave were censored.

Covariates

We reviewed the literature to select a priori possible confounders.[2,8–11] Sociodemographic characteristics, including age, sex, ethnicity (white, African American, Hispanic, or other), education (less vs more than high school), net worth (total household assets minus current debt), and marital status (married or unmarried), were assessed as reported by the

Table 2. Association Between Physical Frailty and Cognitive Impairment With Incident Disability and Mortality (n = 7338)

Variable	Incident ADL Dependence[a]		Mortality[b]	
	Unadjusted	Adjusted[c]	Unadjusted	Adjusted[c]
Physical frailty				
Nonfrail	Reference	Reference	Reference	Reference
Frail	2.8 (2.4–3.1)	1.5 (1.3–1.8)	3.5 (3.0–4.0)	1.9 (1.6–2.3)
Cognitive status				
Normal	Reference	Reference	Reference	Reference
Impaired	2.1 (1.9–2.5)	1.4 (1.2–1.6)	2.2 (2.0–2.5)	1.4 (1.2–1.7)

[a]For incident ADL dependence, data are given as sub–hazard ratio (95% confidence interval); estimates were calculated using the Fine and Gray[31] method, which considered the competing risk of death.

[b]For mortality, data are given as hazard ratio (95% confidence interval); estimates were calculated using Cox proportional hazard models.

[c]Adjusted models included age, sex, ethnicity, education, net worth, marital status, comorbidities (stroke, hypertension, diabetes, cancer, lung disease, heart disease, and depression), and smoking status.

Abbreviation: ADL, activities of daily living (ie, eating, transferring, walking across the room, dressing, toileting, and bathing).

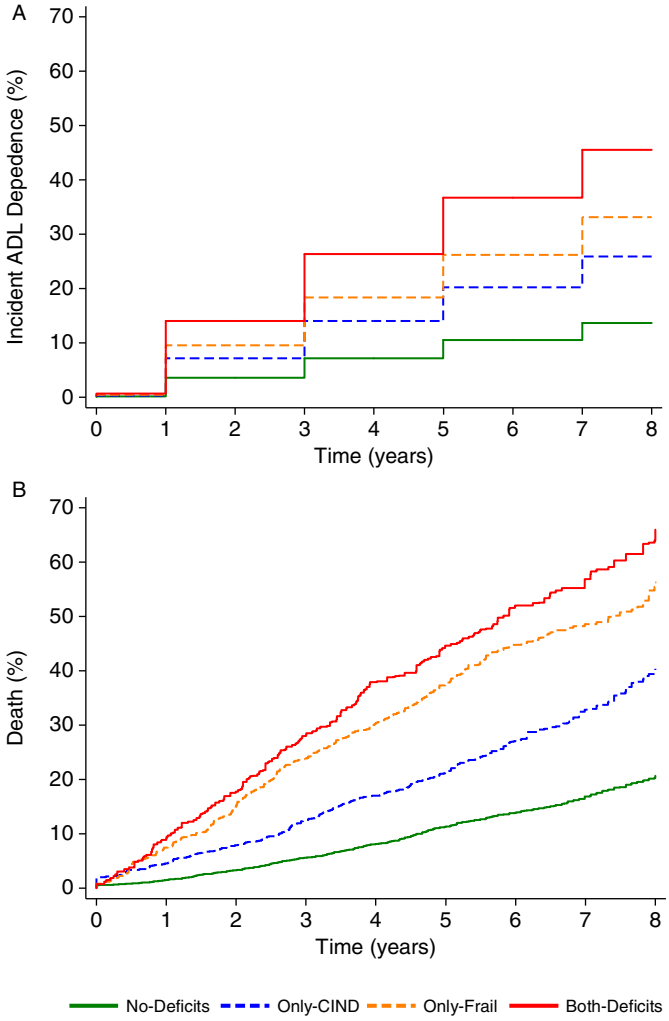

Figure 1. Cumulative incidence of incident activities of daily living (ADL) dependence (A) and death (B) by combining physical frailty and cognitive impairment at baseline (n = 7338). For ADL dependence, the curves were computed using the Fine and Gray[31] method, which considered the competing risk of death. For mortality, the curves were computed using the Kaplan-Meier estimates. ADL include eating, transferring, walking across the room, dressing, toileting, and bathing. CIND indicates cognitive impairment without dementia.

participants. Comorbidities (stroke, hypertension, diabetes, cancer, chronic lung disease, and heart disease) were evaluated by asking participants if a physician had ever told them that they had the disease. Previous work with the HRS has indicated that these conditions are strong predictors of mortality.[29] Depression was defined by the presence of three or more symptomatic items in an eight-item version of the Center for Epidemiologic Studies Depression Scale.[30] The smoking status was classified as current smokers and not current smokers.

Statistical Analysis

We used sampling weights provided by the HRS to account for the unequal probability of participant selection and complex survey design. Descriptive statistics described the baseline characteristics of participants according to the presence of physical frailty and CIND.

To investigate the association of physical frailty and CIND with time to incident ADL dependence, we fit unadjusted and adjusted competing risk hazard models by Fine and Gray, considering death as a competing risk.[31,32] The adjusted analysis included sociodemographic factors, comorbidities, depression, and smoking status. We tested for interaction of physical frailty and CIND with time to ADL dependence, considering $P < .05$ as significant. Finally, we fit competing risk hazard models by Fine and Gray for ADL dependence considering as predictor the four stratified subgroups that resulted from the combination of physical frailty and cognitive status. We used cumulative incidence function to compute the unadjusted probability of developing ADL dependence for these four subgroups.

To investigate the association of physical frailty and CIND with time to death, we fit unadjusted and adjusted Cox proportional hazard models. We also tested for interaction of physical frailty and CIND with time to death. Last, we fit Cox proportional hazard models examining as predictor the four stratified subgroups that resulted from the combination of physical frailty and cognitive status. Kaplan-Meier curves illustrated the differences in survival among these four subgroups.

To estimate whether adding the cognitive measure to a model that already incorporated physical frailty would improve the accuracy of the model to identify participants who are vulnerable from those who are not, we used the Harrell's concordance (C) statistic. This method measures the ability of survival models to assign a higher risk to individuals with short time to the event.[33] We tested the null hypothesis that the Harrell's C statistic was equal for the models with and without cognitive measure.[34] To examine the robustness of our findings, we also computed the continuous net reclassification index (NRI) and the integrated discrimination improvement (IDI).[35] NRI estimates the impact of a new variable to reclassify the participants correctly (ie, those with the event to higher risk and those without the event to lower risk). The IDI compares the discrimination slopes of the models with and without the new variable.[35–37]

Schoenfeld residual analyses confirmed that the proportional assumption of the survival models was met. Statistical analyses were conducted using Stata software, version 15 (StataCorp, College Station, TX).

RESULTS

The baseline participants' characteristics are shown in Table 1. The prevalence of physical frailty was 15%; CIND, 19%; and both deficits, 5%, after applying the HRS sampling weights to represent the US older population (Table 1). Older adults who were physically frail at baseline were more likely to have CIND compared with those who were nonphysically frail (frail vs nonphysically frail = 36% vs 17%; $P < .001$). Physical frailty status and/or CIND at baseline were associated with older age, lower educational level and wealth, and more comorbidities (Table 1). During a median follow-up of 6.7 years, the cumulative incidence of ADL dependence was 23% and that of death was 29%. Both physical frailty and cognitive status were independently associated with incident ADL dependence and mortality (Table 2). After adjusting for confounders, physically

Table 3. The Combined Effects of Physical Frailty and Cognitive Impairment on Incident Disability and Mortality (n = 7338)

Variable	Incident ADL Dependence[a]		Mortality[b]	
	Unadjusted	Adjusted[c]	Unadjusted	Adjusted[c]
Not frail, cognitively normal	Reference	Reference	Reference	Reference
Not frail, cognitively impaired	2.0 (1.8–2.4)	1.5 (1.3–1.8)	2.2 (1.9–2.5)	1.6 (1.4–1.9)
Frail, cognitively normal	2.7 (2.3–3.2)	1.7 (1.4–2.0)	3.8 (3.2–4.5)	2.2 (1.7–2.7)
Frail, cognitively impaired	4.1 (3.3–5.1)	2.0 (1.6–2.6)	4.8 (3.8–5.9)	2.6 (2.0–3.3)

[a]For incident ADL dependence, data are given as sub–hazard ratio (95% confidence interval); estimates were calculated using the Fine and Gray[31] method, which considered the competing risk of death.
[b]For mortality, data are given as hazard ratio (95% confidence interval); estimates were calculated using Cox proportional hazard models.
[c]Adjusted models included age, sex, ethnicity, education, net worth, marital status, comorbidities (stroke, hypertension, diabetes, cancer, lung disease, heart disease, and depression), and smoking status.
Abbreviation: ADL, activities of daily living (ie, eating, transferring, walking across the room, dressing, toileting, and bathing).

Table 4. Impact of Adding a Cognitive Measure to Physical Frailty on Adverse Outcome Discrimination (n = 7338)[a]

Outcomes	Harrell's C (95% CI)			Continuous NRI				IDI	
	Model 1: Only Physical Frailty	Model 2: Physical Frailty + Cognition	*P* Value[b]	For Events	For Nonevents	Total (95% CI)	*P* Value[c]	Absolute IDI (95% CI)	*P* Value[c]
Incident ADL dependence	0.71 (0.69–0.73)	0.74 (0.73–0.76)	<.001	0.09	0.18	0.27 (0.21–0.34)	<.001	0.013 (0.010–0.017)	<.001
Mortality	0.67 (0.66–0.69)	0.70 (0.69–0.71)	<.001	0.14	0.17	0.31 (0.25–0.36)	<.001	0.018 (0.015–0.021)	<.001

[a]Physical frailty (score, 0–5) represented the five components of the physical frailty phenotype, and the cognitive measure (score, 7–27) comprehended a well-validated Health and Retirement Study approach to evaluate cognition (scores of <7 are consistent with dementia, and these individuals were, therefore, excluded).
[b]*P* value compares Harrell's C statistic of the survival models with and without cognitive measure.
[c]*P* values of continuous NRI and IDI analyses.
Abbreviations: ADL, activities of daily living (ie, eating, transferring, walking across the room, toileting, dressing, and bathing); CI, confidence interval; IDI, integrated discrimination improvement; NRI, net reclassification index.

frail participants presented higher risk of incident ADL dependence (sub–hazard ratio [sHR] = 1.5; 95% confidence interval [CI] = 1.3–1.8) and death (HR = 1.9; 95% CI = 1.6–2.3) compared with those who were nonfrail. In addition, older adults with CIND had an approximately 1.5 times increase in the risk of incident ADL dependence (sHR = 1.4; 95% CI = 1.2–1.6) and death (HR = 1.4; 95% CI = 1.2–1.7) compared with those who were cognitively normal (Table 2). We found a significant interaction between physical frailty and CIND in the model for mortality (HR = 0.74; 95% CI = 0.56–0.97), suggesting that CIND may be a stronger predictor of mortality in those without physical frailty than those with physical frailty. There was no significant interaction between these factors for incident ADL dependence (sHR = 0.81; 95% CI = 0.62–1.05).

In the stratified analysis, the combination of physical frailty and CIND identified older adults at an escalating cumulative incidence of ADL dependence (no deficit = 14%, only CIND = 26%, only frail = 33%, both deficits = 46%; $P < .001$) and death (no deficit = 21%, only CIND = 41%, only frail = 56%, both deficits = 66%; $P < .001$) over 8 years of follow-up. Figure 1 illustrates the increasing cumulative incidence of ADL dependence and death, according to the presence of physical frailty and CIND at baseline. After adjusting for confounders, individuals who were physically frail and cognitively impaired presented the highest risk of incident ADL dependence (sHR = 2.0; 95% CI = 1.6–2.6) and mortality (HR = 2.6; 95% CI = 2.0–3.3) when compared with those who were neither frail nor cognitively impaired (Table 3).

Table 4 shows that adding the cognitive measure to models that already included physical frailty alone increased accuracy in identifying those older adults at higher risk of incident ADL dependence (Harrell's C, 0.74 vs 0.71; $P < .001$) and death (Harrell's C, 0.70 vs 0.67; $P < .001$). The NRI and IDI results also confirmed the positive impact of adding the cognitive measure to physical frailty on outcome discrimination (Table 4).

DISCUSSION

In this study, we estimated the value of including both physical and cognitive elements of vulnerability in risk assessment among older adults. Our findings, in a nationally representative sample of community-dwelling older Americans who were independent at baseline, showed that the combination of physical frailty with CIND identifies the escalating risk of adverse outcomes more accurately than either factor alone. Adding the cognitive measure to models that include physical frailty alone resulted in a statistically and clinically significant increase in recognizing the risk of incident disability and death. The results remained robust even after adjusting for multiple confounders, such as

sociodemographic factors, comorbidities, depression, and smoking status.

Despite the validity of the physical frailty phenotype, a growing body of evidence suggests that other domains (eg, cognitive, psychological, and social aspects) may influence the ability of older individuals to cope with stressors.[21,38,39] In our study, we showed that CIND is a core element of intrinsic vulnerability among older adults living independently in the community. When added to physical frailty, the cognitive status offered additional discriminatory power in differentiating older adults at risk of incident ADL disability and death. Our findings indicate that any effort to detect frailty in the older population should include cognitive evaluation. Adopting this strategy would identify the high percentage of nondisabled older persons with CIND and without physical frailty as vulnerable.[9]

Previous studies have proposed incorporating cognitive impairment in frailty definitions,[8,9] including the well-known Frailty Index and the Tilburg Frailty Indicator.[21,22] However, before this study, little was known on how physical and cognitive functions interact in the path toward adverse events.[11,38] Our study indicates that the effects of physical frailty and CIND are independent and exhibit a pattern of cumulative deficits. We found that physical frailty was associated with higher risk for mortality than CIND. We additionally found an interaction of these two risk factors for mortality. Nevertheless, this finding should be interpreted with caution because the high incidence of death (21%) in the reference group (individuals without both deficits) may have led us to overestimate the significance of this finding in our study. A previous work combining the effects of the Frailty Index and cognitive impairment on mortality did not observe significant interactions between physical and cognitive deficits.[11]

The simultaneous occurrence of both physical frailty and cognitive impairment, in the absence of underlying neurological diseases, has been labeled as "cognitive frailty" by an international consensus of experts.[3,5,40] Previous evidence supports this concept, proposing that physical and cognitive deficits may share a common pathologic basis and that their combination predicts poor outcomes.[10,41–43] In our study, physical frailty associated with cognitive impairment at baseline. Furthermore, we showed that individuals who are both physically frail and cognitively impaired represent 5% of the older population and exhibit a remarkably high vulnerability to adverse outcomes. However, our results also indicate that the cognitive impairment is at least as important in those individuals without physical frailty. Therefore, risk assessment of adverse outcomes for older adults should be extended to account not only for physical frailty but also for CIND and their combination (ie, cognitive frailty).

This study involving older adults still living independently in the community has significant implications for public health. The incidence of adverse outcomes associated with physical frailty and CIND was high and provides a compelling rationale to identify these risk factors early before major adverse events, such as ADL disability, occur. Our results also delineate a target population composed of vulnerable older individuals who can benefit from potential interventions for physical frailty and cognitive impairment, such as healthy dietary habits (eg, the Mediterranean diet), supervised exercise programs, physical therapy, enhanced social support services, and access to primary care. Moreover, our findings help providers to identify new opportunities to slow progression to frailty through interventions designed explicitly for CIND (eg, control cardiovascular risk factors, cognitive training, and socially engaging activities).[38,42]

Some limitations should be noted in our approach. First, the exhaustion item, which is a component of both the depression scale and frailty construct, may have introduced bias to our estimates. However, a sensitivity analysis excluding depression from the models did not change the results. Second, some eligible individuals without physical measures were not included in the study. Nonetheless, we performed all analyses using sampling weights provided by the HRS to account for unequal selection probabilities. Strengths of our study are also notable. We used a longitudinal nationally representative sample of older adults living independently in the community to estimate the predictive power of physical frailty and CIND in currently nondisabled individuals. Participants were followed up for up to 8 years with minimum attrition. Furthermore, we performed robust analyses that considered death as a competing risk and that were adjusted for many confounders.

In conclusion, our findings indicate that physical frailty and CIND are independent predictors of incident disability and death. Together, these factors identify those independent older adults who are vulnerable to adverse health outcomes better than physical frailty alone. Risk assessment among older adults should include both physical frailty and cognitive function. Further research is still needed to understand the underlying mechanisms linking physical and cognitive functions and their impact on aging.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Figure S1. Flowchart of the study participants.