

Impairment of activities of daily living and incident heart failure in community-dwelling older adults

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Aims

Instrumental activities of daily living (IADLs) are tasks that are necessary for independent community living. These tasks often require intact physical and cognitive function, the impairment of which may adversely affect health in older adults. In the current study, we examined the association between IADL impairment and incident heart failure (HF) in community-dwelling older adults.

Methods and results

Of the 5795 community-dwelling adults, aged ≥ 65 years, in the Cardiovascular Health Study, 5511 had data on baseline IADL and were free of prevalent HF. Of these, 1333 (24%) had baseline IADL impairment, defined as self-reported difficulty with one or more of the following tasks: using the telephone, preparing food, performing light and heavy housework, managing finances, and shopping. Propensity scores for IADL impairment, estimated for each of the 5511 participants, were used to assemble a cohort of 1038 pairs of participants with and without IADL impairment who were balanced on 42 baseline characteristics. Centrally adjudicated incident HF occurred in 26% and 21% of matched participants with and without IADL impairment, respectively, during > 12 years of follow-up [matched hazard ratio (HR) 1.33; 95% confidence interval (CI) 1.11–1.59; $P = 0.002$]. Unadjusted and multivariable-adjusted HRs for incident HF before matching were 1.77 (95% CI 1.56–2.01; $P < 0.001$) and 1.33 (95% CI 1.15–1.54; $P < 0.001$), respectively. IADL impairment was also associated with all-cause mortality (matched HR 1.19; 95% CI 1.06–1.34; $P = 0.004$).

Conclusion

Among community-dwelling older adults free of baseline HF, IADL impairment is a strong and independent predictor of incident HF and mortality.

Keywords

Instrumental activities of daily living • Incident heart failure • Propensity score

Introduction

Activities of daily living (ADLs) refer to physical and cognitive activities often necessary for functional independence. Basic ADLs involves ambulation and self-feeding, activities that are fundamental to independent living within one's own residence, and their impairment may indicate a more advanced level of disability. Instrumental ADLs or IADLs, on the other hand, involve activities that require a higher level of cognitive function, such as management

of money and shopping, and are necessary for a more independent living in the community. Impairments of IADLs may indicate an early decline in physical and cognitive functions, and may adversely affect health outcomes in older adults.^{1–5} Heart failure (HF) is common in older adults and is associated with poor outcomes.^{6–12} Because IADL impairment may adversely affect management of HF risk factors such as hypertension and diabetes, it is possible that older adults with IADL impairment will be at increased risk of incident HF. In the current study, we used a

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public-use copy of the Cardiovascular Health Study (CHS) data obtained from the National Heart, Lung, and Blood Institute (NHLBI) to examine if impairments in IADLs are associated with increased risk of incident HF in community-dwelling older adults.

Methods

Study design and participants

Funded by the NHLBI, the CHS is an epidemiological study of 5888 adults ≥ 65 years of age based in four US communities at Forsyth County, NC, Sacramento County, CA, Washington County, MD, and Pittsburgh, PA.¹³ The objective of the CHS was to understand risk factors for cardiovascular morbidity and mortality in older adults. Participants were recruited in two phases: an original cohort (1989–1990) of 5201 mostly white participants was supplemented by a second cohort (1992–1993) of 687 African American participants. Of the 5888 participants, 93 did not consent to be part of the public-use copy of the data, resulting in the final sample size of 5795 participants. Of these, 5511 had data on IADL impairment at baseline, and were also free of centrally adjudicated prevalent HF at baseline.¹⁴

Baseline instrumental activities of daily living

IADLs are defined as tasks that one must be able to perform for independent community living without assistance, supervision, or cues.¹ Individual IADL tasks such as shopping, managing finances, and house cleaning often require both physical and cognitive abilities. Baseline IADL status was determined using the Assessment of Physical Function Form and involved six domains: telephone use, shopping, preparing food, performing light household work, performing heavy household work, and managing finances.¹⁵ Impairment of IADLs was defined as the need for more than a minimal amount of effort to perform the task or if the task caused symptoms.

Incident heart failure and other outcomes

Our primary outcome was new-onset HF during > 12 years of mean follow-up. Incident HF was centrally adjudicated by the CHS Events Committee, and the process of adjudication has been previously described.^{16–18} Briefly, self-reports of physician-diagnosed HF during semi-annual visits were validated by medical record review for a constellation of symptoms, signs, and other supporting findings suggestive of HF, use of medications commonly used for HF, and follow-up surveillance assessments. Compared with the Framingham criteria for HF, the CHS central adjudication of HF is more stringent, and HF patients identified by both CHS and Framingham criteria have been shown to have similar all-cause mortality.¹⁹ Secondary outcomes included all-cause mortality, acute myocardial infarction, angina pectoris, stroke, and peripheral artery disease.

Assembly of a balanced study cohort

Because of the significant imbalances in baseline characteristics between those with and without IADL impairment (*Figure 1*, *Table 1*), we used propensity score matching to assemble a balanced cohort.^{20–22} The propensity score for IADL impairment for a participant is that individual's probability of having IADL impairment given his/her baseline characteristics. We used a non-parsimonious multivariable logistic regression model to estimate propensity scores for IADL impairment for each of the 5511 participants.^{17,23–25} In that model, IADL impairment was the dependent variable, and the 42 baseline characteristics (*Figure 1*) were used as covariates.^{26–28} Using a greedy matching protocol described elsewhere, we were able to match 1038 pairs of participants with and without IADL impairment who had similar propensity scores.

Statistical analysis

For descriptive analyses, Pearson's χ^2 and Wilcoxon rank-sum tests were used for the pre-match data. McNemar's test and paired sample t-test were used for post-match comparisons of means and proportions. Kaplan–Meier and Cox proportional hazard analyses

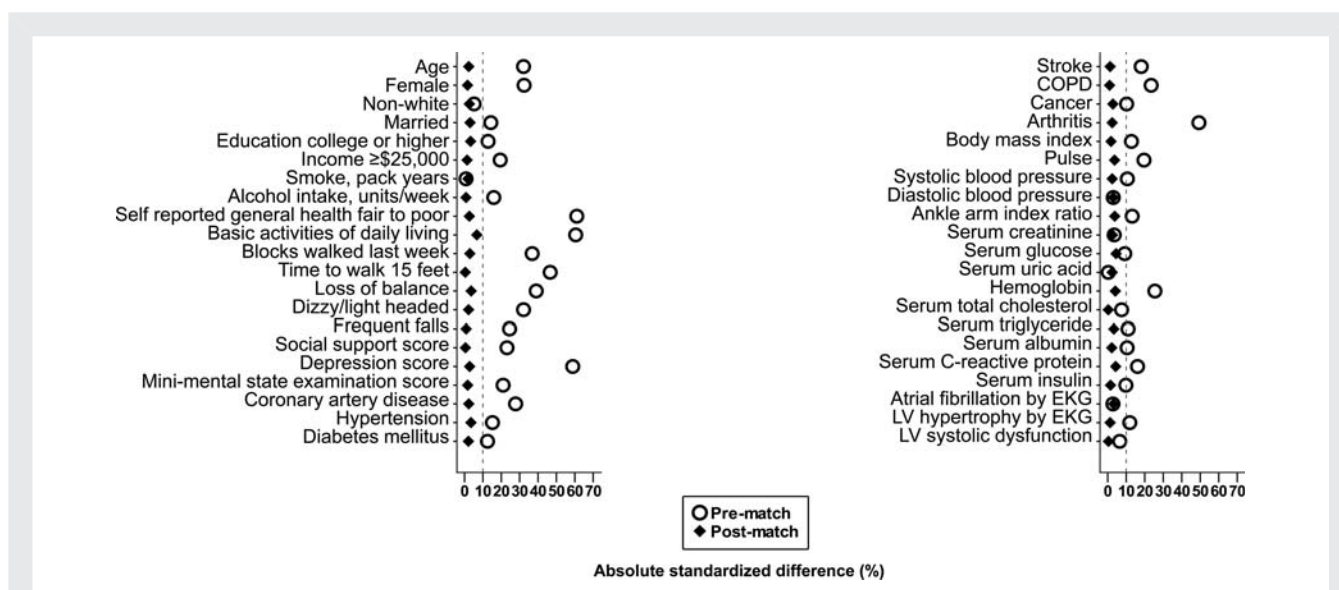


Figure 1 Absolute standardized differences of baseline characteristics of older adults in the Cardiovascular Health Study with and without baseline impairment of instrumental activities of daily living, before and after propensity score matching. COPD, chronic obstructive pulmonary disease; EKG, electrocardiography; LV, left ventricular.

Table 1 Baseline characteristics of Cardiovascular Health Study participants by impairment of instrumental activities of daily living (IADLs), before and after propensity score matching

n (%) or mean (± SD)	Pre-match			Post-match		
	IADL impairment		P-value	IADL impairment		P-value
	No (n = 4178)	Yes (n = 1333)		No (n = 1038)	Yes (n = 1038)	
Age, years	73 ± 5	75 ± 6	<0.001	74 ± 6	74 ± 6	0.598
Female	2256 (54%)	927 (70%)	<0.001	696 (67%)	688 (66%)	0.729
Non-white	644 (15%)	231 (17%)	0.096	168 (16%)	158 (15%)	0.589
Married	2846 (68%)	817 (61%)	<0.001	653 (63%)	668 (64%)	0.526
Education college or higher	1861 (45%)	510 (38%)	<0.001	415 (40%)	432 (42%)	0.479
Income ≥US\$25 000	1610 (39%)	392 (29%)	<0.001	340 (33%)	347 (33%)	0.773
Smoking, pack years	17 ± 26	17 ± 28	0.801	18 ± 28	17 ± 28	0.668
Alcohol intake, units/week	3 ± 7	2 ± 5	<0.001	2 ± 5	2 ± 6	0.861
Self-reported general health fair to poor	710 (17%)	585 (44%)	<0.001	386 (37%)	373 (36%)	0.529
Basic activities of daily living	0.03 ± 0.21	0.39 ± 0.82	<0.001	0.09 ± 0.40	0.12 ± 0.40	0.023
Blocks walked in last week	44 ± 58	25 ± 42	<0.001	30 ± 43	29 ± 44	0.491
Time to walk 15 feet, s	5 ± 2	7 ± 3	<0.001	6 ± 3	6 ± 2	0.919
Loss of balance	790 (19%)	480 (36%)	<0.001	326 (31%)	309 (30%)	0.424
Dizzy/light headed on standing	715 (17%)	408 (31%)	<0.001	281 (27%)	271 (26%)	0.643
Frequent falls	85 (2%)	95 (7%)	<0.001	48 (5%)	50 (5%)	0.915
Social support score	8 ± 3	9 ± 3	<0.001	9 ± 3	9 ± 3	0.899
Depression score	4 ± 4	7 ± 5	<0.001	6 ± 5	6 ± 5	0.466
Mini-mental state examination score, 30 points	28 ± 3	27 ± 3	<0.001	27 ± 3	27 ± 3	0.707
Medical history						
Coronary artery disease	616 (15%)	344 (26%)	<0.001	253 (24%)	243 (23%)	0.638
Hypertension	2361 (57%)	852 (64%)	<0.001	620 (60%)	638 (61%)	0.434
Diabetes mellitus	604 (14%)	255 (19%)	<0.001	171 (16%)	179 (17%)	0.672
Stroke	123 (3%)	91 (7%)	<0.001	55 (5%)	52 (5%)	0.844
Chronic obstructive pulmonary disease	436 (10%)	249 (19%)	<0.001	169 (16%)	173 (17%)	0.854
Cancer	564 (13%)	229 (17%)	<0.001	181 (17%)	170 (16%)	0.554
Arthritis	1893 (45%)	920 (69%)	<0.001	684 (66%)	672 (65%)	0.582
Clinical examination						
Body mass index, kg/m ²	26 ± 4	27 ± 4	<0.001	27 ± 4	27 ± 4	0.678
Pulse rate, b.p.m.	67 ± 11	70 ± 12	<0.001	69 ± 11	69 ± 11	0.387
Systolic blood pressure, mmHg	136 ± 22	138 ± 22	0.001	137 ± 21	138 ± 22	0.587
Diastolic blood pressure, mmHg	71 ± 11	71 ± 11	0.335	70 ± 12	71 ± 11	0.501
Ankle–arm index ratio, ≤0.9	478 (11%)	213 (16%)	<0.001	158 (15%)	144 (14%)	0.391
Laboratory values						
Serum creatinine, mg/dL	0.95 ± 0.35	0.97 ± 0.47	0.223	0.93 ± 0.28	0.94 ± 0.34	0.557
Serum glucose, mg/dL	110 ± 35	113 ± 40	0.003	111 ± 33	112 ± 39	0.306
Serum uric acid, mg/dL	5.7 ± 1.5	5.7 ± 1.7	0.922	6 ± 1	6 ± 2	0.568
Serum total cholesterol, mg/dL	211 ± 39	214 ± 40	0.016	213 ± 38	213 ± 40	0.952
Serum triglyceride, mg/dL	137 ± 73	146 ± 87	<0.001	141 ± 71	143 ± 79	0.455
Serum albumin, g/dL	4.00 ± 0.3	3.97 ± 0.3	0.001	3.98 ± 0.3	3.99 ± 0.3	0.620
Serum insulin, μU/mL	16 ± 22	19 ± 29	0.001	18 ± 29	18 ± 29	0.731
C-reactive protein, mg/dL	4 ± 8	6 ± 9	<0.001	5 ± 11	5 ± 8	0.330
Haemoglobin, g/dL	14.1 ± 1.3	13.8 ± 1.4	<0.001	13.8 ± 1.3	13.9 ± 1.3	0.342
Electrocardiographic findings						
Atrial fibrillation	83 (2%)	32 (2%)	0.357	28 (3%)	23 (2%)	0.568
Left ventricular hypertrophy	155 (4%)	84 (6%)	<0.001	57 (5%)	60 (6%)	0.851
Left ventricular systolic dysfunction	294 (7%)	117 (9%)	0.035	78 (8%)	79 (8%)	1.000

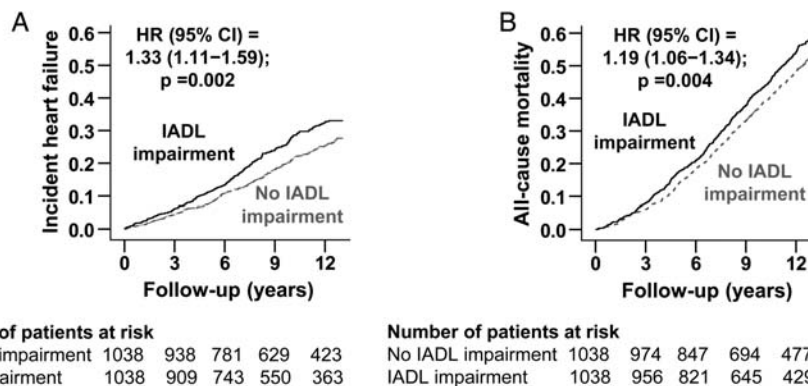


Figure 2 Kaplan–Meier plots for (A) incident heart failure and (B) all-cause mortality by baseline impairment of instrumental activities of daily living (IADLs) in a propensity-matched cohort of older adults in the Cardiovascular Health Study. CI, confidence interval; HR, hazard ratio.

Table 2 Association of impairment of instrumental activities of daily living (IADLs) with incident heart failure in the Cardiovascular Health Study

	Event (%)		Absolute risk difference (%)	HR (95% CI)	P-value
	No	Yes			
Pre-match					
	(n = 4178)	(n = 1333)			
Unadjusted	777 (19%)	359 (27%)	+8%	1.77 (1.56–2.01)	<0.001
Multivariable adjusted	–	–	–	1.33 (1.15–1.54)	<0.001
Propensity adjusted	–	–	–	1.30 (1.12–1.51)	0.001
Post-match					
	(n = 1038)	(n = 1038)			
Propensity matched	217 (21%)	267 (26%)	+5%	1.33 (1.11–1.59)	0.002

CI, confidence interval; HR, hazard ratio.

were used to estimate the associations of baseline IADL impairment with outcomes. To evaluate a dose–response relationship between baseline IADL impairment and outcomes, analyses were repeated categorizing IADL impairment as one impairment or two or more impairments. A formal sensitivity analysis was performed to quantify the degree of a hidden bias due to potential imbalance of an unmeasured covariate that would need to be present to invalidate our main conclusions.²⁹ Subgroup analyses were performed to determine homogeneity of the association of IADL impairment with incident HF. All statistical tests were two tailed with 95% confidence levels, and a P-value < 0.05 was considered significant. SPSS for Windows (Version 15) was used for all data analysis.

Results

Baseline characteristics

In the pre-matched cohort, 75% of participants reported no IADL impairments. Impairments of one, two, three, four, five, and six IADLs were reported by 18.6, 3.4, 1.3, 0.7, 0.1, and 0.1% of participants, respectively. Overall, matched participants had a mean age of 74 (± 6.0) years, 67% were women, and 16% were African

American. Imbalances in baseline characteristics before matching and balances achieved after matching between patients with and without IADL impairment are displayed in Table 1 and Figure 1. After matching, standardized differences for all measured covariates were <10%, suggesting substantial covariate balance across the groups (Figure 1).

Association of impairment of instrumental activities of daily living with incident heart failure and other outcomes

During > 12 years of follow-up, incident HF developed in 26% and 21% of matched participants with and without IADL impairment [hazard ratio (HR) associated with IADL impairment 1.33; 95% confidence interval (CI) 1.11–1.59; P = 0.002; Figure 2 and Table 2]. A hidden covariate that is a near-perfect predictor of incident HF would need to increase the odds of IADL impairment by > 13% before it could potentially explain away this association. The association between IADL impairment and incident HF was homogeneous across various subgroups of patients (Figure 3). Pre-match associations between IADL impairment and incident

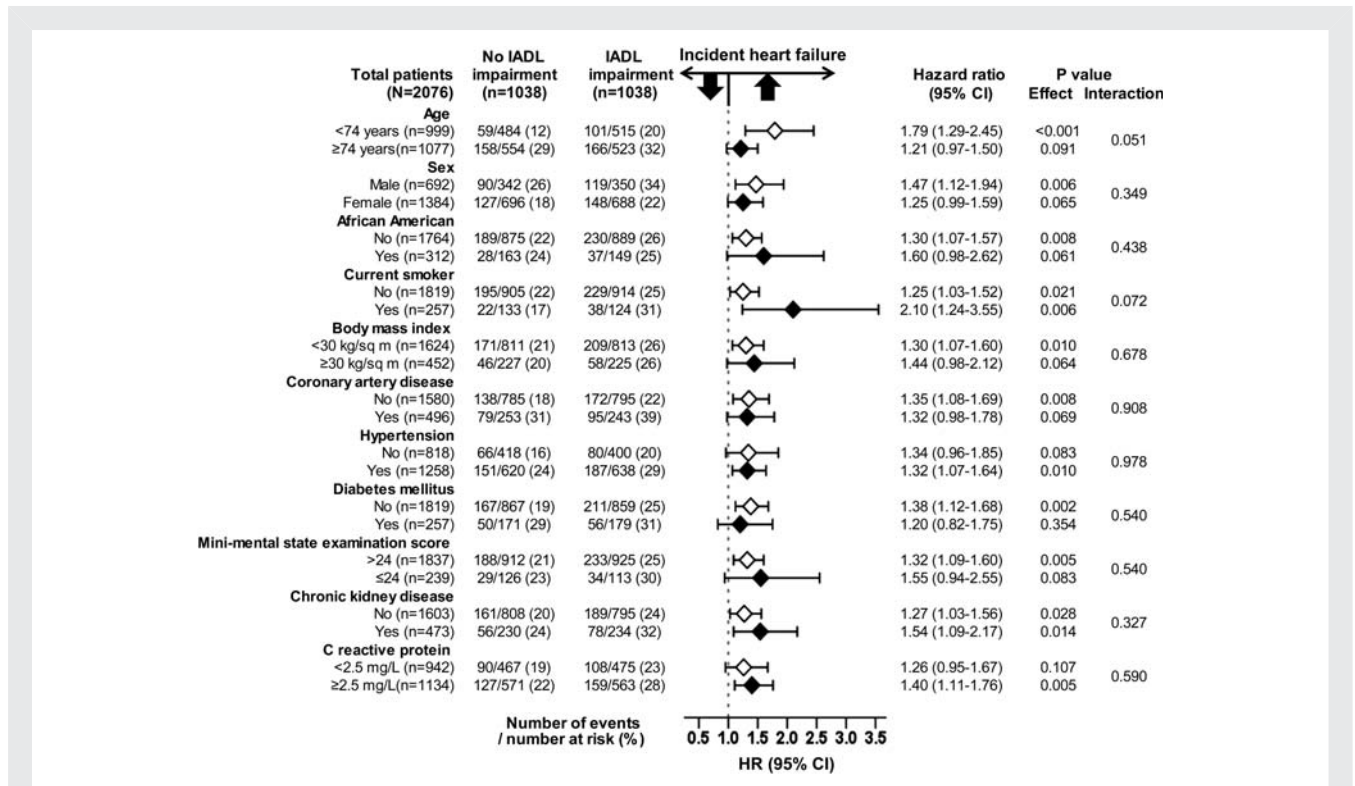


Figure 3 Association of baseline impairment of instrumental activities of daily living (IADLs) and incident heart failure in subgroups of a propensity-matched cohort of older adults in the Cardiovascular Health Study. CI, confidence interval; HR, hazard ratio.

Table 3 Association of impairment of instrumental activities of daily living (IADLs) with other outcomes in the Cardiovascular Health Study

Outcomes	Pre-match		Post-match	
	HR (95% CI)	P-value	HR (95% CI)	P-value
All-cause mortality	1.72 (1.58–1.87)	<0.001	1.19 (1.06–1.34)	0.004
Acute myocardial infarction ^a	1.48 (1.24–1.77)	<0.001	1.29 (0.99–1.67)	0.056
Angina pectoris ^a	1.50 (1.29–1.74)	<0.001	1.33 (1.07–1.65)	0.010
Stroke ^a	1.49 (1.27–1.75)	<0.001	1.08 (0.87–1.34)	0.493
Peripheral artery disease ^a	1.78 (1.23–2.58)	0.002	1.29 (0.77–2.17)	0.330
Transient ischaemic attack ^a	1.56 (1.14–2.13)	0.005	1.26 (0.81–1.97)	0.306

CI, confidence interval; HR, hazard ratio.

^aExcluding participants with baseline conditions; e.g. for analysis of incident stroke, those with a history of stroke at baseline were excluded.

HF are displayed in Table 2. Associations of IADL impairment with other outcomes are displayed in Table 3.

When IADL impairment was categorized as one impairment or two or more impairments, incident HF occurred in 28, 25, and 21% of matched participants with two or more, one, and no IADL impairments, respectively ($\chi^2 P = 0.028$ and P for linear trend = 0.009). Compared with no IADL impairment, HRs for incident HF associated with one and two or more IADL impairments were 1.28 (95% CI 1.06–1.55; $P = 0.010$) and 1.63 (95% CI 1.19–2.22; $P = 0.002$), respectively (P for trend < 0.001).

Discussion

Findings from the current study demonstrate that IADL impairment was associated with increased risk of incident HF in community-dwelling older adults that was independent of many traditional and non-traditional risk factors. Further, the risk of incident HF increased with increasing level of IADL impairment. Baseline IADL impairment also had unadjusted associations with mortality and other incident cardiovascular events, but only its association with all-cause mortality and incident angina pectoris

was independent. To the best of our knowledge, this is the first report of an independent association of IADL impairment with incident HF. These findings suggest that impairments of tasks necessary for independent community living may adversely increase risk of incident HF in older adults.

There are several possible explanations for these findings: residual bias by measured confounders, bias by unmeasured cofounders, and a true association. Because patients in our matched cohort were well balanced on all measured baseline characteristics, bias due to imbalances on measured covariates is unlikely. Findings from our sensitivity analysis suggest that the association observed in our study was rather insensitive to bias due to unmeasured confounders. IADL measures complex function that includes both physical tasks such as heavy housework and cognitive tasks such as managing finances. It is possible that older adults with IADL impairments were not able to dispense their medications or take them at the correct time and/or at the correct dosages, leading to poor control and treatment of various HF risk factors such as hypertension or coronary artery disease among those with IADL impairments. Older adults with IADL impairment may also have difficulty keeping doctors' appointments and understanding dietary and risk factors. Reduced physical activity associated with IADL impairment may also increase the risk of incident HF. It is also possible that the IADL impairment was the early manifestation of subclinical HF in older adults. Impairment of IADLs may be a marker of frailty, which has been shown to be associated with subclinical cardiovascular disease.³⁰

Reduced physical activity has been shown to be associated with incidence of a number of chronic diseases including cancer and cardiovascular disease.^{31–34} However, to the best of our knowledge, this is the first report of an association of impaired physical and cognitive function with incident HF in community-dwelling older adults free of HF at baseline. These findings are important, as both IADL impairment and HF are common in older adults, and findings from the current study suggest that IADL impairment may be used to identify older adults at increased risk for HF. These individuals may be targeted for specific interventions to improve IADL performance as well as better treatment of other risk factors such as an uncontrolled hypertension, diabetes, atrial fibrillation, or ongoing myocardial ischaemia.

Our study has several limitations. Data on IADLs were self-reported and misclassification is possible. Because data on individual IADLs were not available, an analysis to determine which IADL tasks were associated with incident HF was not possible. Also, disability is a dynamic process,³⁵ and it is possible that some older adults without IADL impairment developed new impairments during follow-up, and vice versa. However, this regression dilution may have underestimated the true association between IADL impairment and incident HF.³⁶ Bias due to imbalances in unmeasured confounders is possible. As discussed earlier, findings of our sensitivity analysis suggest that the association of IADL impairment with incident HF was rather insensitive to such an unmeasured confounder.

In conclusion, among community-dwelling older adults without baseline HF, the presence of IADL impairment at baseline is a novel independent risk factor for incident HF and all-cause mortality, which may be used to risk-stratify older adults for targeted

interventions to improve IADL performance and address other HF risk factors. Future studies need to develop and test interventions to prevent IADL impairment in community-dwelling older adults.

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Conflict of interest: none declared.

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