Association of Living Alone and Hospitalization Among Community-Dwelling Elders With and Without Dementia

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Abstract

Background: Older persons account for the majority of hospitalizations in the United States.[1] Identifying risk factors for hospitalization among elders, especially potentially preventable hospitalization, may suggest opportunities to improve primary care. Certain factors—for example, living alone—may increase the risk for hospitalization, and their effect may be greater for some subgroups, such as persons with dementia and the old-old (aged 85+).

Objectives: To determine the association of living alone and risk for hospitalization, and if the observed effect is greater among persons with dementia or the old-old.

Design: Retrospective longitudinal cohort study.

Participants: 2,636 participants in the Adult Changes in Thought (ACT) study, a longitudinal cohort study of dementia incidence. Participants were adults aged 65+ enrolled in an integrated health care system who completed biennial follow-up visits to assess for dementia and living situation. Hospitalizations were identified using automated data.

Main Measures: Hospitalization for all causes and for ambulatory care sensitive conditions (ACSCs).

Key Results: At baseline, the mean age of participants was 75.5 years, 59% were female and 36% lived alone. Follow-up time averaged 8.4 years (standard deviation [SD] 3.5), yielding 10,431 approximately two-year periods for analysis. Living alone was positively associated with being aged 85+, female, and having better physical function, and negatively associated with having dementia. In a regression model adjusted for age, gender, comorbidity burden, and length of follow-up period, living alone was not

associated with all-cause (odds ratio [OR] = 0.93; 95% confidence interval [CI] 0.84, 1.03) or ACSC hospitalization (OR = 0.87; 95% CI 0.72, 1.04). Among participants aged 85+, living alone was associated with a lower risk for all-cause (OR = 0.75; 95% CI 0.60, 0.92), but not ACSC hospitalization. Dementia did not modify any observed associations. **Conclusion:** Living alone in later life did not increase hospitalization risk, and in this population may be a marker of healthy aging in the old-old.

Background

Older adults account for the majority of acute care hospitalizations in the United States.[1,2] Of special concern are reports of high rates for ambulatory care sensitive conditions (ACSCs),[3–5] conditions for which hospitalization may be avoidable with timely and effective primary care.[6,7] A better understanding of risk factors for hospitalization among elders, especially for ACSCs, is necessary to identify opportunities to improve primary care for this expanding subgroup.

Living alone has been associated with more unnecessary days in the hospital[8] and higher hospital readmission rates,[9,10] yet the effect of living alone in old age on the risk for hospitalization has not to our knowledge been previously examined. Living alone is an established risk factor for the onset and progression of chronic disease,[11,12] plausibly through its association with reduced social support,[11] and thus may also increase hospitalization risk.

The effect of living alone on risk for hospitalization may be greater in vulnerable subgroups, such as the old-old (aged 85 years or older) and persons with dementia. The old-old have been shown to utilize emergency medical care at double the rate of adults under age 85.[13] Older adults with dementia are hospitalized more frequently than adults without dementia for all causes and ACSCs,[5,14–17] and persons with dementia who live alone are at higher risk for inadequate self-care, malnutrition, untreated medical conditions, and utilization of emergency medical services compared to those living with others.[18–21]

A better understanding of the relationship of living alone and risk for hospitalization may help focus existing and/or suggest novel approaches for improving care in the outpatient setting. This study uses data from a longitudinal cohort of aging and dementia to determine if living alone is associated with acute care hospitalization in elders, the old-old and those with and without dementia. We hypothesized that living alone would increase the risk for hospitalization in older adults, and that this effect would be greater in the old-old and persons with dementia.

Methods

Setting & Design

All participants were enrolled in the Adult Changes in Thought (ACT) cohort study, a population-based longitudinal study of the incidence of and risk factors for dementia.[22,23] The ACT study enrolls members of the Group Health Cooperative (GHC), an integrated health care delivery system in the Pacific Northwest. At the time of enrollment, all participants were aged 65 or older, cognitively intact, and not residing in a nursing home. As described in detail in prior publications,[22,23] all ACT participants complete biennial follow-up visits to assess cognition and health status until the diagnosis of dementia, death or study disenrollment. Persons identified as having dementia complete at least one annual diagnostic follow-up visit to confirm dementia status and type.

In this study, we used a retrospective longitudinal cohort study design to assess the impact of living alone on all-cause and ACSC hospitalizations among ACT participants.

Follow-up for each participant began at first enrollment in ACT and ended at death or end of study follow-up.

Participants

The data set included participants who were enrolled in ACT between February 1, 1994 and December 31, 2005 and followed until December 31, 2007. Participants were included if they had completed at least 1 ACT follow-up visit while enrolled in GHC and had not withdrawn from ACT when data analysis was initiated on January 13, 2013. This study was approved and a waiver of consent was granted by the Group Health Institutional Review Board. All participants provided written informed consent for ACT assessments at the time of enrollment into ACT.

Measures

Outcome Measures

The primary outcome was all-cause hospitalization, measured as any admission requiring an overnight stay during each follow-up period. Automated hospitalization files that have been validated and used in prior research were used to identify admissions.[24]

The secondary outcome was ACSC hospitalization, which included any admission for angina, asthma, bacterial pneumonia, cellulitis, congestive heart failure exacerbation, chronic obstructive pulmonary disease exacerbation, dehydration, diabetes, duodenal ulcer, ear/nose/throat infection, gastric ulcer, gastroenteritis, hypertension, hypoglycemia, hypokalemia, influenza, malnutrition, peptic ulcer, seizure disorder, or urinary tract

infection. These conditions were selected to be consistent with prior publications of ACSCs in the elderly.[25,26]

Independent Variables

The main independent variable of interest was living alone, which was measured at the beginning of each follow-up period. Participants categorized their living situation as one of the following: (1) live with spouse only; (2) live with spouse and other relatives; (3) live with other relatives or friends; (4) live with other unrelated individuals (e.g., paid help or adult family home); (5) live in nursing home; (6) live alone; (7) refused/do not know/missing. Prior research suggests that living with another individual, whether a spouse, relative or unrelated person, is more indicative of social support and its protective effects than the relationship of the individuals with whom one lives.[27–29] Therefore, we categorized living situation as a binary variable to compare living alone versus living with others. Periods during which a subject was residing in a nursing home were excluded from analysis, since we were interested in identifying acute care hospitalizations among community-dwelling elders.

Effect Modifier

Dementia was included as a potential effect modifier of the association between living alone and hospitalization. While we hypothesized that all older adults living alone in the community are at increased risk for acute care hospitalization, we posited that individuals living alone with dementia would be more highly susceptible.

ACT participants were screened every two years for changes in cognitive function using the Cognitive Abilities Screening Instrument (CASI).[30] As published previously,[5,23] participants scoring below 86 on the CASI or demonstrating symptoms of the onset of cognitive impairment underwent a rigorous dementia diagnostic evaluation to reach a confirmed diagnosis using standardized criteria.[31,32]

Covariates

Potential confounders of the association between living alone and risk for hospitalization, based on published literature, included age,[1,25,26] sex,[33,34] and comorbidity burden[35–40] assessed at the time of enrollment in ACT.

Comorbidity burden was measured using the RxRisk Score, a risk assessment instrument that uses automated ambulatory pharmacy data to identify chronic conditions and associated future health care costs. The RxRisk Score estimates disease burden based on an individual's age, sex and chronic condition profile (identified as conditions with at least one pharmacy dispense over a one-year period).[5,41] Dementia or associated medications are not included in the algorithm.

Additional demographic characteristics, health conditions and behaviors were collected from self-reports upon enrollment into ACT and at each follow-up period, including race/ethnicity, highest educational degree, and annual income. Social support was measured using six questions from the Interpersonal Support Evaluation List (ISEL),[42] a questionnaire that measures four constructs of social support (companionship, self-esteem, emotional support, and instrumental support) using a four-point Likert Scale and

summed such that a lower score indicates higher levels of social support. Depression was measured using the 10-item Center for Epidemiological Studies Depression Scale (CES-D),[43] and depression was defined as a score of 10 or more out of a total of 30. Finally, a Performance-Based Physical Function (PPF) score was calculated based on the total score from four physical function tests (10-ft timed walk, chair-stand time, standing balance and grip strength). Each physical function test was scored from 0 to 4 and summed for a maximum best PPF score of 16.[44]

Statistical Analysis

Consistent with methods for handling time-dependent covariates,[45] we divided each participant's total follow-up time into periods averaging approximately two years (timed to start and end with baseline and biennial follow-up ACT visit dates). In order to avoid bias associated with the inclusion of longer time periods, during which exposures could change, periods longer than 2.5 years in duration were excluded from analysis.

The main analyses examined the dichotomous outcomes of all-cause and ACSC hospitalization occurring in periods during which participants were living alone compared with periods during which participants were living with others. We used a generalized estimating equation (GEE) logistic regression to account for within-person correlation of the multiple follow-up periods. Odds ratios (OR) and 95% confidence intervals (CI) were calculated using empirical standard errors to correct for clustering. For each outcome, we fit an unadjusted model; a multivariate model adjusted for key covariates [age, sex, comorbidity burden (log-transformed RxRisk Score) and length of follow-up period]; and adjusted models with and without dementia status as an

interaction term with living alone (living alone*dementia). Adjusted models were also fit for participants aged 85 years or older. Finally, to ensure that hospitalization at the end of life did not bias the findings, multivariate analyses were repeated for all subjects and those aged 85 or older while excluding periods during which a participant died. Only two observations were excluded from adjusted models because of missing data. All analyses were performed using STATA version 11.0 (StataCorp LP, College Station, TX).

Results

Participant Characteristics at Baseline

Of the 3,638 ACT participants enrolled in ACT between 1994 and 2005, a total of 2,636 subjects met eligibility criteria and were included in the present study (N = 2,636; Figure 1). A small percentage of periods were excluded from analysis because they were longer than 2.5 years (2.0%), the participant was residing in a nursing home at the beginning of the period (1.4%,), or living situation data were missing (0.5%), yielding 10,431 follow-up periods for analysis. Participants were followed for an average of 8.4 years (standard deviation [SD] 3.5) and the average duration of a follow-up period was 2.0 years (mean 703.0 days, SD 118.1). Participants who developed dementia were followed for one follow-up period after diagnosis.

Table 1 reports characteristics of all 2,636 participants and participants aged 85 or older at the time of enrollment in ACT. The mean age of participants when enrolled was 75.5 years (SD 6.3). Participants were predominantly female, white, had at least a high school degree, and reported moderate levels of perceived social support. Thirty-eight percent of all participants (n = 992, where n refers to a subset of the total sample N) were never

hospitalized during study follow-up. A larger proportion of old-old enrollees were female, unmarried, living alone and never smokers, and had a higher comorbidity burden at baseline compared to the entire sample.

Participant Characteristics When Living Alone versus Living with Others

Given that living situation and other covariates changed over time, biennial measures were compared for the primary analysis. Table 2 compares periods during which participants were living alone with periods during which participants were living with others for all periods and for periods when participants were aged 85 or older. Approximately a quarter of the periods included an all-cause hospitalization, and about 6% of the periods included an ACSC hospitalization regardless of whether a participant was living alone or with others. The percentage of follow-up periods including a hospitalization increased as participants aged over 85 (all-cause: 38.8%, ACSC: 13.0%). Periods when a participant was aged 85 or older were 1.65 (95% CI 1.46, 1.84; $p < 0.01$) times as likely as periods when a participant was younger than 85 to include an all-cause hospitalization and 2.22 (95% CI 1.90, 2.69; $p < 0.01$) times as likely to include an ACSC hospitalization.

Across all follow-up periods, when participants were living alone they were more likely than those living with others to be older, female, white, unmarried, and non-smokers. Those living alone also reported lower perceived social support and demonstrated worse physical performance, but were less likely to carry a diagnosis of dementia than those living with others. A larger proportion of participants aged 85 or older were living alone

(54.8%) compared to the entire cohort (39.3%) and those under age 85 (36.2%). Participants aged 85 or older and living alone demonstrated better physical function but lower perceived social support compared to those living with others.

Association of Living Alone and Risk for Hospitalization

Table 3 presents unadjusted and adjusted odds ratios for the association between living alone and risk for all-cause and ACSC hospitalization. Again, period was used as the unit of analysis. In this cohort of older adults, no association was found between living alone and risk for all-cause or ACSC hospitalization when controlling for age, gender, comorbidity burden and length of follow-up period.

Among individuals aged 85 or older, the odds of having an all-cause hospitalization when living alone were 0.75 (95% CI 0.60, 0.92; $p < 0.01$) as much as when living with others. ACSC hospitalization was not significantly associated with living status in this age group.

Excluding periods in which a person died strengthened the observed association of living alone and risk for all-cause hospitalization in the old-old (OR = 0.69; 95% CI 0.54, 0.87; $p < 0.01$), but did not substantially alter the risk measure for all participants (OR = 0.93; 95% CI 0.83, 1.03; $p = 0.17$) or for ACSC hospitalization in either the old-old (OR = 0.88; 95% CI 0.61, 1.27; $p = 0.50$) or all participants (OR = 0.87; 95% CI 0.70, 1.07; $p = 0.19$). Dementia did not modify the association of living alone and hospitalization among all participants or those aged 85 or older.

Discussion

This study found no association between living alone and risk for hospitalization in older adults, despite evidence that those living alone had slightly lower social support, which we posited might be one way living alone would increase hospitalization risk. The risk for hospitalization in this sample increased with age, with the odds of an all-cause hospitalization increasing by 65% and the odds of an ACSC hospitalization doubling in those aged 85 or older compared to those under 85. As adults in this study aged, living alone became more common, evidenced by a higher proportion of follow-up periods during which a participant aged 85 or older was living alone compared to the entire cohort.

Our main hypotheses, that living alone would be associated with an increased risk for all-cause and ACSC hospitalization, were not supported for this sample as a whole. Although those living alone reported significantly lower perceived social support than those living with others, there was notable overlap between the scores of the two groups, and those living alone may have received support in areas not captured by our measure of perceived interpersonal social support. For example, participants in this study may have had access to supportive factors such as home health care, community-based senior programs, or contacts with non-physician health professionals. Participants in this study also may have been more engaged in the management of their health than the general population, by nature of their enrollment in an integrated health care delivery system.

Such protective factors may have accounted for a lack of an observed association between living situation and hospitalization in this cohort.

We did not anticipate discovering a lower risk for all-cause hospitalization among adults aged 85 or older who were living alone compared to those living with others. We predicted a higher risk for hospitalization among the oldest adults living alone, since the old-old are frequently at risk for frailty and associated health problems.[46] In contrast, by examining the old-old as a subgroup we likely highlighted a resilient group of participants who developed less comorbidity, allowing them to continue living independently. In support, we found that those who were living alone and aged 85 or older were less likely to have dementia or heart disease and had a lower comorbidity burden compared to those living with others. Accumulation of chronic conditions and cognitive impairment may lead older adults to move in with others or into an institution, while also placing them at a higher risk for hospitalization. Yet even in the old-old, we did not find a significant association between living situation and risk for ACSC hospitalization. Incentivizing preventive, collaborative care and reducing acute care hospitalizations are integral to GHC's approach to care, and living situation may not significantly impact the risk for ACSC hospitalization in an elderly population receiving proactive ambulatory care.

The presence of dementia also did not alter the association of living alone and risk for hospitalization in this cohort of aging adults, perhaps due to the limited follow-up of participants who developed dementia. In this study, hospitalization data were only

examined for the first two years following dementia diagnosis, since living situation measures were not updated after diagnosis. As a result, less than 4% of the follow-up periods analyzed included a participant with dementia. In contrast, a prior publication examining rates of hospitalization in this cohort and following participants with dementia for an average of 9.6 years reported higher rates of all-cause and ACSC hospitalization in participants with dementia compared to those who remained dementia free.[5] Since rates of hospitalization and the risks associated with living alone likely increase with dementia severity,[20,2147,48] the restricted follow-up of participants in this study probably limited our ability to detect a relationship between living situation and hospitalization in this subgroup.

This study has several limitations. As discussed, participants may be healthier than the general population, due to access to an integrated delivery system with a preventive approach to managing chronic conditions and readily available alternatives to hospitalization (e.g., 24-hour nurse consultation hotline). Furthermore, participants reside in the urban parts of the Puget Sound region, and as a cohort likely have access to resources unique to a metropolitan region relative to a more rural population. Finally, longitudinal follow-up of participants who developed dementia would have permitted a more thorough examination of transitions in living situation as the disease progressed, potentially revealing differences in risk factors for hospitalization between adults with and without dementia.

This study also has a number of notable strengths. It is the first study to reveal an intriguing phenomenon of a reduced risk of hospitalization in the old-old living alone. It also adds to the small amount of literature addressing longitudinal changes in living situation among older adults,[18,28,29,37,39,49,50] by illustrating an increasing risk for hospitalization and prevalence of persons living alone as adults age. The sample size was large and attrition rates low (ACT completeness of follow-up rates are estimated to be higher than 95%) with an average follow-up duration of 8.4 years across all participants. Automated hospitalization files permitted complete capture and accurate classification of hospitalization data.

Our findings suggest that living alone in advanced age may not always be a risk factor for hospitalization, and for some adults could be a marker of healthy aging. Living alone likely does present a challenge to some older adults (e.g., those living in more isolated regions), but identifying certain protective factors may generate opportunities to support healthy aging. The trend toward living solo has grown as disability rates have declined[51] and a preference for aging in place has gained popularity with older adults.[52] Understanding the experiences of the old-old who continue to live alone can contribute to the design of supportive models of outpatient care that aim to keep older adults healthy and independent.

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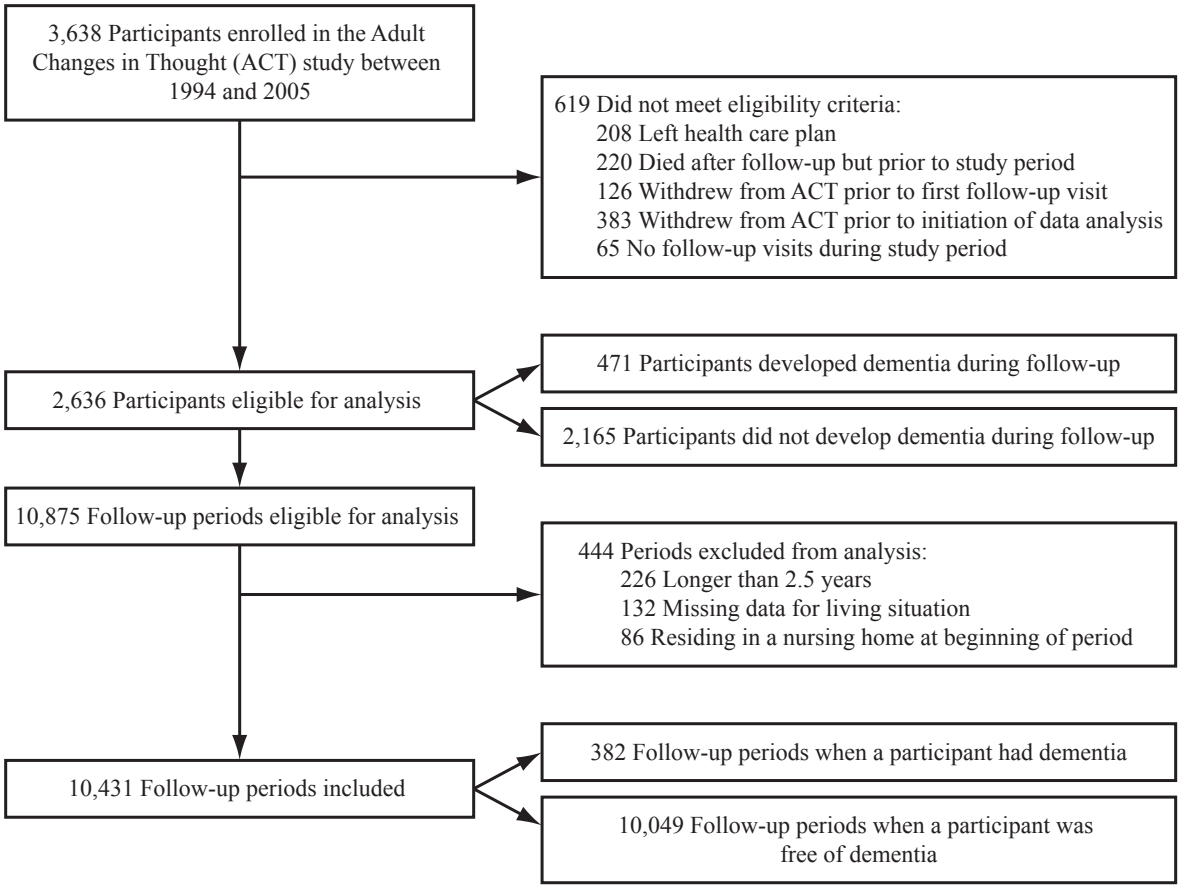

Figure 1. Participants and Follow-up Periods Included in Analysis

Table 1. Baseline Demographic and Health Characteristics of All Participants (N = 2,636) and Participants Aged 85+ (n = 226)

	All Participants	Participants Aged 85+*
Age, n (%)		
65-74	1,374 (52.1)	---
75-84	1,036 (39.3)	---
85+	226 (8.6)	226 (100.0)
Female, n (%)	1,554 (59.0)	163 (72.1)
Nonwhite, n (%)	243 (9.2)	11 (4.9)
Married, living as, n (%)	1,437 (54.5)	60 (26.6)
Income < $15,000, n (%)	408 (15.5)	62 (27.4)
High School Graduate, n (%)	2,117 (80.3)	165 (73.0)
Difficulty with 1+ ADLs, n (%)	581 (22.0)	70 (31.0)
PPF Score†, mean (SD)	10.4 (2.2)	9.7 (2.7)
Self-reported health, poor, n (%)	45 (1.7)	7 (3.10)
Depression‡, n (%)	273 (10.4)	26 (11.7)
Diabetes (ever reported), n (%)	248 (9.4)	15 (6.7)
Cancer (ever reported), n (%)	450 (17.1)	43 (19.0)
Heart Disease§, n (%)	512 (19.5)	54 (24.1)
Smoking Status, n (%)		
Never	1,252 (47.6)	128 (56.6)
Past	1,230 (46.7)	91 (40.3)
Current	151 (5.7)	7 (3.1)
Developed Dementia, n (%)	471 (17.9)	71 (31.4)
Social Support‖, mean (SD)	8.1 (2.6)	8.3 (2.4)
RxRisk Score¶, USD, mean (SD)	4,439.9 (2,929.7)	5,285.2 (2,650.1)
Living Situation, n (%)		
Alone	956 (36.3)	138 (61.1)
Spouse Only	1,249 (47.4)	54 (23.9)
Spouse and Other Relatives	158 (6.0)	3 (1.3)
Other Relatives and Friends	225 (8.5)	18 (8.0)
Other Unrelated Individuals	42 (1.6)	10 (4.4)
Nursing Home	5 (0.2)	3 (1.3)
Ever Hospitalized during follow-up, n (%)	1,644 (62.4)	171 (75.7)

*These data represent baseline measures from 226 participants who were aged 85 or older at baseline; however, follow-up periods from participants who reached age 85 or older during study follow-up were included in subsequent analyses.
†PPF Score is the Performance-Based Physical Function Score ranging from 0 to 16. A higher PPF Score indicates better physical function.
‡Depression is flagged as present for a score of >= 10 on the Center for Epidemiologic Studies Depression Scale (CES-D).
§Heart disease is defined as prevalent myocardial infarction, angina, CABG, angioplasty.
‖Social support is measured by the mean score on 6 items from the Interpersonal Support Evaluation List (ISEL), where each item is scored on a scale of 1-4 for a total potential score of 24. A lower score indicates higher levels of interpersonal support.
¶The RxRisk Score is measured in U.S. dollars. A lower RxRisk Score indicates a lower comorbidity burden.

Table 2. Comparison of Participant Characteristics during Periods when Living Alone versus Living with Others: All Periods (2a) and Periods during which Participants were Aged 85+ (2b)*

2a	All Follow-Up Periods				
	Living Alone (n = 4,100)	Living with Others (n = 6,331)	Unadjusted *p*-value	Age & Sex Adjusted *p*-value†	All Periods (N = 10,431)
All-Cause Admission, n (%)	1,062 (25.9)	1,607 (25.4)	0.55	0.12	2,669 (25.6)
ACSC Admission, n (%)	242 (5.9)	393 (6.2)	0.52	**0.05**	635 (6.1)
Age‡, n (%)					
65-74	1,019 (24.9)	2,295 (36.3)	**< 0.01**	---	3,314 (31.8)
75-84	2,129 (51.9)	3,250 (51.3)		---	5,379 (51.6)
85+	952 (23.2)	786 (12.4)		---	1,738 (16.6)
Female, n (%)	3,211 (78.3)	3,000 (47.4)	**< 0.01**	**< 0.01**	6,211 (59.5)
Nonwhite, n (%)	287 (7.0)	537 (8.5)	**0.01**	0.32	824 (7.9)
Married, living as‡, n (%)	24 (0.6)	1,380 (21.8)	**< 0.01**	**< 0.01**	1,404 (13.5)
Income < $15,000‡, n (%)	927 (22.6)	457 (7.2)	**< 0.01**	**< 0.01**	1,384 (13.3)
High School Graduate, n (%)	3,356 (81.9)	5,073 (80.2)	0.09	0.20	8,429 (80.9)
Difficulty with 1+ ADL#, n (%)	1,302 (31.8)	1,756 (27.7)	**< 0.01**	0.06	3,058 (29.3)
PPF Score‡§, mean (SD)	9.5 (2.9)	9.7 (3.0)	**< 0.01**	**0.04**	9.6 (2.9)
Poor self-reported health#, n (%)	102 (2.5)	190 (3.0)	0.12	0.08	292 (2.8)
Depression‡‖, n (%)	475 (11.8)	574 (9.2)	**< 0.01**	0.12	1,049 (10.3)
Diabetes‡ (ever reported), n (%)	406 (10.0)	774 (12.3)	**< 0.01**	0.08	1,180 (11.4)
Cancer‡ (ever reported), n (%)	921 (22.6)	1,509 (24.1)	**0.08**	0.03	2,430 (23.5)
Heart Disease¶, n (%)	961 (23.6)	1,601 (25.6)	**0.03**	0.71	2,562 (24.8)
Smoking Status‡, n (%)					
Never	1,990 (48.8)	2,963 (47.2)	**< 0.01**	**< 0.01**	4,953 (47.8)
Past	1,870 (45.9)	3,072 (49.0)			4,942 (47.7)
Current	217 (5.3)	241 (3.8)			458 (4.4)
Dementia‡, n (%)	118 (2.9)	264 (4.2)	**< 0.01**	**< 0.01**	382 (3.7)
Social Support‡#, mean (SD)	8.1 (2.7)	7.8 (2.4)	**< 0.01**	**< 0.01**	7.9 (2.5)
RxRisk Score**, USD, mean (SD)	4,111.0 (2,365.5)	4,283.5 (2,834.6)	**< 0.01**	0.34	4,232.4 (2,685.1)

2b	Follow-Up Periods during which Participants were Aged 85+				
	Living Alone (n = 952)	Living with Others (n = 786)	Unadjusted *p*-value	Age & Sex Adjusted *p*-value	All Periods (n = 1,738)
All-Cause Admission, n (%)	340 (35.7)	334 (42.5)	**< 0.01**	**< 0.01**	674 (38.8)
ACSC Admission, n (%)	112 (11.8)	114 (14.5)	0.09	0.12	226 (13.0)
Age, n (%)					
65-74	---	---	---	---	--
75-84	---	---	---	---	--
85+	---	---	---	---	100.0
Female, n (%)	773 (81.2)	391 (49.8)	**< 0.01**	**< 0.01**	1,164 (67.0)
Nonwhite, n (%)	36 (3.8)	46 (5.9)	**0.04**	0.39	82 (4.7)
Married, living as, n (%)	3 (0.3)	57 (7.3)	**< 0.01**	**< 0.01**	60 (3.5)
Income < $15,000, n (%)	233 (24.5)	87 (11.1)	**< 0.01**	**< 0.01**	320 (18.4)
High School Graduate, n (%)	709 (74.5)	594 (75.6)	0.13	0.50	1,303 (75.0)
Difficulty with 1+ ADL, n (%)	444 (46.6)	390 (49.6)	0.22	**< 0.01**	834 (48.0)
PPF Score, mean (SD)	8.8 (3.3)	8.2 (3.9)	**< 0.01**	**< 0.01**	8.5 (3.6)
Poor self-reported health, n (%)	41 (4.4)	31 (4.1)	0.75	0.94	72 (4.2)
Depression, n (%)	110 (12.0)	99 (13.6)	0.35	0.22	209 (12.7)
Diabetes (ever reported), n (%)	89 (9.5)	61 (8.0)	0.30	0.56	150 (8.8)
Cancer (ever reported), n (%)	248 (26.3)	227 (30.0)	0.08	0.43	475 (28.0)
Heart Disease, n (%)	274 (29.2)	276 (36.5)	**< 0.01**	0.09	550 (32.5)
Smoking Status, n (%)					
Never	544 (57.8)	416 (54.8)	0.04	0.06	960 (56.5)
Past	375 (39.9)	327 (43.1)			702 (41.3)
Current	22 (2.3)	16 (2.1)			38 (2.2)
Dementia, n (%)	61 (6.4)	115 (14.6)	**< 0.01**	**< 0.01**	176 (10.2)
Social Support, mean (SD)	8.1 (2.6)	7.8 (2.5)	**0.02**	**< 0.01**	7.9 (2.6)
RxRisk Score, USD, mean (SD)	4,639.9 (2,110.0)	5,201.4 (2,697.5)	**< 0.01**	0.16	4,893.5 (2,408.8)

[*]Follow-up periods rather than participants are the unit of analysis in this table. Thus, all categorical variables are reported as the percentage (%) of periods when each characteristic was present and continuous variables are averaged across follow-up periods. For example, 25.9% of periods when subjects were living alone included an all-cause admission. The mean PPF score averaged across all follow-up periods was 9.6 (SD 2.9).

[†]P-value tests if the percentages or means in periods when a participant was living alone versus not living alone differ, calculated using a logistic regression with period as the unit of analysis, controlling for age and sex, and accounting for repeated observations using GEE with empirical standard errors. Tests in age groups compare age 75+ versus age < 75 and in smoking status compare ever versus never smoked. Values in bold are statistically significant at the $p = 0.05$ level.

‡Time-varying variables were measured during biennial follow-up visits, and the updated values for each follow-up period were used in analysis.
§PPF Score is the Performance-Based Physical Function Score ranging from 0 to 16. A higher PPF Score indicates better physical function.
‖Depression is flagged as present for a score of >= 10 on the Center for Epidemiologic Studies Depression Scale (CES-D).
¶Heart disease is defined as prevalent myocardial infarction, angina, coronary artery bypass grafting, and/or angioplasty.
#Social support is measured by the mean score on 6 items from the Interpersonal Support Evaluation List (ISEL), where each item is scored on a scale of 1-4 for a total potential score of 24. A lower score indicates higher levels of interpersonal support.
**The RxRisk Score is measured in U.S. dollars. A lower RxRisk Score indicates a lower comorbidity burden.

Table 3. Association of Living Alone and Risk for All-Cause or ACSC Hospitalization

	Unadjusted OR (95% CI)	Unadjusted *p*-value	Adjusted OR[*] (95% CI)	Adjusted *p*-value[†]
All Ages				
All-Cause Hospitalization	1.03 (0.93, 1.14)	0.59	0.93 (0.84, 1.03)	0.17
ACSC Hospitalization	0.95 (0.79, 1.13)	0.56	0.87 (0.72, 1.04)	0.13
Age 85+				
All-Cause Hospitalization	**0.75 (0.59, 0.92)**	**< 0.01**	**0.75 (0.60, 0.92)**	**< 0.01**
ACSC Hospitalization	0.79 (0.59, 1.04)	0.09	0.86 (0.63, 1.16)	0.32

[*]Models were adjusted for age, sex, comorbidity burden (log-transformed RxRisk Score) and length of follow-up period.
[†]P-value tests if the percentages in periods when a participant was living alone versus not living alone differ, calculated using a logistic regression with period as the unit of analysis and accounting for repeated observations using GEE with empirical standard errors. Risk measures in bold are statistically significant at the $p = 0.05$ level.