



The Association Between Income and Incident Homebound Status Among Older Medicare Beneficiaries

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IMPORTANCE: A large and growing population of older adults with multimorbidity, cognitive impairment, and functional disability live in the community, but many never or rarely leave their homes. Being homebound is associated with decreased access to medical services, poor health outcomes, and increased mortality. Yet, it is unknown what factors, in particular socioeconomic factors, are associated with new onset of homebound status.

OBJECTIVE: To evaluate the association between income and risk of becoming homebound.

DESIGN: Observational cohort study using 2011 to 2018 data from the National Health and Aging Trends Study, a nationally representative sample of Medicare beneficiaries aged 65 years and older.

SETTING: Population-based study in the United States.

PARTICIPANTS: A total of 7,042 initially nonhomebound community-dwelling older adults.

EXPOSURE: Total annual household income at baseline (in 2011) measured via self-report.

OUTCOME: Annual measure of homebound status, defined as leaving home an average of 1 d/wk or less.

RESULTS: Over 7 years, 15.81% of older adults in the lowest income quartile ($\leq \$15,003$) became homebound, compared with only 4.64% of those in the highest income quartile ($> \$60,000$). In a competing risks analysis

accounting for risks of death and nursing home admission, and adjusted for clinical and demographic characteristics, those in the lowest income quartile had a substantially higher subhazard of becoming homebound than those in the highest income quartile (1.65; 95% confidence interval = 1.20–2.29). Moreover, we see evidence of a gradient in risk of homebound status by income quartile.

CONCLUSION AND RELEVANCE: Our work demonstrates that financial resources shape the risk of becoming homebound, which is associated with negative health consequences. In the context of existing income disparities, more support is needed to assist older adults with limited financial resources who wish to remain in the community. *J Am Geriatr Soc* 00:1-8, 2020.

Keywords: homebound; long-term care; socioeconomic status; social determinants of health

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INTRODUCTION

Focus on long-term care in the community is increasingly important as policy incentives shift care away from the nursing home setting. A large and growing population of individuals with multimorbidity, cognitive impairment, and functional decline live in the community but are homebound, defined as rarely or never leaving home. Our previous work using data from the National Health and Aging Trends Study (NHATS) identified two million homebound persons,¹ a population larger than the nursing home population. More individuals become homebound each year (range = 1.8%–3.1% of adults aged >65 years, 2012–2018) than enter a nursing home.²

Although being homebound is relatively common, existing evidence suggests that it may have tremendous clinical implications for patients. By virtue of their condition, the

homebound are understudied and often “invisible” relative to assessments of care delivery and quality.³ The homebound experience high symptom burden⁴ and significant functional impairment.¹ They also have increased medication use,⁵ hospitalization,^{6,7} and healthcare utilization¹ compared with their nonhomebound counterparts. When compared with individuals with similar demographic, functional, and clinical characteristics, the homebound have greater mortality.^{8,9} Consequences of being homebound, such as difficulty accessing routine medical care¹ and inability to engage in valued activities,¹⁰ may contribute to these poor health outcomes.

Currently, we know little about what factors contribute to *becoming* homebound among older adults. The vast majority of research on the homebound is cross-sectional^{10,11} or is limited to “treated” samples receiving home-based care.^{12,13} It is essential that we both improve opportunities to prevent becoming homebound and work to mitigate the adverse health effects of being homebound (e.g., by disseminating existing medical and supportive services in the home or by developing new care models to improve access to care for homebound populations). To do this, we must develop a better understanding of how often, and under what circumstances, patients are likely to become homebound.

Guided by our previously developed conceptual model of the multilevel determinants of becoming homebound,⁸ we posit that the cumulative effect of cognitive and functional impairment; illness burden; and limited individual, social, and community/environmental resources make it difficult to leave home to engage in valued life activities and access appropriate care. Notably, this model highlights the key role of social determinants of health and conceptualizes individuals as embedded within a social context, which powerfully shapes and constrains how individuals live in the community.

Growing evidence regarding the association between income and health^{14,15} is highly relevant to the population of older adults who are at risk of becoming homebound. In the United States, between 2001 and 2014, higher income was associated with greater longevity, and differences in life expectancy across income groups increased over time.¹⁵ Although socioeconomic disparities around disease incidence, treatment, and nursing home placement have been documented,¹⁶⁻¹⁸ it is unclear how income impacts the risk of becoming homebound. This gap in knowledge is surprising amidst growing concerns about economic hardship and aging¹⁹ as well as increasing evidence that providing care for illnesses, such as dementia, is financially straining in terms of high out-of-pocket costs and unpaid caregiving time.²⁰ Given the complex and often costly long-term needs of homebound individuals, income may be a particularly relevant social determinant of health for this population. Therefore, the goal of this study was to determine if the risk of becoming homebound is greater for individuals with lower incomes.

METHODS

Sample

The NHATS is a cohort study of U.S. Medicare beneficiaries aged 65 years and older that began in 2011.²¹ In-person annual interviews were conducted with study participants or with proxy respondents if the participant was

unable to respond. Study participants were asked detailed questions about how they performed daily activities in the month before the interview, as well as their medical comorbidities, socioeconomic status, and home environment. Our analyses evaluated incident homebound status between 2012 (NHATS wave 2) and 2018 (NHATS wave 8). We included 7,042 participants from the NHATS cohort who were initially community dwelling and not homebound in 2011.

Measures

Homebound status was the primary outcome for this study. We defined homebound status using previously published constructs based on responses to NHATS questions¹ (i.e., the self-reported frequency of a participant leaving his or her home). Participants were asked, “How often did you go out in the last month?” Participants who responded that they never or rarely (≤ 1 d/wk) went out were considered homebound. Nursing home status was determined annually via NHATS interview. Based on previous work,²² deaths were determined from Medicare claims or NHATS status.

Income was evaluated among the full NHATS population at wave 1 (2011). NHATS respondents report total annual household income. Additionally, income from the following individual sources are reported: Social Security, Supplemental Security Income, Veterans Administration payments, pension plans, any earned income derived from retirement accounts, mutual funds/stocks, bonds, bank accounts, and certificates of deposit. NHATS allows individuals to estimate amounts in bracketed ranges if exact figures are unknown. Of NHATS respondents, 31% did not report any amount for total income and 13% reported income brackets only. For both of these groups, NHATS provides multiple imputed values derived from answers to individual income sources and other respondent characteristics.²³ Stata’s *mi estimate* was used to determine summary statistics and regression models. Respondent income quartiles were allowed to vary across imputations. Quartile thresholds were averaged across imputations.

Guided by our conceptual model of the determinants of homebound status,⁸ we included other baseline demographic, health-related, and geographic variables in our analysis. These included age, sex, and race/ethnicity (Black, Hispanic, White, or other race), education level, social isolation (i.e., no one identified in social network), and Medicaid status of the participant. NHATS asks respondents if a physician has ever told them they had the following conditions: heart attack, heart disease, high blood pressure, arthritis, osteoporosis, diabetes mellitus, type II, lung disease, cancer, dementia, and broken or fractured hip. Presence of depressive symptoms was classified based on Patient Health Questionnaire score greater than 3,²⁴ and anxiety was classified based on the Generalized Anxiety Disorder score greater than 3.²⁵ We developed a count of conditions based on the above. Functional impairment was defined as having any impairment or difficulty in one or more activities of daily living (ADLs). Probable dementia was based on criteria established by NHATS,²⁶ which incorporated self-report of dementia; the Alzheimer’s Disease-8 screening tool²⁷; and a cognitive interview that assessed memory, orientation, and executive function. Individuals were classified

into census region and metropolitan or rural area (per Rural-Urban Continuum Code classification) based on the county in which they resided at the time of their interview in 2011.

Analysis

We identified incident homebound cases over each of seven waves of follow-up (NHATS waves 2–8). Competing risks for homebound status were death or a move to a long-stay nursing home. All individuals were observed until homebound status, a competing risk, censoring due to dropout, or the end of the study period.

We examined demographic and clinical characteristics by baseline (2011) income quartile using unadjusted bivariate linear or logistic regression. We then evaluated outcomes through 2018 (incident homebound, incident nursing

home residence, or death) by income quartile. Finally, among individuals with follow-up data at wave 2, we fit a Fine-Gray competing risks regression model²⁸ to predict cumulative incidence of homebound status, adjusting for demographic and clinical variables, censoring for loss to follow-up, and accounting for the competing risks of nursing home entry and death. We modeled the subdistribution hazard function²⁹ to determine the rate of becoming homebound for subjects who are either not currently homebound or who have previously experienced a competing event. Because of the important role of functional impairment in homebound status, we stratified results by baseline ADL status in secondary analyses.

All analyses adjusted for NHATS analytic weights that take into account differential probabilities of selection and nonresponse.³⁰ All analyses were conducted using Stata16.

Table 1. Characteristics by Baseline Income Quartile (n = 7,042)

Characteristics		Lowest income quartile 1 (n = 2,022)	Income quartile 2 (n = 1,865)	Income quartile 3 (n = 1,748)	Highest income quartile 4 (n = 1,407)
Demographics	Age, mean, y	76.05**	75.87**	74.03**	72.39
	Female	67.15**	59.82**	50.81**	43.06
	White Non-Hispanic	66.83**	82.53**	87.23**	91.84
	Black Non-Hispanic	14.32**	7.76**	6.62**	3.30
	Hispanic	12.80**	6.38**	3.93*	2.38
	Other race/ethnicity	6.04**	3.33	2.22	2.49
	Married	24.74**	47.41**	71.69**	82.48
	Education: ≥HS	59.13**	74.32**	88.67**	96.30
	Medicaid	33.05**	8.16**	2.03	1.31
	Medigap	46.76**	60.54	65.92	65.53
	Self-reported health = fair/poor	36.59**	26.29**	17.44**	9.81
	Presence of a paid helper	7.53	6.15*	5.94*	8.54
	Social isolation	9.13**	6.74*	5.01	4.04
	Clinical/function	0–1 Condition	22.82**	22.51**	28.97**
2–4 Conditions		54.90	60.19	57.11	56.80
≥5 Conditions		22.27**	17.31**	13.92**	7.67
Heart attack		16.42**	15.04**	13.40**	8.59
Stroke		12.49**	10.08**	8.58**	5.33
Cancer		21.00**	26.05	27.48	28.48
Heart disease		18.86*	16.68	16.25	15.01
Diabetes mellitus, type II		28.76**	24.53**	21.99*	18.03
Lung disease		17.50**	16.24**	14.12*	10.77
Probable dementia		15.09**	8.81**	4.69**	2.26
≥1 ADL difficulty or impairment	44.03**	37.79**	28.60**	21.49	
Homebound status	Ever homebound	15.81**	11.31**	6.88**	4.64
Geographical	Metropolitan area	80.35**	79.63**	80.94**	87.18
	Northeast	18.85	19.50	17.93	20.89
	Midwest	21.13	24.14	24.88	21.33
	South	40.02	35.48	37.51	34.70
	West	19.99	20.88	19.68	23.08

Note: Data are given as percentage, unless otherwise indicated. Quartile 1 = 0 to \$15,003; quartile 2 = \$15,004 to \$30,000; quartile 3 = \$30,000 to \$60,000; quartile 4 = greater than \$60,000. Social isolation = having no one identified in social network; estimates adjusted for survey weights.

Abbreviations: ADL, activity of daily living; HS, high school.

*P < .05, **P < .01 (relative to highest income quartile).

RESULTS

Over 7 years of follow-up, we identified 851 incident homebound cases among 7,042 initially community-dwelling Medicare beneficiaries (Supplementary Figure S1).

We compared characteristics of older adults by baseline income quartile (Table 1). Relative to those in the highest quartile of annual income (>\$60,000 in 2011), older adults in the lowest quartile of annual income (\leq \$15,003) were older (76.05 vs 72.39 years). They were also significantly more likely to be female (67.15% vs 43.06%) and non-Hispanic Black (14.32% vs 3.30%), and they were less likely to have \geq high school education or more (59.13% vs 96.30%) or be married (24.74% vs 82.48%). They also had higher frequency of cognitive and functional impairments, including more dementia (15.09% vs 2.26%) and ADL difficulty or impairment (44.03% vs 21.49%) than higher-income older adults.

Over 7 years, 15.81% of older adults in the lowest income quartile became homebound compared with 11.31% in the next lowest quartile (\$15,004–\$30,000), 6.88% in the second highest quartile (\$30,001–\$60,000), and only 4.64% those in the highest income quartile. Figure 1 shows, unadjusted, the percentage with each outcome after 1 year of follow-up. There is a gradient in risk of homebound status by income quartile. Additionally, the risk of homebound status (at next wave) was far higher than risk of nursing home status among older adults across all income quartiles. For example, among those in the lowest income quartile, 6.54% became homebound the next year, compared with only 1.91% who entered a nursing home and 4.23% who died.

In the competing risk model adjusted for age, sex, race, education, marital status, Medicaid status, social isolation, ADL difficulty or impairment, self-rated health, number of clinical conditions, probable dementia, presence of a paid helper, urbanicity, and census region, we continue to see a

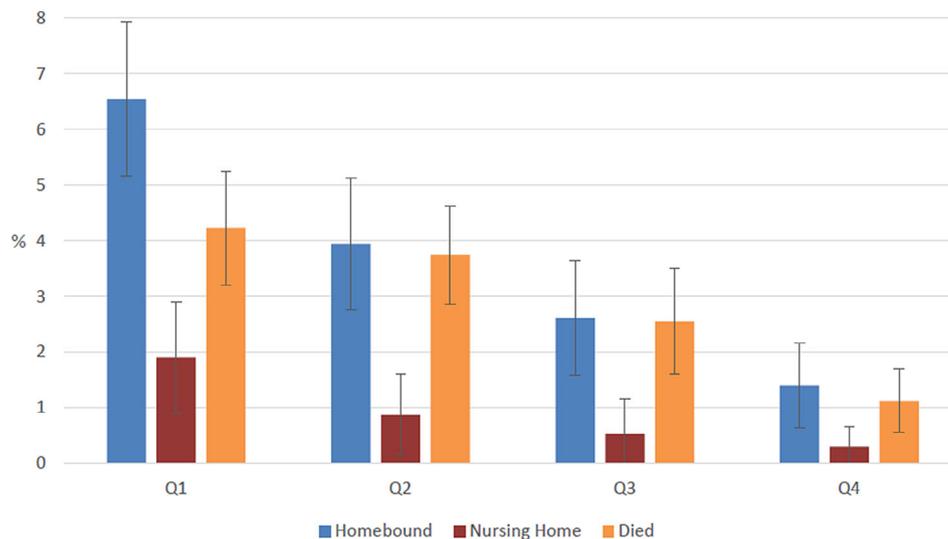


Figure 1. Proportion of community-dwelling, nonhomebound population in 2011 with observed homebound status, death, and nursing home residence at 1-year follow-up by income quartile (Q) ($n = 5,965$). Household income quartile 2011 (Q1 = \$0–\$15,003; Q2 = \$15,004–\$30,000; Q3 = \$30,000–\$60,000; Q4 = >\$60,000); weighted estimates are unadjusted and limited to older adults without loss to follow-up in wave 2.

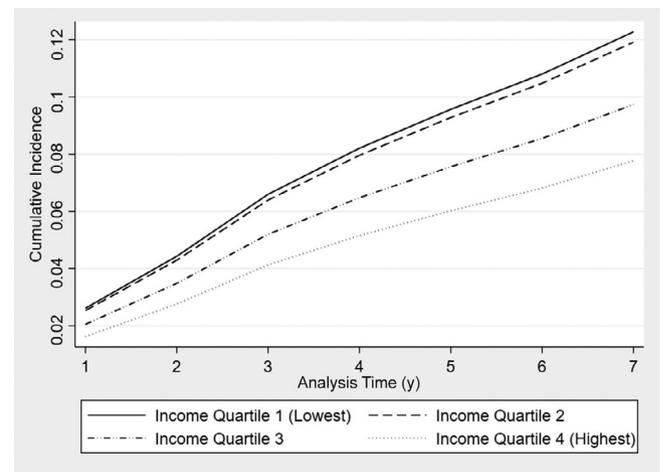


Figure 2. Seven-year homebound incidence by baseline income quartile status. Estimates account for competing risks of nursing home placement or death and are weighted to reflect 2010 Medicare population estimates; adjusted for age, sex, race, education, marital status, Medicaid, social isolation, activity of daily living difficulty or impairment, self-rated health, number of self-reported clinical conditions, probable dementia, presence of a paid helper, urbanicity, and census region. Quartile 1 = \$0 to \$15,003; quartile 2 = \$15,004 to \$30,000; quartile 3 = \$30,000 to \$60,000; quartile 4 = greater than \$60,000.

gradient in risk of homebound status over time by income quartile (Figure 2).

In the adjusted competing risks regression model, relative to the top quartile of income (quartile 4), being in the bottom income quartile (quartile 1) remained a significant predictor (subhazard ratio (SHR) = 1.65; 95% confidence interval (CI) = 1.20–2.29) of homebound status (Table 2), as did being in the second lowest quartile (SHR = 1.56; 95% CI = 1.15–2.11). Those in the second highest income

Table 2. Competing Risks Model of Homebound Status

Variable		Unadjusted (n = 5,965)		Adjusted (n = 5,820)	
		SHR	95% CI	SHR	95% CI
Income quartile	1 (Lowest)	4.12	3.13–5.43	1.65	1.20–2.29
	2	2.80	2.10–3.72	1.56	1.15–2.11
	3	1.63	1.18–2.26	1.25	0.90–1.73
Demographics	Aged 70–74 y			1.16	0.84–1.61
	Aged 75–79 y			1.99	1.48–2.68
	Aged 80–84 y			1.93	1.42–2.61
	Aged 85–89 y			2.56	1.85–3.54
	Aged ≥90 y			2.91	2.03–4.18
	Female			1.47	1.22–1.77
	Black Non-Hispanic			1.09	0.89–1.34
	Hispanic			1.54	1.16–2.04
	Education: ≥HS			0.85	0.70–1.03
Social/caregiving	Medicaid			1.44	1.15–1.81
	Married			0.97	0.80–1.17
	Social isolation			0.96	0.66–1.39
Clinical/function	Has paid helpers			0.94	0.73–1.20
	Probable dementia			1.43	1.14–1.79
	ADL difficulty or impairment			2.00	1.66–2.42
Geographical	Self-reported health = fair/poor			1.28	1.05–1.56
	2–4 Conditions			1.14	0.89–1.45
	≥5 Conditions			1.52	1.13–2.03
	Metropolitan area			1.26	1.01–1.56
	Northeast			1.03	0.79–1.36
	Midwest			0.97	0.74–1.27
	South			1.12	0.89–1.41

Note: Competing risks = nursing home or death; weighted to wave 1 to reflect 2010 Medicare population estimates; baseline characteristics only; fourth quartile income (highest) = referent category. Abbreviations: ADL, activity of daily living; CI, confidence interval; HS, high school; SHR, subhazard ratio.

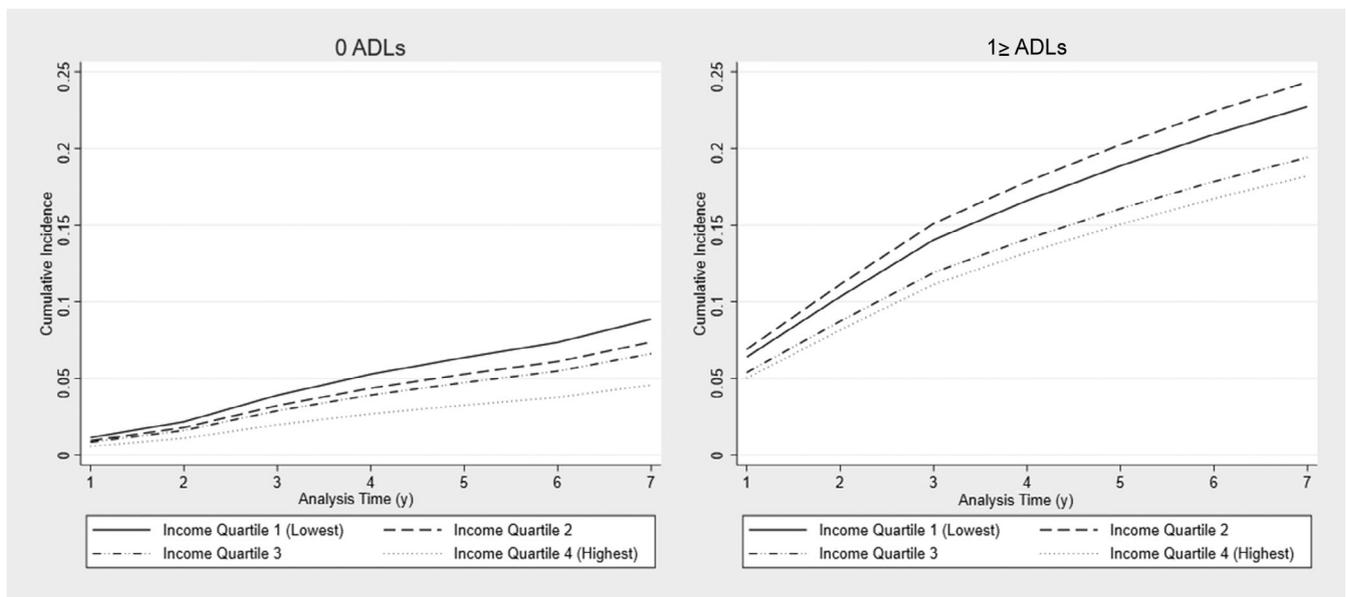


Figure 3. Seven-year homebound incidence by baseline income quartile status, stratified by activity of daily living (ADL) status. Estimates account for competing risks of nursing home placement or death and are weighted to reflect 2010 Medicare population estimates; adjusted for age, sex, race, education, marital status, Medicaid, social isolation, self-rated health, number of self-reported clinical conditions, probable dementia, presence of a paid helper, urbanicity, and census region. Quartile 1 = \$0 to \$15,003; quartile 2 = \$15,004 to \$30,000; quartile 3 = \$30,000 to \$60,000; quartile 4 = greater than \$60,000.

bracket (quartile 3) had a greater homebound incidence than those in the highest income bracket (quartile 4) (SHR = 1.25; 95% CI = 0.90–1.73), although this finding was not statistically significant.

Women had an increased likelihood of becoming homebound (SHR = 1.47; 95% CI = 1.22–1.77), as did those of Hispanic ethnicity (SHR = 1.54; 95% CI = 1.16–2.04), relative to non-Hispanic Whites. Clinical and functional characteristics also predicted homebound status, including high comorbidity, dementia, and self-reported poor or fair health (relative to good, very good, or excellent). The strongest predictor of homebound status was ADL difficulty or dependence (SHR = 2.00; 95% CI = 1.66–2.42). Having Medicaid (SHR = 1.44; 95% CI = 1.15–1.81) and living in a metropolitan area were significant predictors of homebound status (SHR = 1.26; 95% CI = 1.01–1.56), although no association with geographical region was detected.

More than one-third (37.79%) of the sample reported any difficulty or dependence in ADLs at baseline when they were nonhomebound living in the community. When we stratified by baseline ADL disability (Figure 3), the effect of low income on homebound status was most pronounced among those without baseline disability. Individuals without baseline disability in the lowest income bracket (quartile 1) had an increased risk (SHR = 2.09; 95% CI = 1.27–3.45) of becoming homebound compared with individuals without baseline disability in the highest bracket (quartile 4) (Supplementary Table S1). Among those with baseline disability, we do not see evidence of a clear gradient by income.

DISCUSSION

Older adults with low incomes are more likely to become homebound than their higher-income counterparts, even after adjusting for demographic and clinical factors, including functional disability.

In fact, the impact of homebound status onset by income gradient was most evident among those without baseline disability. This study builds on prior work that demonstrates a strong cross-sectional relationship between income and homebound status,¹ and calls for greater attention to the role of income and lack of financial resources as predictors of homebound status in older adults. Lower-income older adults may be especially vulnerable to the diseases, impairments, and disabilities that lead to becoming homebound. Moreover, they may also be less likely to find ways to accommodate or overcome these disabilities due to their limited resources. Further work is necessary to examine the multiple pathways by which income may be associated with becoming homebound, and with negative health consequences among the homebound population.³¹

Our findings add to a growing body of literature linking income with aging-related outcomes. Prior studies have found that low income and financial strain predict earlier mortality^{15,32} and disability.³³ Although older adults at the lowest income levels in our sample had the greatest risk of becoming homebound, those in the middle income brackets also had increased homebound incidence relative to those at the higher-income levels. Although higher-income individuals may be better able to afford paid

support,³⁴ out-of-pocket costs related to caregiving may be particularly onerous for those of relatively low income but above the threshold to receive services from Medicaid.³⁵ Medicaid is one of the most important sources of long-term care financing in the United States, but only covers those who are poor or have become poor in the process of paying for care. Medicaid status was itself associated with an increased risk of becoming homebound; in post-hoc analyses, we did not observe evidence that the association between income status and homebound incidence varied by Medicaid status (data not shown), which may in part be due to the heterogeneity of Medicaid benefits from state to state.

Apart from income, this study points to several other nonclinical factors that play important roles in the cause of homebound status. For example, we see that the Hispanic population is more likely to become homebound, which may reflect decreased nursing home use and increased receipt of care from family members.³⁶ We also note that women and those living in metropolitan areas are more likely to become homebound. Further research is needed to determine care preferences, health-related sequelae of homebound status, and service accessibility and needs among these subpopulations. Although we did not detect differences related to geographical region, analyses of service availability (e.g., nursing home beds and home care agencies) by location should be pursued in future studies.

For those who do become homebound, we must ensure that patients and their families have access to the care they need to remain safely in the community. These needs may be especially complex due to financial and social vulnerability coupled with high functional impairment, dementia, and multimorbidity. Expanding access to home-based care is integral to preserving the safety and well-being of this growing population. Although home-based medical care (HBMC) has experienced growth³⁷—fueled by value-based care models, technological advancements (e.g., portable medical equipment), and a growing evidence base³⁸—it is still not widely implemented. Among Medicare beneficiaries, only 11% of the homebound receive HBMC.³⁹ Of particular relevance to the homebound population in the wake of the COVID-19 pandemic is access to telehealth. Well-documented disparities in broadband access and digital literacy among older adults persist, especially in rural areas.^{40–42} Homebound individuals of lower income with limited technological capacity may experience gaps in critical healthcare services that greatly limit access to quality care.

This study has several potential limitations. Although the inclusion of participants with proxy respondents (approximately 5% annually) likely improved the representativeness of the sample, it may have increased risk of measurement error, especially for socioeconomic exposures. Furthermore, NHATS imputed income data for 43.6% of the sample because of missingness.²³ Although respondents with imputed income were different than those with complete data available (e.g., older, more likely to be female, and more likely to have probable dementia), our results were not substantively different when limited to complete cases only (Supplementary Table S2). In addition, household wealth is a more comprehensive measure of financial resources than income for older adults who may rely on

accumulated assets in addition to income, but wealth was not measured in this study. Although we used survival models that account for censoring due to loss to follow-up, differential loss to follow-up remains a concern in longitudinal studies, such as NHATS. Low socioeconomic status is often associated with loss to follow-up.⁴³ To the extent that income is associated with both loss to follow-up and homebound status in our sample, it would bias our estimates of the relationship between income and homebound incidence toward the null. Although our measure of homebound status is limited to a 1-month period (i.e., last 30 days) and based on self-report at yearly intervals, it is the best available measure of homebound status available and has been used widely.^{1,10} Finally, we only examined baseline income status; future work is needed to examine change in income as well as other time-varying attributes in relation to homebound status.

In conclusion, we find that in addition to clinical and functional characteristics, becoming homebound is strongly associated with lower income. In the context of wide income disparities within the United States, more work is needed to understand whether we can prevent or delay homebound status and meet care needs for particularly vulnerable individuals.

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Author Contributions: Ornstein and Siu were involved in the study concept and design. Ornstein, Bollens-Lund, Garrido, Liu, and Husain were involved in analysis and interpretation of data. Reckrey, Kelley, Ankuda, Ornstein, Bollens-Lund, Garrido, Liu, Ferreira, Husain, and Siu were involved in preparation of the manuscript.

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SUPPORTING INFORMATION

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

Supplementary Figure S1: Incident homebound status, death nursing home status, and censoring at annual interviews, 2011 to 2018, among older adult participants of the National Health and Aging Trends Study.

Supplementary Table S1: Competing Risks Model of Homebound Status by Baseline ADL Difficulty or Impairment (n = 5,870)

Supplementary Table S2: Competing Risks Model of Homebound Status Using Those with Nonimputed Income Data Only (n = 3,423)