WP 26/18

Midlife Health and Later Life Economic Inequality

Nicolò Russo; Rory McGee: Mariacristina De Nardi;

Margherita Borella and Ross Abram

August 2026

http://www.york.ac.uk/economics/postgrad/herc/hedg/wps/

Midlife Health and Later Life Economic Inequality

Nicolò Russo, Rory McGee, Mariacristina De Nardi,
Margherita Borella, Ross Abram*

April 9, 2026

Abstract

Health shapes a broad set of later-life outcomes that are central to macroeconomics and public policy, including disability receipt, retirement, long-term care use, and survival. Yet we know little about how much differences in midlife health contribute to disparities in these outcomes later in life by race, ethnicity, and gender. Using the Health and Retirement Study, we construct a measure of health based on frailty and document large disparities at midlife. Black men and women have frailty levels at age 55 comparable to those of White men and women who are 13 and 20 years older, respectively, while the corresponding gaps for Hispanic men and women are 8 and 12 years. We then estimate a dynamic system linking health at age 55 to subsequent outcomes. Equalizing the distribution of health at age 55 across groups substantially reduces disparities in time spent in poor health, disability benefit receipt, and nursing home residence. Importantly, midlife health can account for later-life disparities more than education, health insurance coverage, and marital status jointly.

*Nicolò Russo: Goethe University Frankfurt; Rory McGee: Western University; Mariacristina De Nardi: University of Minnesota, Federal Reserve Bank of Minneapolis, CEPR, and NBER; Margherita Borella: University of Torino and CeRP-Collegio Carlo Alberto, Italy; Ross Abram: Churchill Asset Management. We thank Bocar Ba, Martín García-Vázquez, Andrew Goodman-Bacon, Karen Kopecky, Johannes Spinnewijn, Jon Skinner, and Marcos Vera Hernandez for helpful comments. The research reported herein was performed pursuant to grant RDR18000003 from the US Social Security Administration (SSA), funded as part of the Retirement and Disability Research Consortium. Borella gratefully acknowledges funding from the European Union - Next Generation EU, Mission 4 Component 2, within the NRRP (National Recovery and Resilience Plan) project "Age-It - Ageing well in an ageing society" (PE0000015 - CUP H73C22000900006). Russo gratefully acknowledges financial support from the German Research Foundation, grant no. 462655750.

1 Introduction

Health influences a broad set of later-life outcomes that are central to macroeconomics and public policy, including disability receipt, retirement, labor supply, nursing home residence, survival, and time spent in poor health. These outcomes shape reliance on major government programs such as Disability Insurance, Social Security, Medicare, and Medicaid, affect tax revenues, and help determine the protection these programs provide to households. Because these margins interact, and because the programs linked to them can substitute for or complement one another, understanding the role of health in shaping multiple important economic outcomes is crucial for a broader set of economic and policy questions.

Our paper takes a first step in this direction by asking how much differences in health in midlife account for subsequent differences in later-life health and economic outcomes by race, ethnicity, and gender. To do so, we construct an interpretable and portable measure of health, document large disparities in that measure in midlife, and quantify how much those disparities account for later-life differences across several margins.

Our main finding is that differences in health already present at age 55 account for a substantial share of subsequent inequality in later-life health and economic outcomes by race, ethnicity, and gender. In our estimated dynamic system, equalizing health at age 55 reduces gaps in time spent in poor health, disability benefit receipt, nursing home residence, and life expectancy by quantitatively important amounts. More broadly, our results suggest that disparities in disability receipt, retirement, long-term care use, health span, and survival are not simply distinct inequalities that coexist but, in part, different expressions of the same underlying differences in health. This matters for both interpretation and policy evaluation. Studying a single outcome or program in isolation may understate the role of health, miss how disparities spill over across margins, and overlook interactions between social insurance and long-term care systems.

To carry out this exercise, we first need a measure of health that is comparable across groups, has a clear quantitative interpretation, and predicts economically relevant outcomes.

We use the Health and Retirement Study (HRS), which reports impairments, diagnoses, functional limitations, and conditions. We summarize this information into a frailty index, defined as the share of accumulated health deficits. Frailty has been used extensively in the medical literature, which often interprets it as a proxy of biological aging.[1] In economics, Harttgen et al. (2013) provides an early survey-based application of the frailty index, while Dalgaard and Strulik (2014) and Strulik (2015) introduce model-based uses of health deficits. Later work both constructs frailty from survey data and incorporates it into quantitative models of economic behavior. Braun, Kopecky, and Koreshkova (2019) employs it to study long-term care insurance demand among the elderly, and Hosseini, Kopecky, and Zhao (2020) and Hosseini, Kopecky, and Zhao (2022) use it to document facts about the evolution of health over the life cycle and to study the role of health in generating earnings inequality.

Constructing frailty requires choices about which deficits to include and how to weigh them. We compare alternative versions of the index, including more comprehensive versions and versions that use principal component analysis to determine deficit weights, and evaluate their predictive power for a broad set of subsequent economic outcomes across demographic groups. Our baseline measure performs best in predicting these outcomes, is easy to construct and interpret, and can be exported to other datasets and applications. We therefore use it as the basis for our analysis.

Using this baseline frailty measure, we document large health inequality by race, ethnicity, and gender at age 55. Black men and women have frailty levels comparable to those of White men and women who are 13 and 20 years older, respectively. Similarly, Hispanic men and women have frailty levels comparable to those of White men and women who are 8 and 12 years older, respectively. These differences in frailty are considerably larger than the three- to four-year Black–White gaps in life expectancy reported in the US Life Tables (Arias and Xu 2025) and suggest that midlife health disparities may have important consequences for later-life health and economic outcomes.

1. Mitnitski, Mogilner, and Rockwood (2001) and Mitnitski et al. (2002), for instance, identify aging with the accumulation of deficits and use the frailty index as a proxy for biological age.

We then estimate a dynamic system that relates health and other observables to subsequent outcomes. We use these estimates to estimate what happens under the observed health distribution and to generate counterfactuals in which we assign Black and Hispanic men and women the distribution of health at age 55 of their White counterparts (while holding fixed the estimated laws of motion).

We find that, under their observed initial health at age 55, White men and women spend 40% and 52% of their remaining years in poor health, compared to 50% and 65% for Black men and women and 48% and 62% for Hispanic men and women. Under this counterfactual, disparities later in life decline markedly. Equalizing health at age 55 reduces the gap in the time spent in bad health between Black and White individuals by 54% for men and 64% for women, and the gap between Hispanic and White individuals by 27% and 40% for men and women, respectively. It also narrows Black–White differences in life expectancy by 29% for men and 46% for women. These results indicate that midlife health disparities account for a substantial share of later-life differences in both the *quality* and the *quantity* of remaining life, as measured by health and lifespan.

Health inequality also accounts for important differences in other economic outcomes. Black individuals over age 55 spend roughly twice as long on disability as White and Hispanic individuals, and equalizing health at age 55 halves this disparity. In addition, Black individuals receive the shortest duration of retirement benefits after age 55, with differences in health at this age accounting for nearly half of the gap relative to White individuals.

We also compare the contribution of midlife health with that of education, health insurance coverage, and marital status. In most cases, equalizing health at age 55 generates larger reductions in racial gaps than equalizing these socioeconomic characteristics jointly. For Black individuals, midlife health differences account for substantially more of the disparities in disability receipt, time spent in poor health, and retirement duration than socioeconomic differences do. For Hispanic individuals, the pattern is similar, except for total working years and men's time spent in poor health, where socioeconomic characteristics play a comparable or larger role. Taken together, these comparisons indicate that midlife health inequality is a central contributor to many later-life racial and ethnic disparities.

Our empirical approach is designed to quantify how health disparities at midlife are associated with later-life outcomes across several margins at once. Rather than estimating a fully specified model of preferences and decision rules, we use estimated transition laws to trace how differences in initial health are linked to subsequent differences in survival, disability benefit receipt, retirement benefit receipt, nursing home residence, and time spent in poor health. In this sense, our framework provides a complementary diagnostic tool for assessing the extent to which health inequality at midlife accounts for later-life inequality.

Our paper relates to the literature on health, labor supply, savings, and retirement (e.g., French (2005); De Nardi, French, and Jones (2009); Attanasio, Kitao, and Violante 2010). That literature studies the interaction between health and economic behavior, but typically abstracts from racial and ethnic disparities. By focusing explicitly on these gaps, we provide complementary evidence on the extent to which health inequality is associated with differences in later-life economic outcomes.

Our paper also relates to the large literature on racial health disparities. A broad body of work documents differences in healthcare utilization, spending, and health outcomes across racial and ethnic groups, emphasizing the roles of insurance coverage, access to care, geographical segregation, and discrimination.[2] A related strand of research develops summary measures of health for use in economic analysis. For example, Danesh, Kolstad, Spinnewijn, and Parker (2024) constructs an index of chronic disease burden using administrative prescription data in the Netherlands, while Blundell, Britton, Costa Dias, and French (2023) and Blundell, Britton, Costa Dias, French, and Zou (2025) develop an instrumented measure of health to estimate its effect on employment among older workers. We contribute to both strands of the literature by combining a parsimonious and portable measure of health with a

2. See, among others, Boulware et al. (2003), Geiger (2003), Cook and Manning (2009), Alsan and Wanamaker (2017), Kim et al. (2018), Alsan, Garrick, and Graziani (2019), Dieleman et al. (2021), Lin et al. (2021), Hill, Artiga, and Haldar (2022), Arapakis et al. (2024), and Darden and Macis (2024).

dynamic accounting framework that quantifies how disparities at midlife are associated with differences in both health trajectories and economic outcomes later in life.

Our findings imply that disparities in health at age 55 are closely linked to later-life inequality in both health and economic outcomes. This highlights the importance of policies that improve health before age 55. Importantly, such improvements need not rely exclusively on high-cost medical interventions. Evidence from food and health policy shows that relatively low-cost and scalable interventions can alter health-related behaviors, particularly among high-risk populations (e.g., Dubois, Griffith, and O'Connell 2017; Dubois, Griffith, and O'Connell 2020). To the extent that such policies shift the distribution of health before age 55, our results suggest that they may also affect disparities later in life.

The remainder of the paper proceeds as follows. Section 2 describes the data. Section 3 constructs and validates our health measure. Section 4 documents midlife health inequality. Section 5 presents the dynamic framework and counterfactual results. Section 6 concludes.

2 Data

We use data from the Health and Retirement Study (HRS), which began in 1992 and is conducted every two years. The HRS provides data on U.S. residents aged 51 and older, as well as their spouses, and oversamples Black and Hispanic individuals (HRS Staff (2017)). Several studies have documented the high quality of the HRS in recruiting and retaining minority respondents (Ofstedal and Weir (2011) and Schroeder, Weir, and West (2023)).

Key variables, such as difficulties with activities of daily living (ADLs), first appeared in the 1996 survey; therefore, we use data from 1996 to 2018. We select respondents younger than age 100 who identify as non-Hispanic White, non-Hispanic Black, or Hispanic.[3] Our sample consists of 216,166 person-year observations. Appendix A presents more details.

3. We follow the 2020 U.S. Census (available at https://www.census.gov/programs-surveys/decennial-census/technical-documentation/questionnaires.2020_Census.html), which categorizes "White" and "Black" as races and "Hispanic" as an ethnicity. Our data do not allow us to distinguish races further. The HRS race variable takes three values: White, Black, and "other," which includes American Indians, Alaskan Natives, Asians, Native Hawaiians, and Pacific Islanders. In our unselected starting sample, these

The first step in constructing a frailty index is selecting which health deficits to include. We follow the guidelines in Searle et al. (2008) and select 35 binary deficits for our baseline frailty index. In a robustness exercise, detailed in Section 3.1, we augment our baseline index with more deficits and construct a frailty index composed of 51 deficits. Appendix A.1 reports more details on all health deficits.

To facilitate exposition, Table 1 groups deficits consistently with the Katz Index of Independence in Activities of Daily Living (Katz, Downs, Cash, and Grotz (1970) and Katz (1983)), which is a tool used by medical professionals to assess one's ability to perform basic activities independently. These groups comprise activities of daily living (ADLs), difficulties with instrumental activities of daily living (IADLs), and other functional limitations. ADLs refer to basic activities required to take care of oneself and include having difficulty bathing and dressing. IADLs refer to more complex activities that allow people to live independently. We include as IADLs the deficits that appear in the Lawton-Brody Instrumental Activities of Daily Living scale (Lawton and Brody (1969)), which is the most common checklist used by medical professionals to determine one's difficulties with IADLs. We classify as "other functional limitations" all the remaining deficits that refer to functional limitations that do not enter either the Katz Index of Independence in Activities of Daily Living or the Lawton-Brody Instrumental Activities of Daily Living scale. The fourth and fifth groupings of deficits include diagnoses by medical professionals (as reported by the respondent) and indicators of healthcare utilization. Finally, there are addictive diseases, such as obesity (i.e., having a body-mass index (BMI) larger than 30) and smoking. Regarding the latter deficits, we follow the medical literature and classify obesity and smoking as diseases. The American Medical Association (AMA) recognized obesity as a chronic disease in 2013. Many papers in the medical literature (for instance, Bernstein and Toll (2019)) also consider smoking to be a chronic disease.

observations make up between 5 and 10% of the total sample. However, because the groups in the "other" race category are very different from each other, we drop them from our sample.

To augment our baseline frailty index, we include deficits related to chronic pain (Skinner and Atlas (2010) documents the prevalence of pain among HRS respondents, emphasizing its importance across demographic groups), mental health, cognition, and harmful habits like smoking and being a heavy alcohol user. These additional deficits are included only in the expanded 51-deficit version of the index discussed in Section 3.1.

2.1 Deficits Prevalence

To describe the sources of frailty differences at age 55, we report prevalence rates for each health deficit included in the frailty index by race, ethnicity, and gender. Figure 1 summarizes the prevalence of deficits for the 55–59 age group, for both women and men, for all deficits included in our baseline frailty index.[4] It shows that the most prevalent deficit differs across race and gender groups, indicating that frailty gaps are not driven by a single condition common to all groups. For women, the most prevalent deficit varies by race. Among White women, the most common deficit is having ever smoked (54.5%), while among Hispanic women it is difficulty climbing several flights of stairs (51.5%), and among Black women it is high blood pressure (67.2%). In contrast, for men in all three groups, the most prevalent deficit (after having ever smoked) is high blood pressure, affecting 42.4%, 43.7%, and 60.8% of White, Hispanic, and Black men, respectively. This pattern is consistent with the prevalence of high blood pressure by age and race reported in McWilliams, Meara, Zaslavsky, and Ayanian (2009).

Other major health deficits also display systematic differences across groups. Obesity and diabetes are substantially more prevalent among Hispanic and Black men and women than among White individuals (as also found by Peek, Cargill, and Huang (2007) and Petersen, Pan, and Blanck (2019)). For example, obesity affects 33.6% of White women, compared with 44.3% and 55.4% of Hispanic and Black women, and 32.7% of White men, compared with 35.4% and 40.4% of Hispanic and Black men. Similarly, diabetes affects 11.0% of White

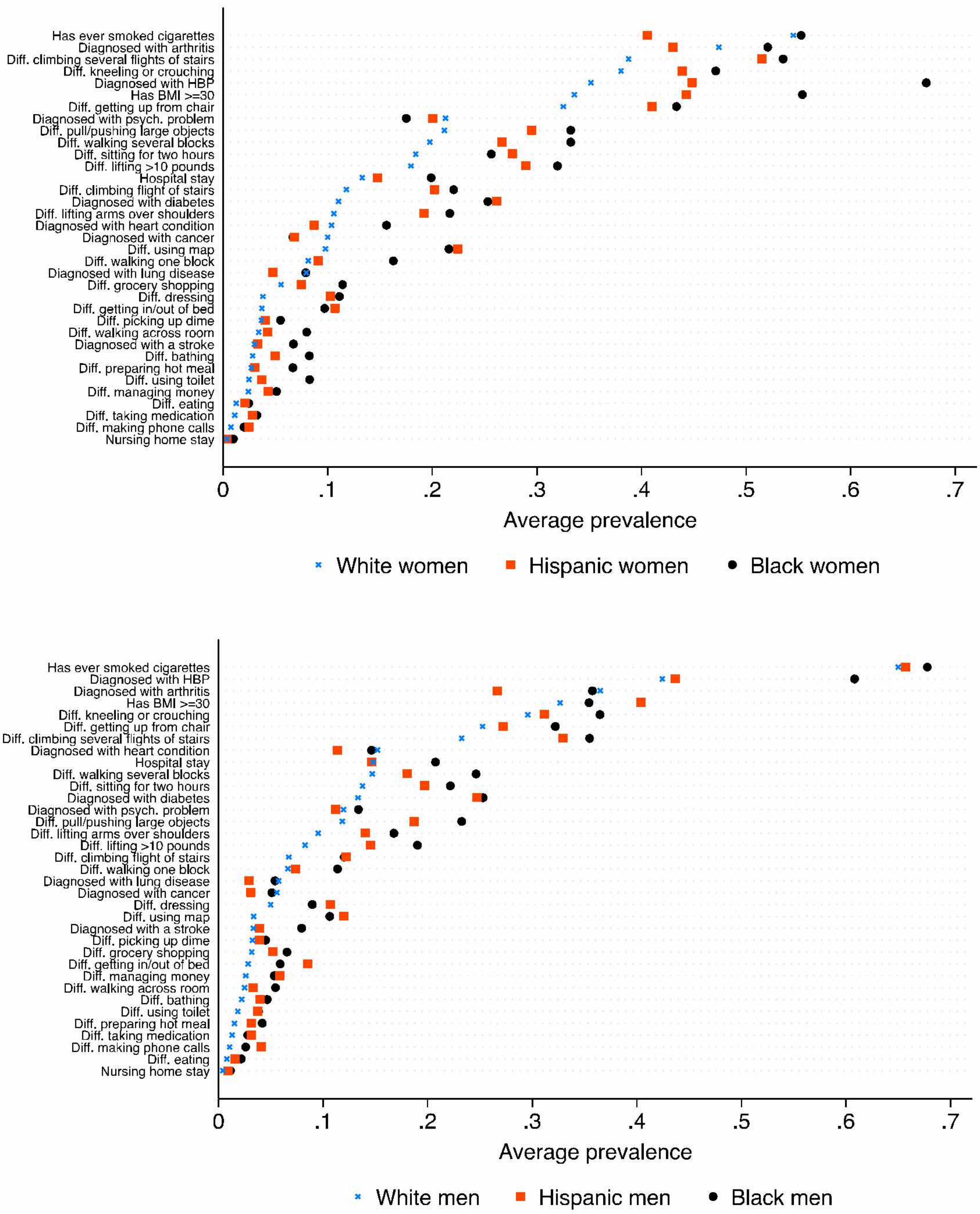
4. We do not report data for our younger group (ages 51 to 54) because, due to the nature of the sampling frame, it is the smallest group and under-represents men.

Table 1: Health deficits

Deficit	Deficit
Baseline frailty	
ADLs	Difficulty lifting a weight heavier than 10 lbs
Difficulty bathing	Difficulty lifting arms over the shoulders
Difficulty dressing	Difficulty picking up a dime
Difficulty eating	Difficulty pulling/pushing large objects
Difficulty getting in/out of bed	Difficulty sitting for two hours
Difficulty using the toilet	
Difficulty walking across a room	***Diagnoses***
Difficulty walking one block	Diagnosed with high blood pressure
Difficulty walking several blocks	Diagnosed with diabetes
	Diagnosed with cancer
IADLs	Diagnosed with lung disease
Difficulty grocery shopping	Diagnosed with a heart condition
Difficulty making phone calls	Diagnosed with a stroke
Difficulty managing money	Diagnosed with psychological or psychiatric problems
Difficulty preparing a hot meal	Diagnosed with arthritis
Difficulty taking medication	
Difficulty using a map	***Healthcare Utilization***
	Has stayed in the hospital in the previous two years
Other Functional Limitations	Has stayed in a nursing home in the previous two years
Difficulty climbing one flight of stairs	
Difficulty climbing several flights of stairs	***Addictive Diseases***
Difficulty getting up from a chair	Has BMI larger than 30
Difficulty kneeling or crouching	Has ever smoked cigarettes
Augmented frailty	
Pain	***Cognition***
Frequently troubled by pain	Gets lost in familiar environment
	Wanders off
Mental health	Cannot be left alone
Felt depressed	Has hallucinations
Felt like everything was an effort	Cannot count backwards from 20
Had restless sleep	
Did not feel happy most of the time	***Harmful habits***
Felt alone	Smokes now
Felt sad	Heavy alcohol use
Could not get going	
Did not enjoy life	

Notes: Each deficit takes a value of 0 (if the respondent reports not having it) or 1 (if the respondent reports having it).

Figure 1: Prevalence of health deficits, ages 55–59



women and 13.3% of White men, compared with roughly one quarter of Hispanic and Black women and men. Functional limitations show comparable gradients: 38.8% of White women report difficulty climbing several flights of stairs, compared with 51.5% and 53.5% of Hispanic and Black women, and 23.3% of White men report such difficulty, compared with 33.0% and 35.5% of Hispanic and Black men.

Differences in frailty at age 55 thus reflect systematic gaps across a wide range of health deficits rather than concentration in a small number of conditions. This broad-based pattern motivates our use of a composite frailty measure and supports counterfactuals that shift overall health at age 55, rather than focusing on a few specific conditions.

2.2 Constructing Frailty

Equally weighted **frailty** is the ratio between a person's health deficits at a certain age and the total number of deficits considered. To construct our baseline frailty index, we use the 35 health deficits described above and weight them equally. In Section 3.1, we also experiment with weighting deficits using principal component analysis (PCA) as a robustness exercise.

3 How Should We Measure Health?

Our goal is to obtain a parsimonious, easy-to-interpret measure of health that summarizes disparities in health across racial groups using a single indicator. Such a measure is useful in applications that require a univariate measure of health, such as structural models with health risk. To be useful in these settings, such a measure of health should also predict economically relevant outcomes later in life. In addition, we will use this measure to parsimoniously summarize health in our dynamic system.

To identify such a measure, we compare the predictive performance of frailty with that of SRHS, which is the workhorse measure of health in the economics literature. In particular, we evaluate the extent to which frailty and SRHS help predict becoming a disability insurance recipient, starting to receive Social Security retirement benefits, entering a nursing home, and dying. To do this, we estimate logistic regressions for each of these four outcomes. Appendix B provides more details about our empirical strategy.

Table 2 reports the pseudo-R^2 values for our logistic regressions. For each outcome, the first row of results (labeled "Basic Controls") refers to a regression with our basic controls only. The following rows report the results when adding one of our two measures of health. The last row for each group of outcomes includes both of our measures of health.[5]

Table 2 reveals several interesting facts. First, health is an important determinant of all outcomes for all demographic groups. That is, the pseudo-R^2 substantially increases for all outcomes and groups when adding either measure of health. Second, including both SRHS and frailty helps better explain all outcomes for most of our groups, and that when only one health indicator is included, frailty outperforms SRHS for most outcomes.

Third, the importance of health varies by outcome and demographic group. Health adds the most predictive power to the basic-controls-only regression for disability insurance recipiency, followed by nursing home entry in the next wave, death, and receiving Social Security benefits. The improvements in explanatory power range from 5% (for SRHS, when predicting becoming a Social Security retirement benefits recipient next wave for White men) to 1005% (for including both SRHS and frailty, when predicting becoming a disability insurance recipient for Hispanic men). Several papers have examined the effects of health on retirement and found results consistent with ours, including French (2005), Blundell, French, and Tetlow (2016), and French and Jones (2017).

This shows that both SRHS and frailty effectively predict key economic outcomes by race and ethnicity and, in this sense, are reliable measures of health. Combined, they predict these outcomes even more accurately. However, our subsequent analysis requires a univariate measure, motivating our selection of frailty over SRHS on the basis of predictive power.

5. In Appendix B.1, we describe the relationship between the frailty index and the economic outcomes described in this section. In particular, we report the marginal effects and predicted probabilities obtained from the logistic regressions whose pseudo-R^2's we present in the "Frailty" row of Table 2

Table 2: Pseudo-R^2 table

		Women			Men		
		White	Hispanic	Black	White	Hispanic	Black
SDI Recipient Next Wave	Basic Controls	0.048	0.046	0.036	0.045	0.022	0.032
	SRHS	0.212	0.122	0.129	0.186	0.112	0.122
	Frailty	0.244	0.193	0.185	0.245	0.222	0.175
	Frailty and SRHS	0.268	0.202	0.199	0.264	0.241	0.196
SS Benefits Recipient Next Wave	Basic Controls	0.118	0.081	0.083	0.134	0.101	0.120
	SRHS	0.128	0.110	0.102	0.140	0.128	0.126
	Frailty	0.126	0.091	0.097	0.142	0.112	0.139
	Frailty and SRHS	0.132	0.123	0.114	0.147	0.145	0.145
NH Entry Next Wave	Basic Controls	0.241	0.172	0.169	0.220	0.144	0.122
	SRHS	0.285	0.209	0.206	0.266	0.194	0.176
	Frailty	0.315	0.231	0.214	0.303	0.272	0.234
	Frailty and SRHS	0.319	0.250	0.227	0.308	0.291	0.244
Death Next Wave	Basic Controls	0.166	0.157	0.120	0.140	0.157	0.109
	SRHS	0.240	0.194	0.169	0.219	0.212	0.151
	Frailty	0.266	0.221	0.189	0.237	0.244	0.176
	Frailty and SRHS	0.276	0.230	0.201	0.251	0.253	0.182
		Percentage change from basic controls					
SDI Recipient Next Wave	SRHS	341%	166%	260%	318%	412%	283%
	Frailty	407%	320%	416%	450%	916%	449%
	Frailty and SRHS	458%	341%	454%	492%	1,005%	514%
		Percentage change from basic controls					
SS Benefits Recipient Next Wave	SRHS	9%	37%	23%	5%	27%	5%
	Frailty	7%	13%	17%	6%	11%	16%
	Frailty and SRHS	12%	53%	38%	10%	43%	21%
		Percentage change from basic controls					
NH Entry Next Wave	SRHS	18%	21%	22%	21%	35%	44%
	Frailty	31%	34%	27%	38%	89%	92%
	Frailty and SRHS	32%	45%	34%	40%	102%	102%
		Percentage change from basic controls					
Death Next Wave	SRHS	45%	24%	41%	57%	35%	39%
	Frailty	60%	41%	57%	69%	55%	62%
	Frailty and SRHS	66%	47%	67%	79%	61%	61%

3.1 Alternative Health Deficits and Weights

We now turn to evaluating alternative versions of our frailty index to assess how additional deficits and weighting methods affect its predictive power. We begin with the baseline frailty index, constructed using 35 deficits, and compare it to four variants: PCA-weighted baseline frailty, equally-weighted frailty with 51 deficits, PCA-weighted frailty with 51 deficits, and augmented frailty without diagnosed deficits.

To evaluate whether our baseline frailty is a better measure of health than its variants, we compare its predictive power for the outcomes described in the previous section by estimating logistic regressions, changing the frailty measure, and comparing the resulting pseudo-R^2.

For our PCA-frailty, we perform principal component analysis (PCA) and derive weights based on the first principal component of the deficits, following Poterba, Venti, and Wise (2017) and Hosseini, Kopecky, and Zhao (2022). Figure 2 shows that PCA increases the weights of ADL and IADL deficits while assigning lower or even negative weights to behaviors like heavy alcohol use and smoking. Negative weights for heavy alcohol use arise because it is negatively correlated with most deficits (and positively correlated with lung disease, depression, and other behavioral deficits). Importantly, PCA-frailty shows no significant improvement in predictive power over the equally weighted baseline frailty (see Table 3).[6]

To explore the impact of including more health information, we construct an augmented frailty index with 51 deficits. This version incorporates additional measures related to pain, mental health, cognition, and unhealthy behaviors like smoking and excessive alcohol consumption (See bottom panel of Table 1). The inclusion of these deficits also does not result in higher predictive power for most outcomes compared to the baseline frailty index.

Next, we apply PCA to the augmented frailty index, assigning weights based on the first principal component of the 51 deficits. Because four cognition-related deficits have minimal variation (such as hallucinations and wandering off), PCA-weighting excludes them

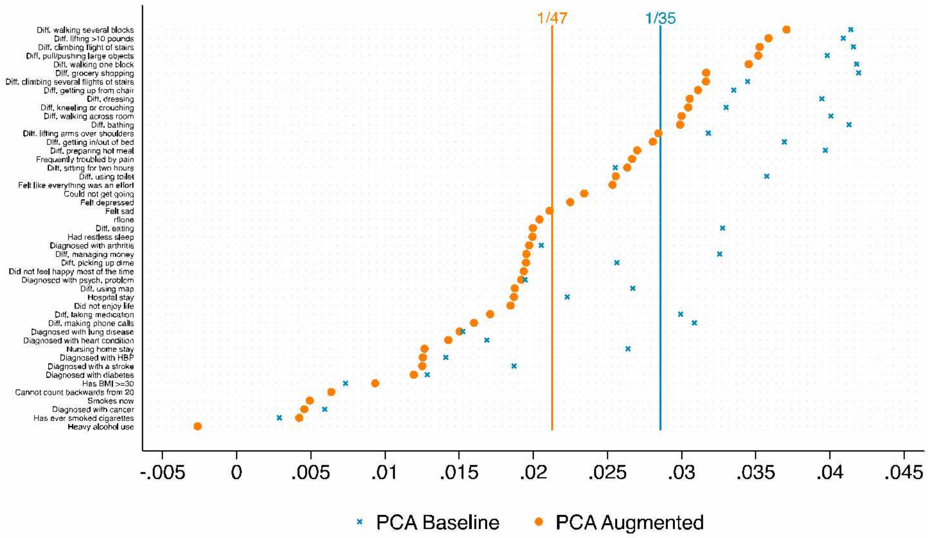
6. Appendix B.3 reports the proportion of variance in the data explained by the principal components and the PCA weights in table format.

and only uses 47 deficits. Figure 2 shows that, similar to the PCA-weighted baseline frailty, this measure places greater weight on ADL and IADL deficits and less on behavioral factors. As shown in Table 3, baseline frailty outperforms PCA-weighted augmented frailty for most outcomes.

Finally, because Searle, Mitnitski, Gahbauer, Gill, and Rockwood (2008) states that as long as a frailty index includes 30 deficits, the exact composition of these deficits does not matter, and because there may be heterogeneity in the diagnosis rate across the demographic groups we consider, we also remove the eight diagnosed deficits from augmented frailty and weigh the resulting 43 deficits equally. Table 3 shows that baseline frailty outperforms this variant of the frailty index as well. This is particularly visible for nursing home entry and death, which signals that diagnosed deficits are important determinants of these outcomes. This is also consistent with the fact that heart disease and cancer are the leading causes of death in the United States.

Thus, our baseline frailty index is the most predictive health measure in our sample. Neither adding more deficits nor applying PCA weighting substantially improves predictive power or alters frailty dynamics, consistent with Hosseini, Kopecky, and Zhao (2022). In addition, our baseline frailty index is easy to construct and readily exportable to other settings, as it relies on health deficits that are commonly available in datasets such as the Survey of Health, Ageing and Retirement in Europe (SHARE) and the Medical Expenditure Panel Survey (MEPS).

Figure 2: Deficit weights



Notes: The blue markers report the weights associated with the PCA-weighted baseline frailty. The solid blue line denotes the weight for the equally weighted baseline frailty, equal to 1/35=0.0286. The orange dots represent the weights associated with the PCA-weighted augmented frailty. The solid orange line marks the weight for the equally weighted augmented frailty, equal to 1/47=0.0213.

Table 3: Pseudo-R^2 for alternative frailty measures

		Women			Men		
		White	Hispanic	Black	White	Hispanic	Black
SDI Recipient Next Wave	Basic Controls	0.048	0.046	0.036	0.045	0.022	0.032
	Baseline Frailty	0.244	0.192	0.185	0.245	0.222	0.175
	PCA Baseline Frailty	0.247	0.185	0.185	0.245	0.212	0.184
	Augmented Frailty	0.242	0.182	0.184	0.253	0.188	0.176
	PCA Augmented Frailty	0.248	0.178	0.189	0.254	0.201	0.183
	Augmented Frailty without diagnoses	0.237	0.175	0.180	0.241	0.178	0.170
SS Benefits Recipient Next Wave	Basic Controls	0.119	0.081	0.084	0.135	0.102	0.118
	Baseline Frailty	0.126	0.093	0.097	0.142	0.114	0.137
	PCA Baseline Frailty	0.127	0.092	0.097	0.142	0.114	0.137
	Augmented Frailty	0.125	0.095	0.095	0.143	0.117	0.139
	PCA Augmented Frailty	0.126	0.095	0.095	0.144	0.122	0.140
	Augmented Frailty without diagnoses	0.126	0.095	0.093	0.142	0.117	0.136
NH Entry Next Wave	Basic Controls	0.242	0.172	0.165	0.219	0.139	0.120
	Baseline Frailty	0.321	0.233	0.212	0.302	0.272	0.237
	PCA Baseline Frailty	0.320	0.230	0.211	0.304	0.268	0.238
	Augmented Frailty	0.290	0.209	0.181	0.277	0.242	0.175
	PCA Augmented Frailty	0.287	0.204	0.179	0.276	0.236	0.173
	Augmented Frailty without diagnoses	0.288	0.204	0.180	0.275	0.235	0.174
Death Next Wave	Basic Controls	0.169	0.160	0.122	0.141	0.154	0.107
	Baseline Frailty	0.270	0.220	0.192	0.239	0.239	0.174
	PCA Baseline Frailty	0.265	0.216	0.187	0.236	0.233	0.172
	Augmented Frailty	0.204	0.145	0.116	0.201	0.196	0.123
	PCA Augmented Frailty	0.197	0.113	0.109	0.196	0.191	0.119
	Augmented Frailty without diagnoses	0.196	0.140	0.109	0.195	0.189	0.119

4 How Large are Health Disparities?

Given that frailty is the single most predictive measure of health and has an intuitive quantitative interpretation, we use it to study health inequality.

4.1 How Unequal is Frailty?

Frailty is a crucial indicator of an individual's health and resilience. But does the burden of frailty differ across racial and ethnic groups? To explore this, we turn to Figure 3, where Panels (a) and (b) report average frailty levels for men and women, respectively.

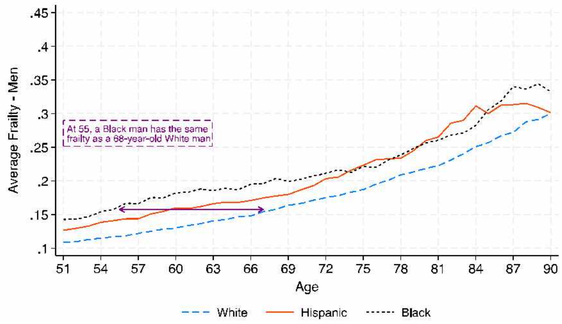
The data suggest a clear pattern: on average, White men and women experience lower levels of frailty compared to Black and Hispanic men and women. For example, a 55-year-old Black man typically exhibits a level of frailty similar to that of a Hispanic man who is 5 years older (age 60) and a White man who is 13 years older (age 68). Similarly, a 55-year-old Black woman tends to show frailty comparable to a Hispanic woman who is 6 years older (age 61) and a White woman who is 20 years older (age 75). These disparities persist throughout life but tend to narrow as individuals age, primarily because sicker individuals, particularly men, tend to have shorter lifespans.

Since frailty is constructed using 35 deficits, we can go from frailty to the number of one's health deficits by multiplying one's frailty by 35. For instance, 55-year-old Black women have, on average, one more health deficit compared to White women of the same age. As Figure 1 shows, the most prevalent deficits for White women between 55 and 59 are having ever smoked, being diagnosed with arthritis and high blood pressure, and having difficulties kneeling and climbing several flights of stairs. Beyond these five deficits, Black women are also affected by obesity. Moreover, the most common deficits that White and Black women share tend to be more prevalent for Black women. Similarly, 55-year-old Black men, on average, have over two more health deficits compared to White men of the same age. In particular, the four most prevalent deficits for White men between 55 and 59 are having ever smoked, being diagnosed with high blood pressure and arthritis, and obesity. These four deficits are also among the most common for Black men, but Black men in this age group also report having difficulty kneeling and climbing several flights of stairs. Here, too, the four most common deficits that Black and White men share tend to be more prevalent for Black men. These findings align with those of Carey, Miller, and Molitor (2024), who show that Black Americans are unhealthier than their White and Hispanic counterparts.

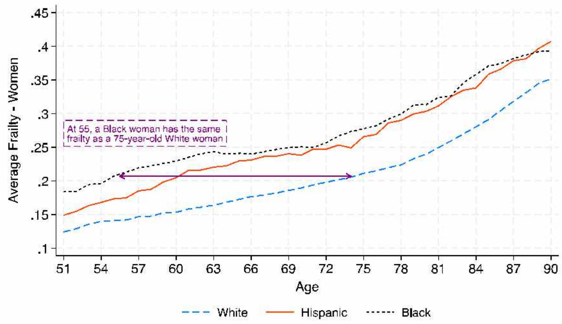
Panels (c) and (d) illustrate the percentage of individuals without frailty or health deficits by race and ethnicity, with men on the left and women on the right. Panel (c) shows that, up to approximately age 75, White men exhibit the highest proportion of individuals free from health deficits. For instance, at age 55, the share of White men with no health deficits stands at 8.9%, which is one and a half times greater than that of Black men (6.0%) and 0.5 percentage points higher than Hispanic men (8.4%). Beyond age 75, these proportions tend to converge across racial and ethnic lines, partly due to the impact of mortality. These patterns hold true for women as well. For example, at age 55, the share of White women without frailty is 8.1%, more than double that of Black women (2.6%) and 1.2 percentage points higher than Hispanic women (6.9%). Notably, disparities in women's average frailty persist for a longer period, continuing until around age 80.

Panels (e) and (f) display the standard deviations of frailty for men and women by race and ethnicity. Before age 70, women tend to exhibit greater variability in frailty than men across all demographic groups. Compared with White individuals, Black and Hispanic individuals display both higher average frailty and higher dispersion. However, dispersion is similar between Black and Hispanic individuals, suggesting that differences in average frailty between these groups mainly reflect level shifts rather than differences in variability. Additionally, the standard deviation of frailty tends to decrease with age. This trend can be attributed to two factors: the impact of mortality, as those with higher frailty levels are more likely to pass away, and the inherent construction of frailty, which has an upper limit of one, causing frailty levels to converge as individuals age.

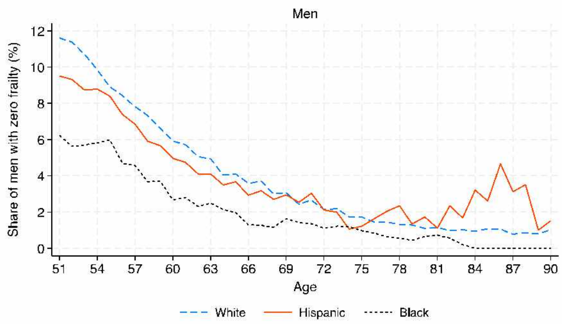
Figure 3: Average frailty, share with zero frailty, and standard deviation of frailty by age



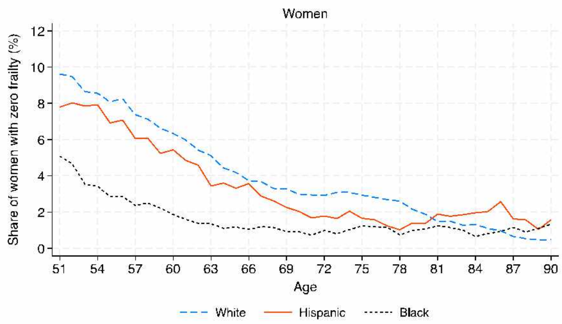
(a) Average frailty. Men



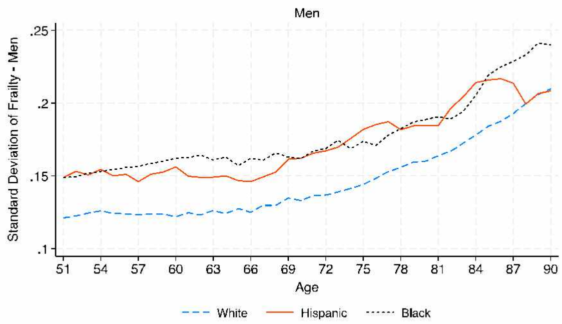
(b) Average frailty. Women



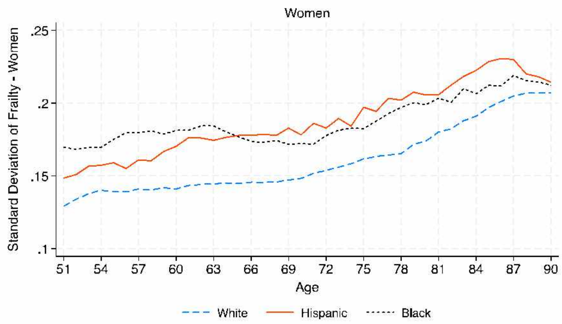
(c) Share with zero frailty. Men



(d) Share with zero frailty. Women



(e) Standard deviation of frailty. Men



(f) Standard deviation of frailty. Women

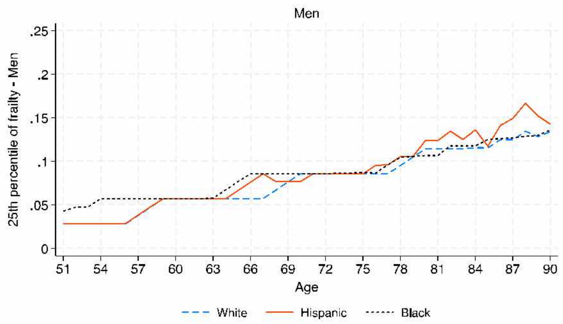
Notes: Men (left) and women (right). Each statistic is smoothed using a three-year moving average.

Figure 4 presents data on the 25th and 75th percentiles of frailty, categorized by age, race, and gender. Starting with men, Panels (a) and (c) show that differences in frailty levels among the healthiest individuals (those in the 25th percentile of frailty) are relatively modest across various racial and ethnic groups. At this frailty percentile, 60-year-old men from White, Hispanic, and Black backgrounds all experience fewer than two health deficits. However, at higher frailty percentiles, these disparities become more pronounced. Notably, Black men in the 75th percentile of frailty exhibit higher levels of frailty compared to their White and Hispanic counterparts at the same percentile. For instance, 60-year-old Black men in the 75th percentile of frailty have 9.3 health deficits, compared to 7.6 deficits for Hispanic men and 6.0 deficits for White men at the same frailty percentile.

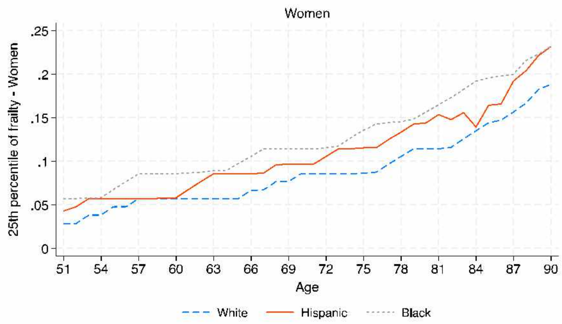
Turning to women, Panels (b) and (d) reveal more substantial disparities by race and ethnicity across all percentiles. In general, White women experience fewer deficits. For example, at age 60, White and Hispanic women at the 25th frailty percentile experience approximately two health deficits, whereas Black women face 3.0 health deficits. The contrast is even more pronounced at the 75th frailty percentile, with figures standing at 7.4, 10.4, and 11.8 health deficits for White, Hispanic, and Black women, respectively.

As argued by many others (including Alesina, Ferroni, and Stantcheva (2021)), racial gaps are large. Our results emphasize that these disparities extend beyond educational attainment and direct measures of economic well-being such as wages (as shown, for instance, by Borjas and Katz (2007)) or earnings (as documented by Kondo et al. (2024)) and that they encompass many facets of health. Health, in turn, is not only important per se but also affects many later-life economic outcomes. Our analysis quantifies how much of these disparities can be accounted for by differences in health already present at midlife.

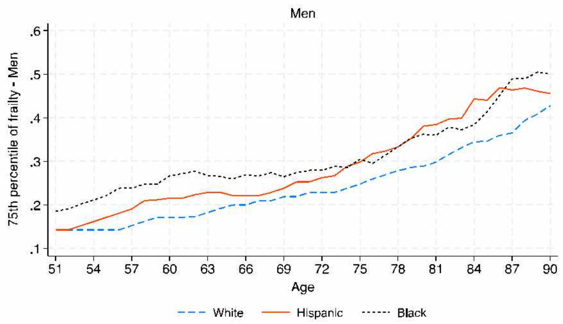
Figure 4: 25th and 75th frailty percentiles by age



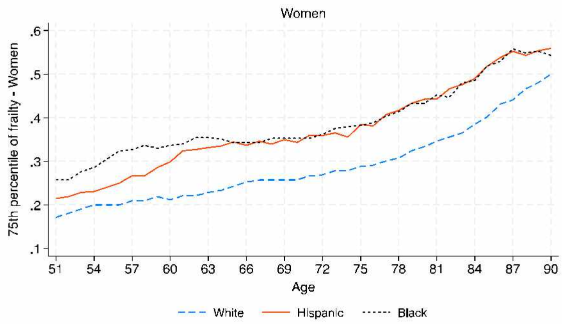
(a) 25th percentile of frailty. Men



(b) 25th percentile of frailty. Women



(c) 75th percentile of frailty. Men



(d) 75th percentile of frailty. Women

Notes: Men (left column) and women (right column). Each statistic is smoothed using a three-year moving average.

5 Quantifying the Role of Health Inequality

After documenting large health inequality by race, ethnicity, and gender, we quantify how initial health differences at age 55 are associated with differences in life expectancy and in the duration of disability, retirement, and nursing home residency.

5.1 Methodology

The core of our methodology is a statistical model that captures the dynamic evolution of health, mortality, and our economic outcomes of interest. We first estimate a Markov process for frailty, which we discretize into five levels for tractability. While we use the cutoff points of frailty quintiles to determine an individual's category, we label each category as excellent, very good, good, fair, or poor health, as in self-reported health responses. We estimate the health transition probabilities of those who survive the next period using an ordered logistic regression as

$$Prob(h_{i,t+1} = j) = H(h_{it}, X_{it}), \quad j = \{\text{Excellent, Very good, Good, Fair, Poor}\}, \tag{1}$$

where X is a set of covariates that includes cohort dummies, race dummies, the interactions of race and discretized frailty, gender dummies and their interactions with discretized frailty, health insurance coverage dummies and their interactions with discretized frailty, a second-order polynomial in age and its interactions with gender, marital status dummies, a second-order polynomial in years of education, and the interaction between years of education and age.

For the remaining outcomes, we use logistic regressions and model the probability of dying by the next wave as

$$\Pr(d_{i,t+1} = 1) = D(h_{it}, X_{it}), \tag{2}$$

and the probability of receiving disability benefits as

$$\Pr(di_{it} = 1) = \begin{cases} DI(h_{it}, di_{i,t-1}, X_{it}), & \text{if } age_{it} < FRA_i, \\ 0, & \text{if } age_{it} \geq FRA_i, \end{cases} \tag{3}$$

where we account for the fact that disability benefits convert to retirement benefits upon reaching the full retirement age (FRA).

We model the probability of receiving Social Security retirement benefits as

$$\Pr(ss_{it} = 1) = \begin{cases} 0 & \text{if } age_{it} \leq 60, \\ SS(h_{it}, X_{it}, t), & \text{if } 60 \leq age_{it} \leq 75 \text{ and } ss_{i,t-1} = 0, \\ 1, & \text{if } age_{it} > 75 \text{ or } ss_{i,t-1} = 1. \end{cases} \tag{4}$$

Here, the set of controls, X_{it}, also includes a dummy for full retirement age, which we describe in Appendix B.2.

We model the probability of living in a nursing home as

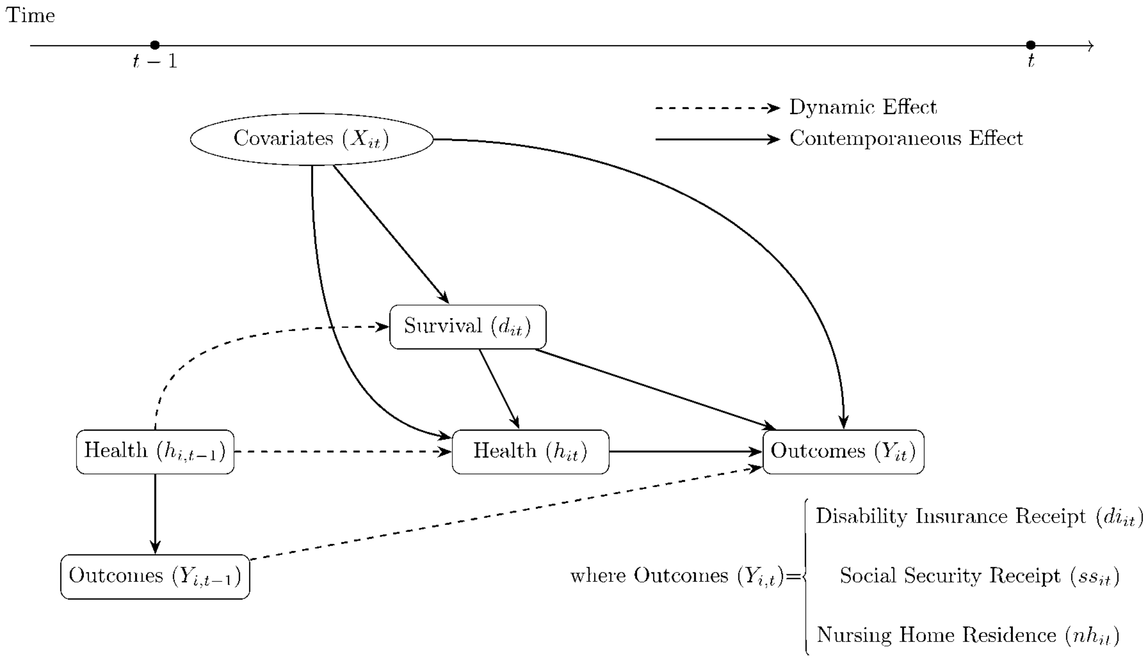
$$\Pr(nh_{it} = 1) = NH(h_{it}, nh_{i,t-1}, X_{it}). \tag{5}$$

After estimating the probabilities in Equations (1)-(5), we simulate histories of health, disability and retirement benefits recipiency, nursing home stays, and death.[7] We quantify the implications of equalizing health at age 55 by assigning everyone the initial frailty (at age 55) of White people on our realized simulation histories. Appendix C describes the details of the implementation of our counterfactual experiment.

The system of equations above defines a dynamic model of survival, health evolution, and economic outcomes that we use in our simulations. Figure 5 summarizes the timing and causal structure implied by this system. For example, last period's health directly affects

7. In these simulations, we focus on a single cohort and zero out the estimated cross-cohort differences.

Figure 5: A dynamic model of survival, health evolution, and economic Outcomes



survival and, conditional on surviving, the probability of transitioning to better or worse health today. However, previous health has no direct effect on disability insurance, Social Security benefit receipt, or nursing home residency. We assume that only current health directly affects these outcomes. Nevertheless, our model generates rich correlations between previous health and these outcomes through three indirect channels: (1) the dynamic effect on health today, (2) the impact on previous outcomes and their dynamic effects, and (3) common covariates such as race, gender, and education over time.

Our specification allows race and gender to directly affect the probability of survival, health transitions, and economic outcomes. Additionally, we allow them to have differential effects by current health. These features capture two important forces that may generate inequality. First, they capture (potentially optimal) differences in the choices of individuals, such as those with longer expected lifespans retiring later. Second, they capture structural barriers that might lead to different outcomes across groups even if agents make the same choices. For example, the leniency of disability insurance screening may differ by gender

(Low and Pistaferri 2019) and race, or certain groups may be systematically less likely to find gainful employment even when searching for work.

We also allow transitions to depend on education, marital status, and health insurance coverage directly. These factors may have direct effects on health transitions that mediate the effects of race. In addition, they allow us to capture broad differences in the occupations of individuals that affect future health and the necessary health capital to continue working, as well as the non-wage amenity value of employment.

Our statistical approach yields a flexible model that incorporates many factors and allows for rich dynamic relationships between our outcomes of interest. Although we do not specify a full model of inter-temporal decision-making, we view our estimated transitions as both capturing the evolution of exogenous state variables and approximating the decision rules that relate choices to the state variables and that arise in a structural model based on lifetime utility maximization. As we do not estimate a fully specified structural model and recover the "deep" parameters governing preferences, we assume that those factors remain fixed when simulating our counterfactual. In fact, our counterfactuals only change agents' initial conditions. Thus, our results are consistent with a large class of structural models with Markovian health transitions. These include those in which forward-looking agents endogenously make health investments, choose whether to apply for disability, claim Social Security, and enter a nursing home.

5.2 Marginal Effects

How important is health compared to other observables? We examine the marginal effects implied by our estimated transitions. These effects show how current health compares with other observables in predicting future health, survival, disability insurance recipiency, Social Security claiming, and nursing home residence. Appendix D reports the corresponding tables.

Among the observables in our system, current health is the strongest predictor of **future health**. For example, compared to someone in "excellent" health, someone in poor health is 75.6 percentage points less likely to be in "excellent" health within two years and 90.9 percentage points more likely to remain in "poor" health. The second-largest predictor of future health is being Black: all else equal, Black individuals are 1.3 percentage points less likely than White individuals to be in "excellent" health and 0.2 percentage points more likely to be in "poor" health. Not being legally married has significant effects on all possible future health realizations. For instance, being single reduces the likelihood of "excellent" health by 0.7 percentage points and raises the likelihood of "poor" health by 0.5 percentage points. Being one year older decreases the probability of "excellent" or "very good" health (by 0.2 and 0.05 percentage points, respectively) and increases the probability of "fair" or "poor" health (by 0.05 and 0.2 percentage points). Education, instead, has positive effects, with each additional year raising the likelihood of "excellent" or "very good" health (by 0.3 and 0.01 percentage points) and lowering the likelihood of worse health realizations. Hispanic individuals are 0.3 percentage points less likely to be in "excellent" health compared to White individuals, and men are 0.2 percentage points less likely than women to be in "poor" health. Interestingly, health insurance has no significant effects on future health.

Current health is the observable with the largest impact on mortality. Compared to someone in "excellent" health, the increase in the **probability of death** ranges from 1.1 percentage points for someone in "very good" health to 13.7 percentage points for someone in "poor" health. The second largest contributor to the probability of death is gender, with being a man increasing the probability of dying next wave by 3.8 percentage points. Gender is followed by being Hispanic, which decreases one's death probability by 1.5 percentage points, while being single rather than married increases it by 1.2 percentage points. One additional year of age increases the probability of death by 0.3 percentage points. Interestingly, being Black, more educated, and having health insurance coverage have no effects.

Current health is also the strongest predictor of disability benefits recipiency. Compared to someone in "excellent" health, the increase in the **probability of receiving disability benefits** ranges from 2.2 percentage points for someone in "very good" health to 14.5

percentage points for someone in "poor" health. Next, gender is the second-largest determinant of disability recipiency, with men being 1.7 percentage points more likely to receive benefits than women. The third most important contributor is being Hispanic, which lowers the probability by one percentage point. Compared to married people, single people are 0.7 percentage points more likely to receive disability benefits. Having health insurance, being Black, and being older have a small positive effect, ranging from 0.6 to 0.04 percentage points. Finally, one additional year of education has almost no effect on this probability.

Age is the most important predictor of the **probability of receiving retirement benefits**. Being one year older increases this probability by 7.4 percentage points. The second most important predictor is having health insurance coverage, which lowers the probability of receiving retirement benefits by 5.8 percentage points. The third most important predictor is being Hispanic, which lowers this probability by 4.3 percentage points. Being between one and two years from the full retirement age increases the probability of receiving retirement benefits by an additional 3.3 percentage points. In turn, compared to someone in "excellent" health, being in good health increases the probability of receiving retirement benefits by 2.9 percentage points. Being a man, Black, and having an additional year of education lowers the probability of receiving retirement benefits by 2.5, 2.1, and 1.6 percentage points, respectively.

Having lived in a nursing home in the past one or two years is the largest contributor to the **probability of living in a nursing home**, increasing this probability by 5.9 percentage points. The second largest contributor is being in "poor" rather than "excellent" health, which increases the probability of living in a nursing home by 4.5 percentage points. Third, being single increases the probability by 0.9 percentage points. In turn, being Hispanic reduces this probability by 0.8 percentage points, while being Black reduces it by 0.4 percentage points. Finally, being a man and being one year older increase the probability of living in a nursing home by 0.3 and 0.1 percentage points, respectively.

5.3 Does Inequality in Health at Age 55 Explain Future Outcomes?

We now examine the role of health differences at age 55 in generating disparities in later-life outcomes across racial and ethnic groups. To do so, we perform a counterfactual experiment in which we assign everyone at age 55 the health of White individuals. In Figure 6, we report all the results. Each panel corresponds to a separate figure shown at full size in Appendix E.

Time in bad health. Panel (a) in Figure 6 shows the average fraction of remaining life spent in bad health ("poor" and "fair" health states). The "Baseline" values reveal that women spend more of their remaining lives in bad health than men (40.1% for White men and 51.8% for White women) and that Hispanic men and women spend 8.2 and 9.9 percentage points more time in bad health, respectively, than their White counterparts. For Black men and women, these figures are 10.0 and 13.3 percentage points higher, respectively.

Next, we perform a counterfactual simulation in which we assign Black and Hispanic individuals the initial health of White individuals at age 55. The implied changes are substantial and highlight that frailty at age 55 accounts for a large portion of the disparities in time spent in bad health. Specifically, for Hispanic individuals compared with White individuals, initial health accounts for 26.8% of the gap for men and 40% of the gap for women. For Black individuals, it accounts for 54% of the gap for men, and for 64% for women. To the extent that health proxies an individual's quality of life, this highlights large disparities in the quality of remaining life by race.

Life expectancy. Panel (b) in Figure 6 reports simulated life expectancy at age 55. Hispanic men and women have the longest life expectancy, while Black individuals have the shortest. This result aligns with life expectancy at birth findings by Costa (2015). Figure A-7 also shows that women of all races and ethnicities have a higher life expectancy than men, which is consistent with the results, among others, of Goldin and Lleras-Muney (2019). The observation that Hispanic individuals are in worse health but live longer is known as the "Hispanic health paradox," a phenomenon documented in the medical literature by Fernandez, García-Pérez, and Orozco-Aleman (2023), Cortes-Bergoderi et al. 2013, and Markides and Coreil (1986). Equalizing initial health increases simulated life expectancy for both Hispanic and Black individuals and closes the Black-White gap by 28.6% for men and 46% for women. It is worth noting that these gaps in life expectancy between White and Black people remain despite the decrease in mortality for Black people documented between 1990 and 2010 by Currie and Schwandt (2016). Interestingly, Meara, Richards, and Cutler (2008) documents that the decrease in mortality among Black people is concentrated among the most educated.

Time spent receiving disability benefits. Panel (c) in Figure 6 reports the years spent receiving disability benefits after age 55. In the baseline, Black men and women spend the most years receiving disability benefits, while Hispanic and White people spend similar amounts of time. Specifically, Black men and women spend almost twice as long (1.6 years) receiving disability benefits as White and Hispanic individuals. Equalizing initial health at age 55 closes 43% of the gap between Black and White men and 57% of the gap between Black and White women.

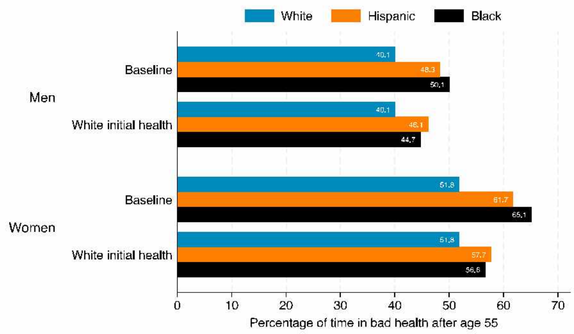
Time spent receiving retirement benefits. Panel (d) in Figure 6 shows that in our simulations, Hispanic individuals spend the longest time claiming Social Security benefits, while Black individuals spend the shortest. Specifically, Hispanic men and women receive retirement benefits for 1.1 and 1.4 years longer than White men and women, respectively. In contrast, Black men and women receive retirement benefits for 2.5 years less than their White counterparts. Equalizing initial health substantially reduces the inequality in the length of receipt of retirement benefits between Black and White individuals. The gap between Black and White men would decrease by 28%, while the one between Black and White women would decrease by 44%.

Working years. Panel (e) in Figure 6 displays the number of working years after age 55, defined as years not receiving Social Security or disability benefits. Hispanic individuals work between 1.2 and 3.6 months (0.1 and 0.3 years) longer than White individuals and over one year longer than Black individuals. Equalizing initial health to that of White individuals increases the number of working years. This increase ranges from about two months (0.2 years) for Hispanic women to almost eight months (0.6 years) for Black women. Notably, the effects of equalizing initial health are comparable to or larger than many Social Security reforms. For example, French (2005) finds that reducing Social Security benefits by 20% leads to an increase of 0.23 working years for men. This is close to the effect of equalizing the health of Hispanic men to that of White men, but is less than half the effect of equalizing health for Black men. Overall, health inequality at age 55 explains about half of the differences between Black and White individuals. Our results are consistent with those of Blundell, Britton, Dias, French, and Zou (2022), who show that racial differences in health are a major determinant of differences in employment across races. Moreover, our results suggest that the worse labor market outcomes experienced by Black individuals, such as higher unemployment rates and lower labor force participation described by Boulware and Kuttner (2024), may also be due to differences in health.

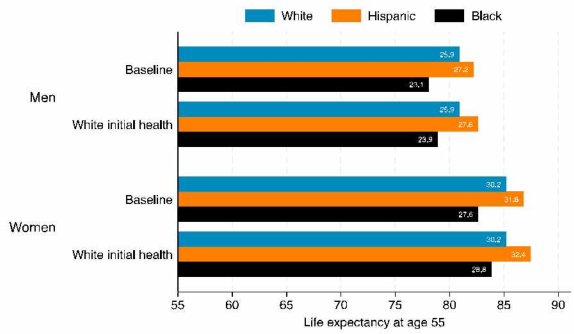
Time spent in a nursing home. Panel (f) in Figure 6 shows the number of years spent in a nursing home after age 55. In our baseline simulations, White men and women spend the most time in a nursing home, while Hispanic individuals spend the least, despite having worse health and a longer life expectancy. Specifically, White men and women spend 0.6 and 1.2 years in a nursing home, respectively, while Hispanic men and women spend 0.4 and 0.9 years, respectively. Consistent with women's longer life expectancy, women of all races and ethnicities spend more years in a nursing home than men. Equalizing initial health does not change the time spent in a nursing home for any group. This is likely because people typically enter a nursing home at around age 84 (Lam et al. (2023)), and, by then, health at age 55 is no longer an important determinant of nursing home residency. Factors like informal care from extended family may have a greater impact. For instance, Almeida, Molnar, Kawachi, and Subramanian (2009) shows that Hispanic Americans have large family networks and high levels of social support, which may explain why they spend less time in nursing homes than their White and Black counterparts.

Overall, our simulation results show that assigning 55-year-old non-White people the frailty of their White counterparts vastly reduces gaps in our outcomes of interest. Moreover, Andrews and Logan (2010) shows that racial health gaps are an important determinant of gaps in educational attainment. Therefore, if policies to reduce health gaps were available, they could also reduce gaps in other important economic outcomes. An example of such a policy is the Moving to Opportunity program in the USA, which offered people the opportunity to move to lower-poverty neighborhoods and, as shown by Sanbonmatsu et al. (2012), resulted in beneficial effects on physical (due to lower obesity rates) and mental health (through lower depression and reduced levels of psychological distress).

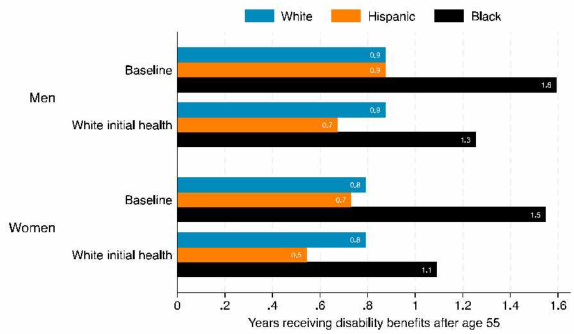
Figure 6: Counterfactual Effects of Equalizing Health at Age 55



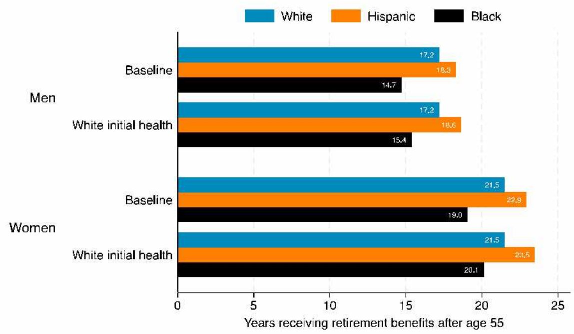
(a) Time in bad health



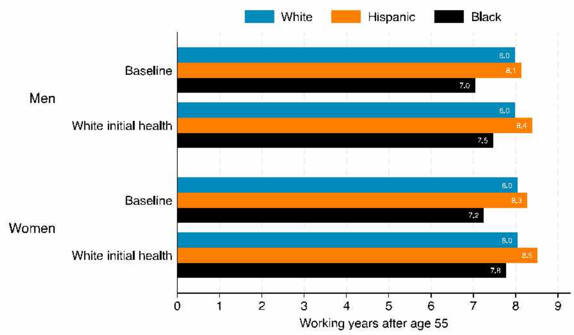
(b) Life expectancy



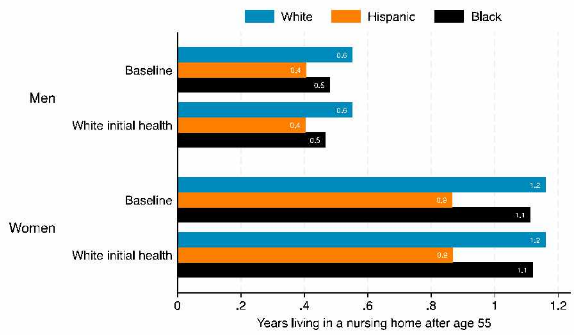
(c) Disability benefits



(d) Retirement benefits



(e) Working years



(f) Nursing home residence

Notes: Panel (a): fraction of remaining life spent in one of the two lowest health states ("poor" and "fair" health, or frailty quintiles), conditional on remaining alive. Panel (b): average life expectancy as of age 55. Panel (c): average number of years receiving disability benefits after age 55. Panel (d): average number of years receiving Social Security retirement benefits after age 55. Panel (e): Average number of working years (years not receiving Social Security or disability benefits) after age 55. Panel (f): Average number of years in a nursing home after age 55.

5.4 Equalizing socioeconomic characteristics

In the previous section, we examine how equalizing health at age 55 affects disparities in later-life outcomes. To benchmark the magnitude of these effects, we compare them to counterfactuals that equalize key socioeconomic characteristics instead. Specifically, we assign Black and Hispanic individuals the years of education, health insurance status, and marital status of White individuals of the same age and gender. We then compare the resulting changes in outcomes with those obtained when health is equalized at age 55. Figure 7 summarizes the results, while each panel is reported at full size in Appendix E.

Time spent in bad health. Equalizing socioeconomic characteristics reduces disparities in time spent in bad health much less than equalizing health at age 55. Panel (a) of Figure 7 shows that removing socioeconomic inequality reduces the gap between Hispanic and White men by 37.8%, compared to the 26.8% closure resulting from removing initial health inequality, and the gap between Black and White men by 11%, compared to the 54% closure resulting from removing health inequality. Turning to women, removing socioeconomic inequality closes 30.3% of the gap between Hispanic and White women, compared to the 40% reduction achieved by removing health inequality, and 5.3% of the gap between Black and White women, compared to the 64% reduction achieved by removing health inequality. Overall, midlife health inequality explains a substantially larger share of disparities in time spent in poor health than midlife socioeconomic inequality.

Life expectancy. In contrast to the time spent in bad health, equalizing socioeconomic characteristics generates changes in life expectancy that are similar to those obtained from equalizing health at age 55. Panel (b) of Figure 7 shows that the reductions in life expectancy gaps are comparable across the two counterfactuals for all groups. This suggests that both midlife health and midlife socioeconomic conditions play important roles in shaping differences in life expectancy after age 55.

Time spent receiving disability benefits. Midlife health inequality plays a much larger role than socioeconomic inequality in explaining disparities in disability benefit receipt. Panel (c) of Figure 7 shows that equalizing socioeconomic characteristics has essentially no effect on the time spent receiving disability benefits. In contrast, equalizing health at age 55 substantially reduces the gaps between White and non-White individuals, closing between 43% and 57% of the Black–White differences depending on gender.

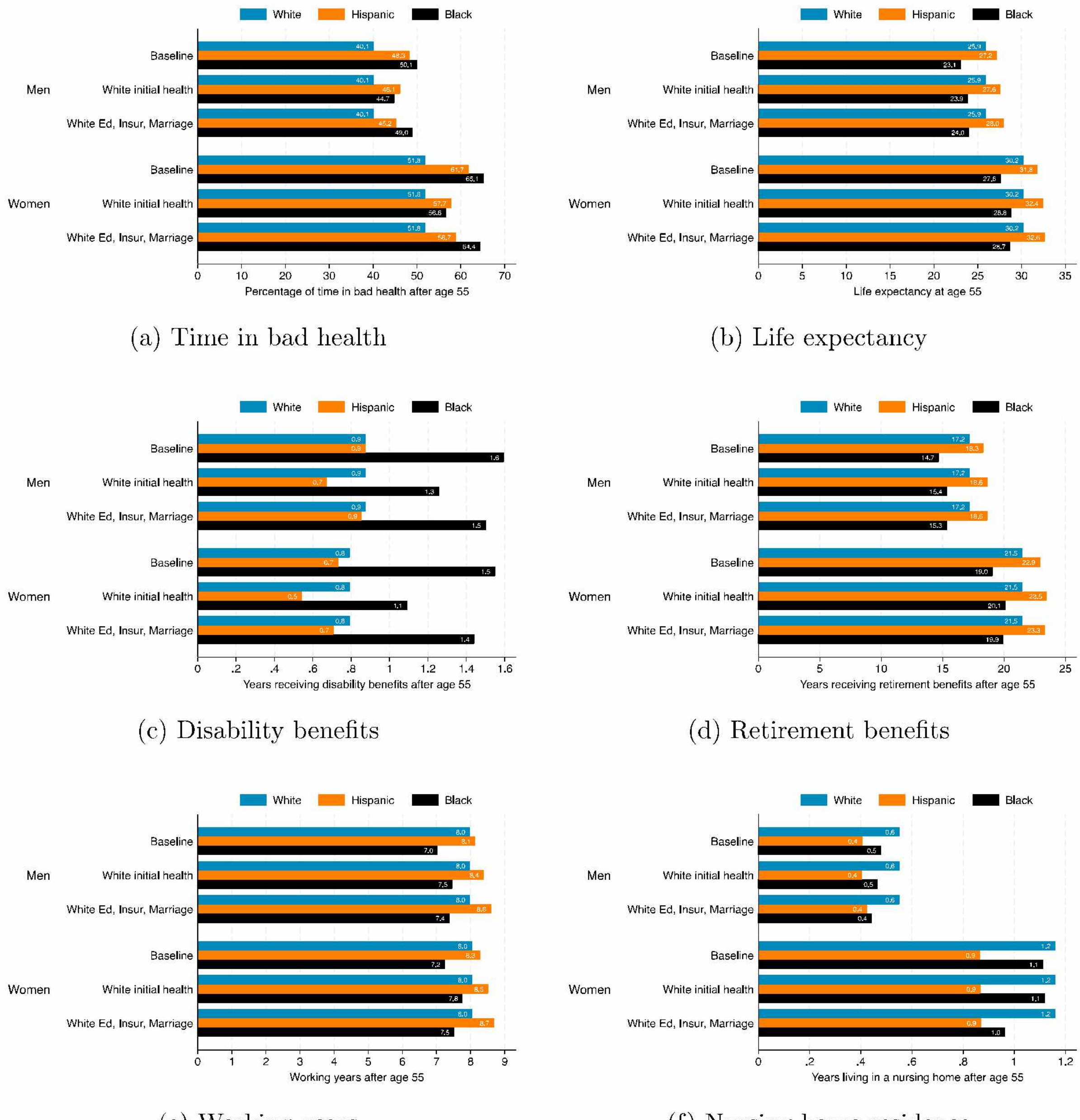
Time spent receiving retirement benefits. Equalizing socioeconomic characteristics and equalizing health at age 55 generate similar changes in the length of time spent receiving Social Security retirement benefits. Panel (d) of Figure 7 shows that both counterfactuals reduce the retirement benefit gaps by comparable magnitudes across groups.

Working years. The relative importance of health and socioeconomic inequality for working years differs across groups. Panel (e) of Figure 7 shows that equalizing socioeconomic characteristics generates larger increases in working years for Hispanic individuals than equalizing health at age 55. In contrast, for Black individuals, equalizing health produces larger increases in working years than equalizing socioeconomic characteristics.

Time spent in a nursing home. Equalizing socioeconomic characteristics has virtually no effect on the time spent in a nursing home. Panel (f) of Figure 7 shows that the simulated years in nursing home residence remain essentially unchanged for all groups. As in the previous section, this suggests that differences in health and socioeconomic characteristics at age 55 play only a limited role in explaining disparities in nursing home residence later in life.

Taken together, these results show that equalizing socioeconomic characteristics generally produces smaller changes in outcomes than equalizing health at age 55. The differences are particularly large for time spent in poor health and disability benefit receipt. For life expectancy and retirement benefits, the two sets of factors play similar roles, while neither appears to explain disparities in nursing home residence. Overall, these comparisons highlight the central role of midlife health inequality in shaping later-life outcomes.

Figure 7: Counterfactual Effects of Equalizing Socioeconomic Characteristics



(a) Time in bad health

(b) Life expectancy

(c) Disability benefits

(d) Retirement benefits

(e) Working years

(f) Nursing home residence

Notes: Panel (a): fraction of remaining life spent in one of the two lowest health states ("poor" and "fair" health, or frailty quintiles), conditional on remaining alive. Panel (b): average life expectancy as of age 55. Panel (c): average number of years receiving disability benefits after age 55. Panel (d): average number of years receiving Social Security retirement benefits after age 55. Panel (e): average number of working years (years not receiving Social Security or disability benefits) after age 55. Panel (f): average number of years in a nursing home after age 55.

6 Conclusions

We study how much disparities in health in midlife account for later-life differences in disability receipt, retirement, work, nursing home residence, survival, and time spent in poor health by race, ethnicity, and gender. These outcomes are economically important in their own right, but they are also linked: they shape reliance on public programs, affect resources later in life, and often move together. Our contribution is to bring them together and quantify how much midlife health helps account for disparities across these margins jointly.

Three findings stand out. First, the baseline frailty index proposed in the medical literature, which assigns equal weight to all deficits, predicts later-life outcomes better than self-reported health and alternative frailty measures based on more complex weighting schemes. Second, health inequality is already large at age 55: Black men and women have frailty levels comparable to those of White men and women who are 13 and 20 years older, respectively, while the corresponding gaps for Hispanic men and women are 8 and 12 years. Third, these differences matter quantitatively. Equalizing health at age 55 substantially reduces racial and ethnic gaps in time spent in poor health, disability benefit receipt, nursing home residence, life expectancy, and retirement duration. In many cases, the role of midlife health is larger than that of education, health insurance coverage, or marital status jointly.

Taken together, these results suggest that later-life disparities in disability receipt, retirement, long-term care use, health span, and survival are connected in part through differences in health already present by midlife. This matters for both interpretation and policy evaluation. Studying one outcome or one program in isolation may understate the role of health and miss how disparities extend across margins.

Our empirical framework is intended as a diagnostic tool. Rather than estimating a fully specified model of preferences and decision rules, we use estimated transitions to quantify how differences in health at midlife are associated with several later-life outcomes at once. In this way, the paper provides a benchmark for future work and helps identify the margins along which health appears most important.

More broadly, our findings suggest that policies that improve health before age 55 may affect not only health itself, but also disability receipt, retirement, long-term care use, and survival. Because health shapes several margins at once, the effects of better health may be broader than one would infer from studying any one later-life outcome in isolation.

References

Alesina, Alberto, Matteo F Ferroni, and Stefanie Stantcheva. 2021. *Perceptions of Racial Gaps, their Causes, and Ways to Reduce Them.* Working Paper, Working Paper Series 29245. National Bureau of Economic Research, September.

Almeida, Joanna, Beth E. Molnar, Ichiro Kawachi, and S.V. Subramanian. 2009. "Ethnicity and nativity status as determinants of perceived social support: Testing the concept of familism." *Social Science & Medicine* 68 (10): 1852–1858.

Alsan, Marcella, Owen Garrick, and Grant Graziani. 2019. "Does Diversity Matter for Health? Experimental Evidence from Oakland." *American Economic Review* 109, no. 12 (December): 4071–4111.

Alsan, Marcella, and Marianne Wanamaker. 2017. "Tuskegee and the Health of Black Men." *The Quarterly Journal of Economics* 133, no. 1 (August): 407–455.

Andrews, Rodney J., and Trevon D. Logan. 2010. "Family Health, Children's Own Health, and Test Score Gaps." *American Economic Review: Papers & Proceedings* 100, no. 2 (May): 195–99.

Arapakis, Karolos, Eric French, John Bailey Jones, and Jeremy McCauley. 2024. "Medical Spending Risk among Older Households by Race." Mimeo.

Arias, Elizabeth, and Jiaquan Xu. 2025. *United States Life Tables, 2023.* Technical report, National Vital Statistics Reports 6. Hyattsville, MD: National Center for Health Statistics. https://www.cdc.gov/nchs/data/nvsr/nvsr74/nvsr74-06.pdf.

Attanasio, Orazio, Sagiri Kitao, and Giovanni L Violante. 2010. "Financing Medicare: A general equilibrium analysis." In *Demography and the Economy,* 333–366. University of Chicago Press.

Bernstein, Steven L, and Benjamin A Toll. 2019. "Ask about smoking, not quitting: a chronic disease approach to assessing and treating tobacco use." *Addiction Science & Clinical Practice* 14 (1): 1–4.

Blundell, R., E. French, and G. Tetlow. 2016. "Chapter 8 - Retirement Incentives and Labor Supply," edited by John Piggott and Alan Woodland, 1:457–566. Handbook of the Economics of Population Aging. North-Holland.

Blundell, Richard, Jack Britton, Monica Costa Dias, and Eric French. 2023. "The impact of health on labor supply near retirement." *Journal of Human Resources* 58 (1): 282–334.

Blundell, Richard, Jack Britton, Monica Costa Dias, Eric French, and Weijian Zou. 2025. "The dynamic effects of health on the employment of older workers: Impacts by gender, country, and race." Working Paper - University of Cambridge.

Blundell, Richard, Jack Britton, Monica Costa Dias, Eric French, and Weijian Zou. 2022. *The Dynamic Effects of Health on the Employment of Older Workers: Impacts by Gender, Country, and Race.* MRDRC Working Paper MRDRC WP 2022-451. Ann Arbor, MI: University of Michigan Retirement and Disability Research Center (MRDRC). https://mrdrc.isr.umich.edu/publications/papers/pdf/wp451.pdf.

Borjas, George J, and Lawrence F Katz. 2007. "The evolution of the Mexican-born workforce in the United States." In *Mexican immigration to the United States,* 13–56. University of Chicago Press.

Boulware, Karl David, and Kenneth N. Kuttner. 2024. "What Explains Black Employment Dynamics?" *AEA Papers and Proceedings* 114:191–95.

Boulware, L. Ebony, Lisa A. Cooper, Lloyd E. Ratner, Thomas A. LaVeist, and Neil R. Powe. 2003. "Race and Trust in the Health Care System." *Public Health Reports* 118 (4): 358–365.

Braun, R Anton, Karen A Kopecky, and Tatyana Koreshkova. 2019. "Old, frail, and uninsured: accounting for features of the US Long-Term care insurance market." *Econometrica* 87 (3): 981–1019.

Carey, Colleen, Nolan Miller, and David Molitor. 2024. *Racial and Ethnic Disparities in SSDI Entry and Health.* Working Paper, Center Paper Series NB23-04. National Bureau of Economic Research, July.

Cook, Benjamin Lê, and Willard G Manning. 2009. "Measuring racial/ethnic disparities across the distribution of health care expenditures." *Health services research* 44 (5p1): 1603–1621.

Cortes-Bergoderi, Mery, Kashish Goel, Mohammad Hassan Murad, Thomas Allison, Virend K Somers, Patricia J. Erwin, Ondrej Sochor, and Francisco Lopez-Jimenez. 2013. "Cardiovascular mortality in Hispanics compared to non-Hispanic whites: A systematic review and meta-analysis of the Hispanic paradox." *European Journal of Internal Medicine* 24 (8): 791–799.

Costa, Dora L. 2015. "Health and the Economy in the United States from 1750 to the Present." *Journal of Economic Literature* 53 (3): 503–70.

Currie, Janet, and Hannes Schwandt. 2016. "Mortality Inequality: The Good News from a County-Level Approach." *Journal of Economic Perspectives* 30, no. 2 (May): 29–52. https://doi.org/10.1257/jep.30.2.29.

Dalgaard, Carl-Johan, and Holger Strulik. 2014. "Optimal Aging and Death: Understanding the Preston Curve." *Journal of the European Economic Association* 12 (3): 672–701.

Danesh, Kaveh, Jonathan T Kolstad, Johannes Spinnewijn, and William D Parker. 2024. *The Chronic Disease Index: Analyzing Health Inequalities Over the Lifecycle.* Working Paper, Working Paper Series 32577. National Bureau of Economic Research, June.

Darden, Michael E, and Mario Macis. 2024. *Trust and Health Care-Seeking Behavior.* Working Paper, Working Paper Series 32028. National Bureau of Economic Research, January. https://doi.org/10.3386/w32028.

De Nardi, Mariacristina, Eric French, and John Bailey Jones. 2009. "Life Expectancy and Old Age Savings." *American Economic Review* 99, no. 2 (May): 110–15. https://doi.org/10.1257/aer.99.2.110. https://www.aeaweb.org/articles?id=10.1257/aer.99.2.110.

Dieleman, Joseph L., Carina Chen, Sawyer W. Crosby, Angela Liu, Darrah McCracken, Ian A. Pollock, Maitreyi Sahu, et al. 2021. "US Health Care Spending by Race and Ethnicity, 2002-2016." *JAMA* 326, no. 7 (August): 649–659. ISSN: 0098-7484.

Dubois, Pierre, Rachel Griffith, and Martin O'Connell. 2017. "The Effects of Banning Advertising in Junk Food Markets." *The Review of Economic Studies* 85, no. 1 (April): 396–436.

———. 2020. "How Well Targeted Are Soda Taxes?" *American Economic Review* 110, no. 11 (November): 3661–3704. https://doi.org/10.1257/aer.20171898. https://www.aeaweb.org/articles?id=10.1257/aer.20171898.

Fernandez, José, Mónica García-Pérez, and Sandra Orozco-Aleman. 2023. "Unraveling the Hispanic Health Paradox." *Journal of Economic Perspectives* 37, no. 1 (February): 145–68. https://doi.org/10.1257/jep.37.1.145.

French, Eric. 2005. "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour." *The Review of Economic Studies* 72, no. 2 (April): 395–427. ISSN: 0034-6527. https://doi.org/10.1111/j.1467-937X.2005.00337.x.

French, Eric, and John Bailey Jones. 2017. "Health, Health Insurance, and Retirement: A Survey." *Annual Review of Economics* 9 (1): 383–409. https://doi.org/10.1146/annurev-economics-063016-103616.

Geiger, H Jack. 2003. "Racial and ethnic disparities in diagnosis and treatment: a review of the evidence and a consideration of causes." *Unequal treatment: Confronting racial and ethnic disparities in health care* 417:1–38.

Goldin, Claudia, and Adriana Lleras-Muney. 2019. "XX>XY?: The changing female advantage in life expectancy." *Journal of Health Economics* 67:102224.

Harttgen, Kenneth, Paul Kowal, Holger Strulik, Somnath Chatterji, and Sebastian Vollmer. 2013. "Patterns of frailty in older adults: comparing results from higher and lower income countries using the Survey of Health, Ageing and Retirement in Europe (SHARE) and the Study on Global AGEing and Adult Health (SAGE)." *PloS one* 8 (10): e75847.

Hill, Latoya, Samantha Artiga, and Sweta Haldar. 2022. "Key facts on health and health care by race and ethnicity." *Kaiser Family Foundation* 26.

Hosseini, Roozbeh, Karen Kopecky, and Kai Zhao. 2020. "How Important Is Health Inequality for Lifetime Earnings Inequality?" Working Paper. https://karenkopecky.net/HKZ_HealthAndEarningsInequality.pdf.

———. 2022. "The evolution of health over the life cycle." *Review of Economic Dynamics* 45:237–263. ISSN: 1094-2025. https://doi.org/10.1016/j.red.2021.07.001.

HRS Staff. 2017. "Sample Sizes and Response Rates" (April). https://hrs.isr.umich.edu/sites/default/files/biblio/ResponseRates_2017.pdf.

Katz, S. 1983. "Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living." *Journal of the American Geriatrics Society* 31, no. 12 (December): 721–727.

Katz, Sidney, Thomas D. Downs, Helen R. Cash, and Robert C. Grotz. 1970. "Progress in Development of the Index of ADL." *The Gerontologist* 10, no. 1_Part_1 (March): 20–30. ISSN: 0016-9013. https://doi.org/10.1093/geront/10.1_Part_1.20.

Kim, Eun Ji, Taekyu Kim, Joseph Conigliario, M. Jane Liebschutz, Michael K. Paasche-Orlow, and Amresh Hanchate. 2018. "Racial and Ethnic Disparities in Diagnosis of Chronic Medical Conditions in the USA." *Journal of General Internal Medicine* 33 (7): 1116–1123. https://doi.org/10.1007/s11606-018-4471-1.

Kondo, Illenin O, Kevin Rinz, Natalie Gubbay, Brandon Hawkins, John L Voorheis, and Abigail K Wozniak. 2024. *Granular Income Inequality and Mobility using IDDA: Exploring Patterns across Race and Ethnicity.* Working Paper, Working Paper Series 32709. National Bureau of Economic Research, July.

Lam, Kenneth, Irena Cenzer, Cari R Levy, Dan D. Matlock, Alexander K. Smith, and Kenneth E. Covinsky. 2023. "The Natural History of Disability and Caregiving Before and After Long-Term Care Entry." *JAMA Internal Medicine* 183, no. 12 (December): 1295–1303.

Lawton, M Powell, and Elaine M Brody. 1969. "Assessment of older people: self-maintaining and instrumental activities of daily living." *The gerontologist* 9 (3_Part_1): 179–186.

Lin, Pei-Jung, Allan T Daly, Natalia Olchanski, Joshua T Cohen, Peter J Neumann, Jessica D Faul, Howard M Fillit, and Karen M Freund. 2021. "Dementia diagnosis disparities by race and ethnicity." *Medical care* 59 (8): 679.

Low, Hamish, and Luigi Pistaferri. 2019. *Disability Insurance: Error Rates and Gender Differences.* Working Paper, Working Paper Series 26513. National Bureau of Economic Research, November. https://doi.org/10.3386/w26513.

Markides, Kyriakos S, and Jeannine Coreil. 1986. "The health of Hispanics in the southwestern United States: an epidemiologic paradox." *Public health reports* 101 (3): 253.

McFadden, Daniel. 1977. "Quantitative Methods for Analyzing Travel Behaviour of Individuals: Some Recent Developments." *Cowles Foundation Discussion Papers,* no. 707.

McWilliams, J Michael, Ellen Meara, Alan M Zaslavsky, and John Z Ayanian. 2009. "Differences in control of cardiovascular disease and diabetes by race, ethnicity, and education: US trends from 1999 to 2006 and effects of medicare coverage." *Annals of internal medicine* 150 (8): 505–515.

Meara, Ellen R., Seth Richards, and David M. Cutler. 2008. "The Gap Gets Bigger: Changes In Mortality And Life Expectancy, By Education, 1981–2000." PMID: 18332489, *Health Affairs* 27 (2): 350–360. https://doi.org/10.1377/hlthaff.27.2.350.

Mitnitski, Arnold, Janice Graham, Alexander Mogilner, and Kenneth Rockwood. 2002. "Frailty, fitness and late-life mortality in relation to chronological and biological age." *BMC Geriatrics* 2 (1). https://doi.org/10.1186/1471-2318-2-1.

Mitnitski, Arnold B., Alexander J. Mogilner, and Kenneth Rockwood. 2001. "Accumulation of Deficits as a Proxy Measure of Aging." Edited by Thomas E. Johnson. *The Scientific World Journal* 1:323–336. ISSN: 2356-6140. https://doi.org/10.1100/tsw.2001.58.

Ofstedal, Mary B., and David R. Weir. 2011. "Recruitment and Retention of Minority Participants in the Health and Retirement Study." *The Gerontologist* 51, no. suppl_1 (June): S8–S20.

Peek, Monica E, Algernon Cargill, and Elbert S Huang. 2007. "Diabetes health disparities." *Medical care research and review* 64 (5_suppl): 101S–156S.

Petersen, Ruth, Liping Pan, and Heidi M Blanck. 2019. "Peer reviewed: Racial and ethnic disparities in adult obesity in the United States: CDC's tracking to inform state and local action." *Preventing chronic disease* 16. https://doi.org/10.5888/pcd16.180579.

Poterba, James M., Steven F. Venti, and David A. Wise. 2017. "The asset cost of poor health." *The Journal of the Economics of Ageing* 9:172–184.

Rockwood, Kenneth, Xiaowei Song, and Arnold Mitnitski. 2011. "Changes in relative fitness and frailty across the adult lifespan: evidence from the Canadian National Population Health Survey." *Cmaj* 183 (8): E487–E494.

Sanbonmatsu, Lisa, Nicholas A. Potter, Emma Adam, Greg J. Duncan, Lawrence F. Katz, Ronald C. Kessler, Jens Ludwig, et al. 2012. "The Long-Term Effects of Moving to Opportunity on Adult Health and Economic Self-Sufficiency." *Cityscape* 14 (2): 109–136. ISSN: 1936007X.

Schroeder, Heather, David Weir, and Brady West. 2023. *Representativeness of the oversamples of Blacks and Hispanics in the Health and Retirement Study: A geographic analysis of 2020.* Technical report. University of Michigan.

Searle, Samuel D, Arnold Mitnitski, Evelyne A Gahbauer, Thomas M Gill, and Kenneth Rockwood. 2008. "A standard procedure for creating a frailty index." *BMC geriatrics* 8 (1): 1–10. https://doi.org/10.1186/1471-2318-8-24.

Skinner, Jonathan, and Steven J. Atlas. 2010. "6. Education and the Prevalence of Pain." In *Research Findings in the Economics of Aging,* edited by David A. Wise, 145–166. Chicago: University of Chicago Press. ISBN: 9780226903088. https://doi.org/doi:10.7208/9780226903088-008. https://doi.org/10.7208/9780226903088-008.

Strulik, Holger. 2015. "Frailty, Mortality, and the Demand for Medical Care." *Journal of the Economics of Ageing* 6:5–12.

APPENDICES FOR ONLINE PUBLICATION

A The Data

We use the RAND HRS Longitudinal File 2018 (V2), which covers the years between 1992 and 2018. Table A-1 describes our sample selection. Our initial sample consists of 264,620 observations for all 14 waves in the HRS. Because we do not observe key health variables until wave 3, we drop observations before the third wave. Then, we restrict our attention to respondents aged 51 to 100. This leaves us with a sample of 222,552 observations. Finally, we drop all observations that report a race or ethnicity other than White, Black, or Hispanic. Our final sample consists of 216,166 individual-year observations.

Table A-1: Sample Selection

Sample	Selected out	Selected in
Initial Sample		264,620
Waves 3 - 14	32,294	232,326
Age between 51 and 100	9,774	222,552
White, Black, and Hispanic Responders	6,386	216,166

Table A-2 shows our sample breakdown by race, ethnicity, and gender in 5-year age bins. It shows that the majority of respondents for each age are White women. This happens because, at younger ages, respondents' younger wives tend to be more numerous, and at older ages because men tend to die faster. The last row of the table also shows that Black and Hispanic respondents tend to be younger than their White counterparts by 5 and 7 years, respectively.

A.1 Candidate Deficit Variables and Their Inclusion

Tables A-3 and A-4 list the 118 health deficits present in the RAND HRS data set, grouped by category, and specify those we do not include in our baseline measure of frailty, as well as the reason for it. The first column shows the name of the variable in the dataset. The

Table A-2: Sample Composition by 5-year age bins

	White		Hispanic		Black		
	Men	Women	Men	Women	Men	Women	All
Age 51-54	4,620	7,231	1,292	1,907	1,524	2,698	19,272
	0.24	0.38	0.07	0.10	0.08	0.14	1.00
Age 55-59	10,572	13,098	2,463	3,111	3,096	4,796	37,136
	0.28	0.35	0.07	0.08	0.08	0.13	1.00
Age 60-64	11,068	13,494	2,092	2,738	2,796	4,426	36,614
	0.30	0.37	0.06	0.07	0.08	0.12	1.00
Age 65-69	10,576	12,731	1,510	1,948	2,157	3,298	32,220
	0.33	0.40	0.05	0.06	0.07	0.10	1.00
Age 70-74	10,195	12,566	1,174	1,438	1,656	2,514	29,543
	0.35	0.43	0.04	0.05	0.06	0.09	1.00
Age 75-79	8,908	11,421	928	1,196	1,304	2,115	25,872
	0.34	0.44	0.04	0.05	0.05	0.08	1.00
Age 80-84	6,136	8,851	515	796	818	1,460	18,576
	0.33	0.48	0.03	0.04	0.04	0.08	1.00
Age 85-89	3,360	5,644	222	467	400	848	10,941
	0.31	0.52	0.02	0.04	0.04	0.08	1.00
Age 90-94	1,226	2,626	95	217	139	388	4,691
	0.26	0.56	0.02	0.05	0.03	0.08	1.00
Age 95-100	232	795	22	69	31	152	1,301
	0.18	0.61	0.02	0.05	0.02	0.12	1.00
Total	66,893	88,457	10,313	13,887	13,921	22,695	216,166
	0.31	0.41	0.05	0.06	0.06	0.10	1
Individuals	11,361	13,994	2,119	2,628	2,953	4,291	37,346
Average birth year	1937	1936	1943	1943	1942	1942	1938

Notes: The first row denotes the number of observations, while the second one displays their share in that age bin. The last two rows display the number of individuals and the average birth year for each demographic group. The last column shows the total by row.

second letter `w` in each variable name is a placeholder for the corresponding HRS wave. For instance, `r3shlt` denotes the self-reported health status variable in the third wave of the HRS. The second column provides a brief description of the variable, while the third column indicates the range of values each variable can take. The fourth column summarizes our reason for elimination when we eliminate that variable.

To establish whether a health deficit should be included in our frailty index, we evaluate candidate deficits along the following dimensions

1. Whether they meet the five criteria outlined in Searle, Mitnitski, Gahbauer, Gill, and Rockwood (2008):

   (a) The candidate deficit must be related to health status.

   (b) The prevalence of the candidate deficit must generally increase with age.

   (c) The candidate deficit must not saturate too early.

   (d) The total set of deficits must cover a range of systems in the body.

(e) If used for comparisons over time, the set of deficits used to construct the frailty index must remain the same.

2. Whether the question related to the deficits has been asked to everyone in every wave.

3. Whether the share of missing values makes the candidate deficit unusable.

Incomplete Variables. Forty-three variables are either not asked consistently between waves 3 and 14 or only asked to a subsample of respondents. We highlight them in yellow in Tables A-3 and A-4. Incomplete variables include several cognition-related deficits, which are only asked about in proxy interviews. We include four of them in our augmented frailty. Namely, we include `rwalone`, `rwhaluc`, `rwander`, and `rwlost`. We do not include the other incomplete cognition variables because several of them are not binary (like `rwdlrc` and `rwser7`) or they are only asked of respondents older than 65 (like `rwcact` and `rwpres`).

Substantial Missing Values Variables. Twenty variables have too many missing values to be usable (between 7% and 45%). A common rule of thumb in the medical and gerontology literature is not to use deficits with more than 5% of missing values when constructing frailty (see Rockwood, Song, and Mitnitski (2011)). Among the twenty variables with an excessive number of missing values, nine are related to depression. We include eight of them in our augmented measure of frailty. In particular, we include `rwdepres`, `rweffort`,`rwsleepr`, `1-rwhappy`, `rwflone`, `rwfsad`, `rwgoing`, and `1-rwenlife`. We do not include the summary mental health score `rwcesd` because it is constructed using fewer variables than the standard CESD score used by clinicians and because there is no clear threshold to establish a risk for clinical depression. We also include the cognition-related variable `rwbwc20` in our augmented frailty index. In particular, we recode this variable so that it takes the value 1 (has the deficit) for everyone who gets the backward count wrong and 0 (does not have the deficit) for everyone who gets the backward count right. We highlight the variables we exclude because of missing values in red in Tables A-3 and A-4.

Vague Variables. Seven variables are vague in the sense that the related questions lack the necessary information to establish whether these variables denote a health deficit. These variables are highlighted in blue in Tables A-3 and A-4. The variable `rwdrugs` reports whether the respondent regularly takes their prescribed medication. However, it does not report (1) The type of medication, (2) Whether the respondent has been prescribed any medication. Without this information, we cannot verify that this variable meets the criteria of Searle, Mitnitski, Gahbauer, Gill, and Rockwood (2008), and thus, it should not be used to construct a frailty index. Similarly, `rwoutpt` does not report the type of outpatient surgery undergone by the respondent, and `rwspcfac` does not specify which type of special facility (such as adult care centers, social work centers, rehabilitation facilities, and meals for the elderly or disabled) the respondent used. The variable `rwdentst` reports whether the respondent has seen a dentist in the previous two years. This variable includes routine checkups and cleaning, so it does not necessarily indicate worse health. Similarly, `rwdoctor` asks whether the respondent reports any doctor visit in the reference period. Doctor visits include annual physical exams and preventive screenings, which are not an indicator of worse health. The variable `rwjoga` reports any difficulty jogging one mile, which might be more related to one's athleticism rather than their overall health status. Finally, `rwhomcar` reports a wide range of home care services. These include, for instance, wound care for pressure sores or a surgical wound, patient and caregiver education, intravenous or nutrition therapy, injections, and monitoring serious illness and unstable health status. Therefore, it is unclear whether this variable meets the criteria of Searle, Mitnitski, Gahbauer, Gill, and Rockwood (2008).

Preventive Care Variables. Six variables refer to preventive care, which is not necessarily a signal of better or worse health. Therefore, these should not be considered deficits. They are highlighted in gray in Tables A-3 and A-4.

Unnecessary Variables. The variables reporting height (`rwheight`) and weight (`rwweight`) are unnecessary because we have a variable reporting BMI. They are highlighted in orange in Tables A-3 and A-4.

Additional Criteria and our frailty definition. In addition, we do not include unhealthy behaviors, that is, the variable related to current smoking (`rwsmoken`) and the three variables related to alcohol consumption (`rwdrink`, `rwdrinkd`, `rwdrinkn`) in our baseline frailty index. However, we include these variables in our augmented frailty. In particular, we include `rwsmoken` and combine `rwdrinkd` and `rwdrinkn` to create a deficit we label "heavy alcohol use."[8] We also include a deficit related to whether respondents are frequently troubled by pain in the augmented frailty index. This deficit is not available in the RAND HRS but is available in the raw HRS data. We exclude self-reported health status from both our frailty indices. Finally, we use BMI as a deficit by creating a binary variable equal to 1 when BMI is greater than 30 (the threshold for obesity). The variables we eliminate in this step are highlighted in purple in Tables A-3 and A-4. Our resulting baseline frailty index is made up of 35 deficits, while our augmented frailty index is made up of 51 deficits, which are summarized in Table 1.

8. The National Institute on Alcohol Abuse and Alcoholism (NIAAA) defines "heavy alcohol use" as consuming more than five drinks a day or 15 drinks a week for men and more than four drinks a day or eight drinks a week for women. We use the variables `rWdrinkd` (number of days a week a respondent drinks) and `rWdrinkn` (number of drinks when the respondent drinks) to construct the deficit. In particular, we construct the average number of drinks per week by multiplying `rWdrinkd` and `rWdrinkn`. Then, we set the deficit equal to 1 (deficit) if the respondent is a man and drinks more than 15 drinks or if the respondent is a woman and drinks more than eight drinks per week.

Table A-3: Candidate deficits by category

Variable Name	Description	Values	Reason for elimination
	ADLs and physical limitations		
`rwarmsa`	Any difficulty reaching arms above shoulder level	binary	
`rwbatha`	Any difficulty bathing	binary	
`rwbeda`	Any difficulty getting in and out of bed	binary	
`rwchaira`	Any difficulty getting up from a chair after sitting for long periods	binary	
`rwclim1a`	Any difficulty climbing one flight of stairs without resting	binary	
`rwclimsa`	Any difficulty climbing several flights of stairs without resting	binary	
`rwdimea`	Any difficulty picking up a dime from the table	binary	
`rwdressa`	Any difficulty getting dressed	binary	
`rweata`	Any difficulty eating	binary	
`rwlifta`	Any difficulty lifting or carrying weights over 10 pounds	binary	
`rwpusha`	Any difficulty pushing or pulling large objects	binary	
`rwsita`	Any difficulty sitting for about two hours	binary	
`rwstoopa`	Any difficulty stooping, kneeling, or crouching	binary	
`rwtoilta`	Any difficulty using the toilet	binary	
`rwwalk1a`	Any difficulty walking one block	binary	
`rwwalkra`	Any diffulty walking across a room	binary	
`rwwalksa`	Any difficulty walking several blocks	binary	
`rwjoga`	Any difficulty jogging one mile	binary	vague question
	Alcohol and Smoking		
`rwsmokev`	Ever smoked	binary	
`rwdrink`	Ever drinks any alcohol	binary	additional
`rwdrinkd`	Number of days a week they drink	continuous	additional
`rwdrinkn`	How many drinks when they drink	continuous	additional
`rwsmoken`	Smoke now	binary	additional
	Cognition		
`rwalone`	Can be left alone for an hour or so	binary	incomplete
`rwvocab`	Vocabulary score	1-10 scale	incomplete
`rwcact`	Correctly name cactus	binary	incomplete
`rwscis`	Correctly name scissors	binary	incomplete
`rwpres`	Correctly name the president	binary	incomplete
`rwvp`	Correctly name the vice-president	binary	incomplete
`rwhaluc`	Ever sees or hears things that are not really there	binary	incomplete
`rwwander`	Ever wanders off and does not return on his or her own	binary	incomplete
`rwlost`	Gets lost in familiar environment	binary	incomplete
`rwbwc20`	Backwards count from 20	0-2 scale	missing values
`rwcogtot`	Summary score for word recall and mental status together	continuous	missing values
`rwdw`	Correct date - day of the week	binary	missing values
`rwdy`	Correct date - day	binary	missing values
`rwmo`	Correct date - month	binary	missing values
`rwyr`	Correct date - year	binary	missing values
`rwmstot`	Summary score for mental status	continuous	missing values
`rwser7`	Serial 7s test	continuous	missing values
`rwtr20`	Summary score for total word recall	continuous	missing values
`rwdlrc`	Delayed word recall	continuous	missing values
`rwimrc`	Immediate word recall	continuous	missing values
	Depression		
`rwcesd`	CESD score	continuous	missing values
`rwdepres`	Felt depressed much of the time in the week before the interview	binary	missing values
`rweffort`	Felt like everything is an effort much of the time in the week before the interview	binary	missing values
`rwenlife`	Enjoyed life much of the time in the week before the interview	binary	missing values
`rwflone`	Felt lonely much of the time in the week before the interview	binary	missing values
`rwfsad`	Felt sad much of the time in the week before the interview	binary	missing values
`rwgoing`	Could not get going much of the time in the week before the interview	binary	missing values
`rwhappy`	Was happy much of the time in the week before the interview	binary	missing values
`rwsleepr`	Slept was restless much of the time in the week before the interview	binary	missing values

Notes: First column: name of the variable in the dataset. Second column: description of the variable. Third column: range of values each variable can take. Fourth column: reason for elimination.

Table A-4: Candidate deficits by category

Variable Name	Description	Values	Reason for elimination
	Diagnoses		
rwarthre	Arthritis or rheumatisms	binary	
rwcancre	Cancer or a malignant tumor of any kind except skin cancer	binary	
rwdiabe	Diabetes or high blood sugar	binary	
rwhearte	Heart attack, coronary heart disease, angina, congestive heart failure, or other heart problem	binary	
rwhibpe	High blood pressure	binary	
rwlunge	Chronic lung disease except asthma such as chronic bronchitis or emphysema	binary	
rwpsyche	Emotional, nervous, or psychiatric problems	binary	
rwstroke	Stroke	binary	
rwalzhee	Ever reported Alzheimer	binary	incomplete
rwmemrye	Ever reported memory-related disease	binary	incomplete
rwdemene	Ever reported dementia	binary	incomplete
rwsleepe	Sleep disorders	binary	incomplete
	Healthcare Utilization		
rwhosp	Hospital stay in the previous 2 years	binary	
rwnrshom	Nursing home stay in the previous 2 years	binary	
rwdentst	Dental visits in the previous 2 years	binary	vague question
rwdoctor	Doctor visit in the previous 2 years	binary	vague question
rwdrugs	Regular use of prescription drugs in the previous 2 years	binary	vague question
rwhomcar	Home health care in the previous 2 years	binary	vague question
rwoutpt	Outpatient surgery in the previous 2 years	binary	vague question
rwspcfac	Use of special facilities or services in the previous 2 years	binary	vague question
	IADLs		
rwmapa	Any difficulty using a map	binary	
rwmealsa	Any difficulty preparing meals	binary	
rwmedsa	Any difficulty taking medications	binary	
rwmoneya	Any difficulty managing money	binary	
rwphonea	Any difficulty using the phone	binary	
rwshopa	Any difficulty shopping for groceries	binary	
rwcalca	Any difficulty using a calculator	binary	incomplete
	Physical Measures		
rwbalful	Full tandem stand	continuous	incomplete
rwbalfulc	Whether made compensatory movements during full-tandem stand	binary	incomplete
rwbalfult	Held a full-tandem stand the max time applicable	binary	incomplete
rwbalsbs	Duration of side-by-side tandem	continuous	incomplete
rwbalsbsc	Whether made compensatory movements during side-by-side stand	binary	incomplete
rwbalsemi	Semi-tandem stand	continuous	incomplete
rwbalsemic	Shether made compensatory movements during semi-tandem stand	binary	incomplete
rwbpdia	Diastolic blood pressure	continuous	incomplete
rwbppos	Position during BP measure	1-3 scale	incomplete
rwbppuls	Pulse	continuous	incomplete
rwbpys	Systolic blood pressure	continuous	incomplete
rwgrp	Hand grip test	continuous	incomplete
rwgrpdom	Dominant heand	binary	incomplete
rwgrpl	Hand grip test - left hand	continuous	incomplete
rwgrppos	Position during hand grip test	1-3 scale	incomplete
rwgrpr	Hand grip test - right hand	continuous	incomplete
rwpmbmi	Measured BMI	continuous	incomplete
rwpmhght	Measured height in centimeters	continuous	incomplete
rwpmwaist	Measured waist	continuous	incomplete
rwpmwght	Measured weight in kilograms	continuous	incomplete
rwpuff	Breathing test	continuous	incomplete
rwpuffpos	Position during breathing test	1-3 scale	incomplete
rwtimwlk	Timed walk test time	continuous	incomplete
rwtimwlka	Timed walk test - walking aid used	binary	incomplete
	Preventive Care		
rwbreast	Monthly self-checks for breast lumps	binary	preventive
rwcholst	Blood test for cholesterol	binary	preventive
rwflusht	Flu shot	binary	preventive
rwmammog	Mammogram	binary	preventive
rwpapsm	Pap smear	binary	preventive
rwprost	Check for prostate cancer	binary	preventive
	Other self-reported measures		
rwbmi	Self-reported BMI	continuous	
rwshlt	Self-reported health status	1-5 scale	additional
rwweight	Self-reported weight in kilograms	continuous	unnecessary
rwheight	Self-reported height in meters	continuous	unnecessary
rwback	Back problems	binary	incomplete
rwvgactx	Frequency of vigorous physical activity	1-5 scale	incomplete
rwvigact	Whether performs vigourous physical activity more than 3 times a week	binary	incomplete
rwltactx	Frequency of light physical activity	1-5 scale	incomplete
rwmdactx	Frequency of moderate physical activity	1-5 scale	incomplete

Notes: First column: name of the variable in the dataset. Second column: description of the variable. Third column: range of values each variable can take. Fourth column: reason for elimination.

A.2 Frailty Computation

When computing frailty, we allow for at most four missing deficits by observation and rescale the index accordingly. Table A-5 shows that doing so allows us to compute frailty for 99% of observations in our sample. We select this cutoff as it trades off the additional variability at the individual level introduced by including too few deficits with the reduction in variability due to maintaining a large sample.

Table A-5 reports the distribution of non-missing deficits in our sample. It shows that we observe a minimum of 12 deficits and that about 83% of observations report non-missing values for all 35 deficits we consider.

Table A-5: Distribution of non-missing deficits

	Frequency	Percentage	Cumulative Percentage
12	9	0.00	0.00
14	1	0.00	0.00
17	3	0.00	0.01
18	9	0.00	0.01
19	7	0.00	0.01
20	8	0.00	0.02
21	16	0.01	0.02
22	14	0.01	0.03
23	19	0.01	0.04
24	27	0.01	0.05
25	34	0.02	0.07
26	50	0.02	0.09
27	91	0.04	0.13
28	140	0.07	0.20
29	247	0.12	0.32
30	478	0.22	0.54
31	1,033	0.48	1.02
32	2,495	1.17	2.19
33	6,593	3.08	5.27
34	25,449	11.91	17.18
35	177020	82.82	100.00

B Details on our Empirical Strategy for Evaluating Health Measures

We start our empirical analysis by dividing our sample into six demographic groups: White, Black, and Hispanic men and women, and for each outcome, we select the appropriate age range to examine. That is, we include respondents of all ages (that is, between 51 and 100) for the outcomes of entering a nursing home, and dying. Instead, we restrict our attention to a narrower age range for receiving Social Security retirement benefits and disability insurance. In particular, we focus on respondents between the ages of 60 and 75 for receiving Social Security retirement benefits to account for the fact that one cannot claim Social Security benefits before age 62 and that few people retire after age 75. Moreover, because disability insurance converts into retirement benefits, once the recipients reach their full retirement age, we focus on respondents between age 51 and full retirement age for the disability insurance recipiency outcome. Appendix B.2 reports more details on the rules regarding disability insurance and the full retirement age.

Table A-6 describes our outcome variables and the values they take. Table A-7 summarizes the age ranges and regressors for each outcome.

Table A-6: Outcome variables

Variable	Description	Values
SDI Recipient Next Wave	In wave t, this variable tells us if the respondent will receive SDI in wave t+1	0 if does not receive SDI in t+1, and did not in t 1 if receives SDI in t+1, but did not in t missing if received SDI in t
Receiving Social Security Benefits Next Wave	In wave t, this variable tells us if the respondent will claim SS benefits in t+1 (ages 60 and older)	0 if no income from SS in t+1 and none in t 1 if positive income from SS in t+1 and none in t missing if claiming SS benefits in t
Nursing Home Entry Next Wave	In wave t, this variable tells us if the respondent will enter a nursing home in wave t+1	0 if does not live in a NH in t+1 and did not in t 1 if lives in a NH in t+1 but did not in t 1 if dies in a NH in t+1 but did not live in it in t missing if lived in a NH in t
Death Next Wave	In wave t, this variable tells us if the respondent will die in wave t+1	0 if alive in t+1 1 if dead in t+1 missing if dead in t

All of our specifications include some "basic" regressors: age (either as a third-order polynomial or age dummies), a second-order polynomial in years of education, and cohort

Table A-7: Age range and regressors other than health and basic regressors

Variable	Age Range	Regressors Other than Health and Basic
SDI Recipient Next Wave	51-FRA	3-order poly in age
Receiving SS Benefits Next Wave	60-75	Age dummies + FRA dummy
Nursing Home Entry Next Wave	51-100	3-order poly in age
Death Next Wave	51-100	3-order poly in age

Notes: Basic regressors include age, years of education, and cohort and marital status dummies. We also interact health with age, age squared, age cubed, and years of education. Age is rescaled as actual age minus 50. To ensure convergence of our logistic regressions, we drop the interactions of SRHS, age squared, and age cubed for SDI recipiency for Hispanic women and Nursing Home Entry for Hispanic men.

and marital status dummies. In some specifications, we then include one of our two health measures and its interactions with age, age squared, age cubed, and years of education. Finally, we include both measures of health and their interactions with age and education. To capture the age discontinuities provided by the Social Security system, we also add a dummy equal to 1 if the respondent is one or two years younger than his or her full retirement age.

To evaluate which health measure is the most predictive one, we compute the McFadden's pseudo-R^2 (or pseudo-R^2) for each regression. It is given by one minus the ratio of the full-model log-likelihood and the intercept-only log-likelihood, that is

$$\text{Pseudo-R}^2 = 1 - \frac{LL(\text{Full Model})}{LL(\text{Intercept-Only Model})}.$$

Therefore, it is not a measure of the proportion of the variance of the dependent variable explained by the model (as in the case of the R^2 in an OLS regression). Instead, it measures the relative improvement in model fit when adding regressors to the intercept-only model. The pseudo-R^2 varies between 0 and 1, and higher values denote a better fit of the full model. McFadden (1977) argues that values between 0.2 and 0.4 denote an "excellent fit" of the full model.

B.1 Relationship between frailty and economic outcomes

In Section 3, we showed that our baseline frailty index is the most predictive measure of health for the economic outcomes we focus on. In this Appendix, we examine the relationship between frailty and economic outcomes and how this relationship varies by race and ethnicity. To answer this question, we use our estimated logistic regressions for each outcome to compute the average marginal effects and predicted probabilities by frailty, race, ethnicity, and gender.

We report the average marginal effects, computed as the average of the marginal effects for each observation in our sample, holding all explanatory variables beyond the one of interest at their observed values. We also display graphs that show the effect of frailty on a given outcome by group. We do this by assigning that frailty value to all observations while leaving all other regressors at their observed values, and report the average predicted probability by demographic group. Our graphs report the marginal effect of frailty on the average frailty associated with having between 1 and 19 health deficits. Over 95% of our sample reports no more than 19 deficits.

Receiving Disability Insurance Benefits. Table A-8 reports the average marginal effects related to becoming an SDI recipient in the next wave. It shows that higher frailty has a statistically significant effect on the probability of receiving SDI. That is, one additional health deficit increases the probability of receiving disability benefits by 0.6 percentage points for men and 0.4 percentage points for women. Age, instead, does not have a significant effect and thus does not play an important role in driving the recipiency of disability benefits, given the other variables that we condition on. An additional year of education reduces the probability of receiving SDI, and more so for men (0.2 percentage points) than women (0.07 percentage points). Being a Hispanic person rather than a White one also reduces this probability, and more so for men (0.8 percentage points) than women (0.5 percentage points). In contrast, being single increases the probability of receiving disability benefits:

the probability of becoming an SDI recipient in the next wave for single men and women is 0.6 percentage points higher than that of married men and women, on average.

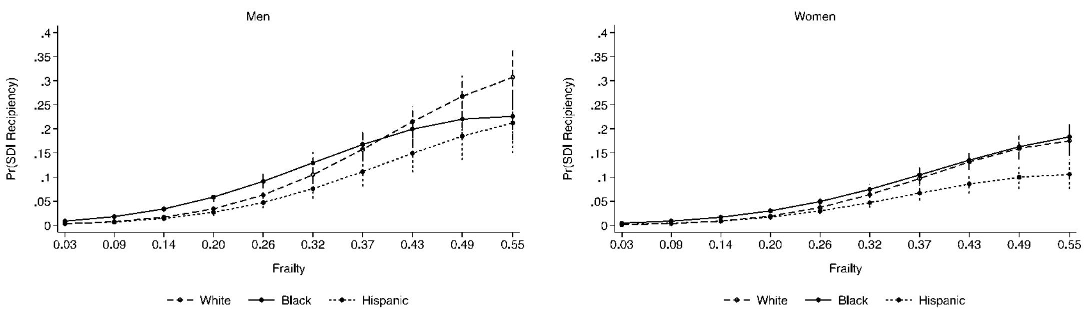
Table A-8: Receiving SDI next wave

	Men		Women	
Frailty	0.00563***	(0.000217)	0.00421***	(0.000148)
Black	0.00592**	(0.00285)	0.00470**	(0.00237)
Hispanic	-0.00803***	(0.00287)	-0.00449*	(0.00260)
Age	-0.0000449	(0.000407)	-0.000139	(0.000287)
Years of Education	-0.00162***	(0.000359)	-0.000661**	(0.000314)
Born 1950-1968	0.00218	(0.00217)	0.00137	(0.00165)
Partnered	-0.00161	(0.00343)	0.0112***	(0.00402)
Single	0.00572**	(0.00241)	0.00578***	(0.00169)

Notes: Marginal effects resulting from logistic regressions.

Figure A-1 displays the predicted probability of receiving SDI benefits in the next wave by the frailty associated with having between 1 and 19 health deficits. As one might expect, more unhealthy men and women are more likely to receive SDI. Looking more closely at men (left panel) shows that, for levels of frailty between 0.03 and 0.26, Black men are more likely to receive SDI benefits, whereas there are no significant differences at higher levels of frailty. Looking at women (right panel) shows that Black and White women tend to have a higher probability of being on disability compared to Hispanic women, especially for frailty higher than 0.43 (15 deficits).

Figure A-1: Predicted probabilities of becoming an SDI recipient next wave by frailty



Notes: Men (left panel) and women (right panel). The frailty values reported in the horizontal axis correspond to 1 to 19 conditions. The vertical lines mark the 95% confidence interval.

Receiving Social Security Benefits. Table A-9 shows the marginal effects on the probability of becoming a Social Security benefits recipient in the next wave. Starting from frailty, having worse health (i.e., higher frailty) increases the probability of retiring for men but not for women. More specifically, one additional health deficit increases the probability of retirement by 0.4 percentage points for men, on average (left column). The point estimate for women, instead, is much smaller and not statistically significant. Years of education reduce the probability of retiring for both men and women, with the effect being larger for women (2.5 percentage points) than for men (1.9 percentage points). Marital status has a particularly large negative effect on women: the probability of retiring for partnered and single women is 5.9 and 6.0 percentage points lower than that of married women, respectively. For both men and women, being Hispanic and being born between 1950 and 1958 significantly reduces the probability of retiring.

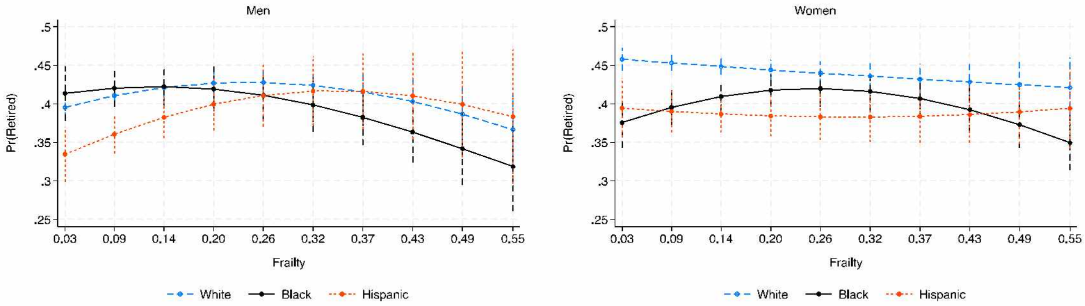
Table A-9: Receiving Social Security benefits next wave

	Men		Women	
Frailty	0.00438***	(0.00144)	-0.00113	(0.00106)
Black	-0.0103	(0.0131)	-0.0406***	(0.0111)
Hispanic	-0.0534***	(0.0157)	-0.0477***	(0.0153)
Years of Education	-0.0192***	(0.00156)	-0.0246***	(0.00146)
FRA Dummy	0.0225	(0.0163)	0.0626***	(0.0167)
Born 1950-1968	-0.125***	(0.0104)	-0.0900***	(0.00961)
Partnered	-0.00767	(0.0207)	-0.0593***	(0.0218)
Single	0.0129	(0.0112)	-0.0595***	(0.00837)

Notes: Marginal effects resulting from logistic regressions. FRA dummy = full retirement age dummy.

Figure A-2 displays the predicted probabilities of retiring in the next wave by the frailty associated with having between 1 and 19 health deficits. Consistent with the marginal effect we computed in Table A-9, the left panel shows that, for men, higher frailty tends to increase the probability of retirement. However, this occurs across some of the frailty range, but not all of it, and its pattern varies by race and ethnicity. That is, the probability of retiring increases in frailty up to 0.37 for Hispanic men, 0.26 for White men, and 0.14 for Black men. Looking at the levels highlights that, at lower levels of frailty, the probability of retiring is significantly lower for Hispanic men. The right panel shows that, for White and Hispanic women, the probability of retiring is quite flat in frailty, especially considering the large confidence intervals. For Black women, the probability of retiring increases up to a frailty of 0.26 and decreases afterward. There are no significant differences in the levels of the probability of retiring by frailty between Black and Hispanic women, while White women have a significantly higher probability of retiring for both low and high levels of frailty.

Figure A-2: Predicted probabilities of becoming a Social Security benefits recipient next wave by frailty



Notes: Men (left panel) and women (right panel). The frailty values reported in the horizontal axis correspond to 1 to 19 conditions. The vertical lines mark the 95% confidence intervals.

Nursing Home Entry. Table A-10 reports the marginal effects associated with nursing home entry in the next wave. Higher frailty significantly increases the probability of entering a nursing home: the probability increases by 0.3 percentage points for both men and women for each additional deficit. Interestingly, here, and unlike for disability recipience, age does have an independent effect on the probability of nursing home entry, even conditional on frailty. Being a year older increases this probability by about 0.2 percentage points for both men and women. Being single also increases it, especially for men, while being a Hispanic man or woman or a Black woman decreases it. In contrast, education has an insignificant effect.

Figure A-3 displays the predicted probabilities of entering a nursing home next wave by the frailty associated with having between 1 and 19 health deficits. For men and women

Table A-10: Entering a nursing home next wave

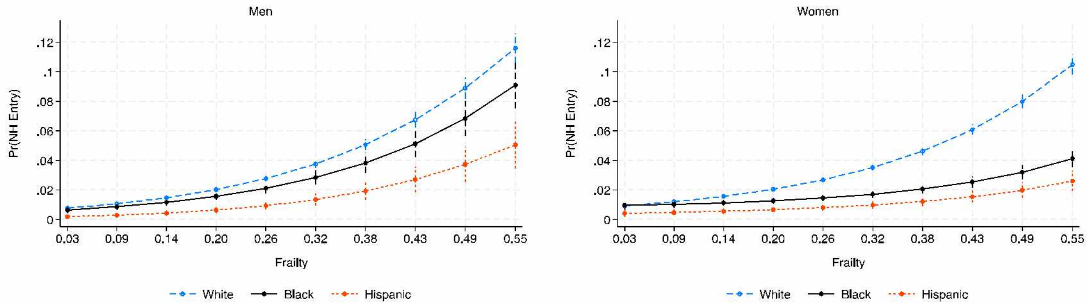
	Men		Women	
Frailty	0.00315***	(0.000102)	0.00302***	(0.0000871)
Black	-0.00231	(0.00179)	-0.0100***	(0.00135)
Hispanic	-0.0122***	(0.00195)	-0.0139***	(0.00216)
Age	0.00212***	(0.0000959)	0.00238***	(0.0000866)
Years of Education	-0.0000721	(0.000168)	0.0000356	(0.000173)
Born 1930-1949	-0.00280*	(0.00154)	-0.00554***	(0.00149)
Born 1950-1968	-0.00254	(0.00479)	-0.00750*	(0.00416)
Partnered	0.00290	(0.00326)	0.00482	(0.00444)
Single	0.0125***	(0.00133)	0.00692***	(0.00107)

Notes: Marginal effects resulting from logistic regressions.

of all races and ethnicities, higher frailty leads to a higher probability of entering a nursing home. In particular, the left panel of Figure A-3 shows that White men have the highest probability of entering a nursing home at all frailty levels. This difference, however, is only statistically different from that of Hispanic men, who are the least likely to end up in a nursing home for every level of frailty. This is particularly noticeable for the unhealthiest men. Indeed, White men with 19 health deficits have an 11.6% chance of entering a nursing home next wave, while Black and Hispanic men with the same number of deficits have a probability of entering a nursing home of 9.0% and 5.1%, respectively. In contrast, the right panel shows that the probability of entering a nursing home is significantly higher for White women than for their Black and Hispanic counterparts. In this case, the predicted probabilities significantly differ by race and ethnicity at almost all frailty levels. Similarly to what we observed for men, White women are the most likely to enter a nursing home, while Hispanic women are the least likely. This is particularly noticeable for the unhealthiest women. Indeed, White women with 19 health deficits have a 10.5% chance of entering a nursing home next wave, while Black and Hispanic women with the same number of deficits have a probability of entering a nursing home of 4.1% and 2.6%, respectively.

Death. Table A-11 reports the marginal effects associated with dying in the next wave. Here, too, frailty has a large effect. Increasing one's frailty by one deficit raises the probability

Figure A-3: Predicted probabilities of entering a nursing home next wave by frailty



Notes: Men (left panel) and women (right panel). The frailty values reported in the horizontal axis correspond to 1 to 19 conditions.

of death by 0.8 and 0.6 percentage points for men and women, respectively. Interestingly, here age also has an independent effect, even conditioning on frailty. One more year of age raises the probability of death by 0.3 percentage points for men and by 0.2 percentage points for women. Being single, rather than married, also increases the probability of death, and more so for men (by 0.1 percentage points) than for women (0.07 percentage points). Hence, for both men and women, being older, being single, and being more unhealthy increase the probability of death, while being born between 1930 and 1968 and being Hispanic lowers it.

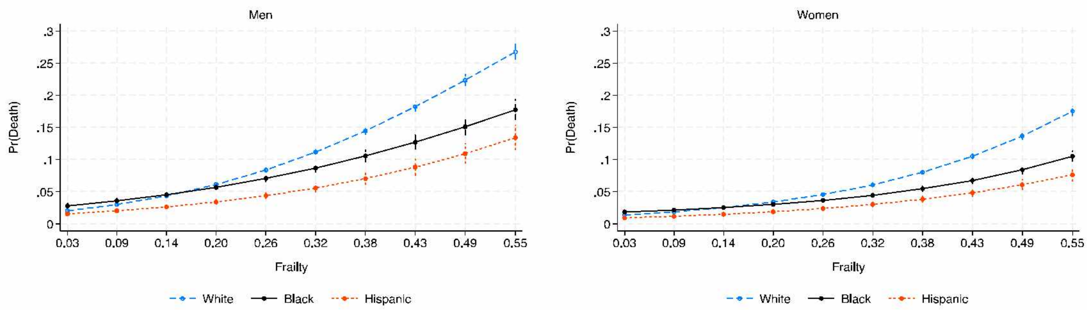
Table A-11: Death next wave

	Men		Women	
Frailty	0.00796***	(0.000143)	0.00588***	(0.0000962)
Black	0.0000404	(0.00279)	-0.00512***	(0.00186)
Hispanic	-0.0120***	(0.00370)	-0.0109***	(0.00303)
Age	0.00330***	(0.000129)	0.00244***	(0.000102)
Years of Education	-0.000611**	(0.000259)	-0.0000203	(0.000228)
Born 1930-1949	-0.0151***	(0.00251)	-0.0103***	(0.00205)
Born 1950-1968	-0.0287***	(0.00436)	-0.0196***	(0.00363)
Partnered	0.0129***	(0.00492)	0.00122	(0.00490)
Single	0.0138***	(0.00195)	0.00675***	(0.00143)

Notes: Marginal effects resulting from logistic regressions.

Figure A-4 presents the predicted probabilities of dying next wave by the average frailty associated with having between 1 and 19 health deficits. For all men and women, higher frailty leads to a higher probability of death. The right panel shows that White men are significantly more likely to die than their Black and Hispanic counterparts for all frailty levels greater than 0.26 (which corresponds to having 9 health deficits). In particular, the most unhealthy White men are more than twice as likely to die as their Hispanic counterparts. Indeed, at a frailty level of 0.55, White men have a 26.7% probability of death, while Black and Hispanic men have a probability of 17.8% and 13.4%, respectively. The right panel displays similar dynamics for women's death probability. Here, for all frailty levels larger than 0.32, White women are the most likely to die, and Hispanic women are the least likely. In particular, the most unhealthy White women are more than twice as likely to die as their Hispanic counterparts. This is signaled by the fact that, at a frailty level of 0.55, the probability of death for White women is 17.5%, while the probabilities for Black and Hispanic women are 10.5% and 7.6%, respectively.

Figure A-4: Predicted probabilities of dying next wave by frailty



Notes: Men (left panel) and women (right panel). The frailty values reported in the horizontal axis correspond to 1 to 19 conditions.

B.2 Disability Insurance and Full Retirement Age

The Social Security Administration runs the Disability Insurance program for workers, their spouses, and dependents to provide insurance against health shocks that limit (partially or entirely) people's ability to work. There are several rules surrounding Disability Insurance eligibility. First, workers must prove a sufficient work history. Second, their condition must meet the Social Security Administration's definition of a disability and last at least a year or result in death. Finally, applicants must be younger than their full retirement age.

The full retirement age depends on a person's year of birth. Table A-12 describes the evolution of the full retirement age as a function of the year of birth.[9]. In our empirical analysis described in Sections 3 and 5, we use a dummy for the Full Retirement Age when estimating logit regressions for the outcome "Receiving Social Security retirement benefits next wave". We construct this dummy using the ages in Table A-12 and setting it equal to 1 if the respondent is between 12 and 24 months younger than their corresponding full retirement age.

Table A-12: Full retirement age

Year of birth	Full retirement age
1937 or earlier	65
1938	65 and 2 months
1939	65 and 4 months
1940	65 and 6 months
1941	65 and 8 months
1942	65 and 10 months
1943-1954	66
1955	66 and 2 months
1956	66 and 4 months
1957	66 and 6 months
1958	66 and 8 months
1959	66 and 10 months
1960 and later	67

B.3 Principal Component Analysis details

Figure A-5 displays the proportion of the variance explained by principal components for the baseline and the augmented frailty index. In both cases, the first principal component captures over 20% of the overall variance. Table A-13 reports the normalized weights resulting from PCA.

9. This table comes from https://www.ssa.gov/pressoffice/IncRetAge.html

Table A-13: PCA weights

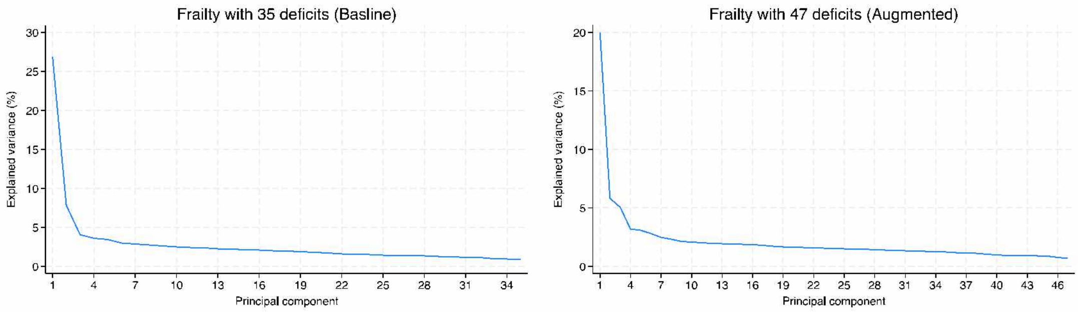
(a) Baseline

	PCA weight
Diff. grocery shopping	0.0419
Diff. walking one block	0.0418
Diff. climbing flight of stairs	0.0416
Diff. walking several blocks	0.0414
Diff. bathing	0.0413
Diff. lifting >10 pounds	0.0409
Diff. walking across room	0.0401
Diff. pull/pushing large objects	0.0398
Diff. preparing hot meal	0.0397
Diff. dressing	0.0395
Diff. getting in/out of bed	0.0369
Diff. using toilet	0.0357
Diff. climbing several flights of stairs	0.0345
Diff. getting up from chair	0.0335
Diff. kneeling or crouching	0.0330
Diff. eating	0.0328
Diff. managing money	0.0326
Diff. lifting arms over shoulders	0.0318
Diff. making phone calls	0.0309
Diff. taking medication	0.0300
Diff. using map	0.0267
Nursing home stay	0.0264
Diff. picking up dime	0.0257
Diff. sitting for two hours	0.0255
Hospital stay	0.0223
Diagnosed with arthritis	0.0206
Diagnosed with psych. problem	0.0194
Diagnosed with a stroke	0.0187
Diagnosed with heart condition	0.0168
Diagnosed with lung disease	0.0152
Diagnosed with HBP	0.0141
Diagnosed with diabetes	0.0128
Has BMI $\geq$ 30	0.0073
Diagnosed with cancer	0.0059
Has ever smoked cigarettes	0.0029

(b) Augmented

	PCA weight
Diff. walking several blocks	.0370641
Diff. lifting >10 pounds	.03587
Diff. climbing flight of stairs	.0352521
Diff. pull/pushing large objects	.0351709
Diff. walking one block	.0345307
Diff. grocery shopping	.0316487
Diff. climbing several flights of stairs	.0316381
Diff. getting up from chair	.031113
Diff. dressing	.0305405
Diff. kneeling or crouching	.0304433
Diff. walking across room	.0299998
Diff. bathing	.0298966
Diff. lifting arms over shoulders	.0284349
Diff. getting in/out of bed	.0280726
Diff. preparing hot meal	.0270129
Troubled by pain	.026653
Diff. sitting for two hours	.0263375
Diff. using toilet	.0255662
Felt everything was an effort	.0253467
Could not get going	.0234303
Felt depressed	.0224874
Felt sad	.0211038
Felt alone	.0204219
Diff. eating	.0199634
Had restless sleep	.0199395
Diagnosed with arthritis	.0197268
Diff. managing money	.0195408
Diff. picking up dime	.019508
Did not feel happy	.0193579
Diagnosed with psych. problem	.0191895
Diff. using map	.0187435
Hospital stay	.0186874
Did not enjoy life	.0184713
Diff. taking medication	.017097
Diff. making phone calls	.0159966
Diagnosed with lung disease	.0150271
Diagnosed with heart condition	.0142573
Nursing home stay	.0126592
Diagnosed with HBP	.0125591
Diagnosed with a stroke	.012511
Diagnosed with diabetes	.0119435
Has BMI $\geq$ 30	.0093313
Backward count from 20	.0063847
Smoke now	.004935
Diagnosed with cancer	.0045589
Has ever smoked cigarettes	.0042137
Heavy alcohol use	-.0026377

Figure A-5: Proportion of the variance explained by principal components



Notes: These figures report the proportion of the variance in the data explained by the principal components.

C The Implementation of our Micro-Simulation Model

To evaluate to what extent health affects how long people spend in a given state, good health, being alive, and so on, we next turn to redefining the variables we study and a simulation exercise. Relative to our prediction exercise in Section 3, the focus of this analysis is the cumulative duration spent in a specific state. For this reason, we use outcome variables that are defined by the current state rather than predicting only the probability of entering a state. Thus, we account for flows both in and out, as well as the probability of remaining.[10] Table A-14 describes our outcome variables and the values they take.

Table A-14: Outcome variables

Variable	Description	Values
Health Next Wave	In wave t, this variable tells us the respondent's discretized health status in wave t+1	1 through 5 (quintile)
Death Next Wave	In wave t, this variable tells us if the respondent will die in wave t+1	0 if alive in t+1 1 if dead in t+1 missing if dead in t
SDI Recipient in Current Wave	In wave t, this variable tells us if the respondent receives SDI in wave t (less than the full retirement age)	0 if does not receive SDI in t 1 if receives SDI in t
Begin Receiving Social Security Benefits in Current Wave	In wave t, this variable tells us if the respondent claims SS benefits in t (ages 60 to 75, not previously claiming in t-1)	0 if no income from SS in t 1 if positive income from SS in t
Being in a Nursing Home in Current Wave	In wave t, this variable tells us if the respondent lives in a NH in wave t	0 if does not live in a NH in t 1 if lives in a NH in t

Details about the counterfactual simulations. Given a sample of initial conditions, we can construct simulated histories of health, disability and retirement benefits recipiency, nursing home stays, and death using the estimated health transitions and outcome probabilities in Equations 1-5.[11] To operationalize this, we select the first observation for individuals

10. The two exceptions to this are death and receiving social security benefits because, as we describe below, both are best modeled as absorbing states.

11. Hispanic people have low rates of nursing home residence. As a result, while we can estimate an ethnicity effect for them, we cannot reliably estimate the Hispanic-specific differential effect of health on nursing home entry. Hence, when estimating Equation 5, we constrain the effect of health for Hispanic people to be the same as that for White people.

between the ages of 53 and 57 to produce our initial conditions and simulate 100 replications of each initial condition to construct simulated histories of health (including death), disability and retirement benefits recipiency, and nursing home stays.[12] Using our simulated histories, we compute the fraction of time spent in bad health, the number of working years, the number of years claiming disability or retirement benefits, the number of years spent in a nursing home in the last two years, and life expectancy. We then equalize initial conditions across races by assigning each non-White person a random draw from the (gender-specific) distribution of initial conditions for White people.

D Marginal Effects for Micro-Simulation Inputs

This section contains tables for the marginal effects in our dynamic system.

12. When simulating, we assign all individuals an initial age of 55 and do not update their marital status or education. Age evolves deterministically, and we assume health insurance coverage remains at the initial condition unless either an individual enrolls in SSDI or reaches the age of 65. This captures statutory eligibility for Medicare, which covers over 95% of the retirees in our sample.

Table A-15: Marginal effects from ordered logit on health

Very good health in period $t-1$		
Excellent health in period t	-0.660^{***}	(0.00259)
Very good health in period t	0.315^{***}	(0.00297)
Good health in period t	0.268^{***}	(0.00196)
Fair health in period t	0.0459^{***}	(0.000741)
Poor health in period t	0.00180^{***}	(0.0000130)
Good health in period $t-1$		
Excellent health in period t	-0.747^{***}	(0.00223)
Very good health in period t	-0.0745^{***}	(0.00269)
Good health in period t	0.470^{***}	(0.00237)
Fair health in period t	0.331^{***}	(0.00244)
Poor health in period t	0.0202^{***}	(0.000403)
Fair health in period $t-1$		
Excellent health in period t	-0.755^{***}	(0.00222)
Very good health in period t	-0.214^{***}	(0.00205)
Good health in period t	0.0971^{***}	(0.00154)
Fair health in period t	0.658^{***}	(0.00224)
Poor health in period t	0.214^{***}	(0.00204)
Poor health in period $t-1$		
Excellent health in period t	-0.756^{***}	(0.00222)
Very good health in period t	-0.227^{***}	(0.00204)
Good health in period t	-0.0114^{***}	(0.000310)
Fair health in period t	0.0862^{***}	(0.00195)
Poor health in period t	0.909^{***}	(0.00204)
Black		
Excellent health in period t	-0.0127^{***}	(0.00177)
Very good health in period t	0.00994^{***}	(0.00182)
Good health in period t	0.000888	(0.00130)
Fair health in period t	-0.000367	(0.00132)
Poor health in period t	0.00220^{*}	(0.00125)
Hispanic		
Excellent health in period t	-0.00342^{*}	(0.00197)
Very good health in period t	0.00735^{***}	(0.00201)
Good health in period t	0.000628	(0.00156)
Fair health in period t	-0.00190	(0.00161)
Poor health in period t	-0.00266	(0.00162)
Being a man		
Excellent health in period t	0.00170	(0.00110)
Very good health in period t	-0.00118	(0.00117)
Good health in period t	-0.00108	(0.000913)
Fair health in period t	0.00297^{***}	(0.00100)
Poor health in period t	-0.00242^{**}	(0.00100)
Having health insurance		
Excellent health in period t	0.00220	(0.00218)
Very good health in period t	0.00342	(0.00240)
Good health in period t	0.000542	(0.00201)
Fair health in period t	-0.00437^{*}	(0.00229)
Poor health in period t	-0.00180	(0.00229)
Age		
Excellent health in period t	-0.00188^{***}	(0.0000648)
Very good health in period t	-0.000483^{***}	(0.0000227)
Good health in period t	0.0000230	(0.0000191)
Fair health in period t	0.000476^{***}	(0.0000243)
Poor health in period t	0.00186^{***}	(0.0000474)
Being partnered		
Excellent health in period t	-0.00725^{***}	(0.00192)
Very good health in period t	-0.000995^{***}	(0.000259)
Good health in period t	0.000577^{***}	(0.000156)
Fair health in period t	0.00191^{***}	(0.000497)
Poor health in period t	0.00573^{***}	(0.00153)
Being single		
Excellent health in period t	-0.00652^{***}	(0.000802)
Very good health in period t	-0.000899^{***}	(0.000118)
Good health in period t	0.000520^{***}	(0.0000728)
Fair health in period t	0.00175^{***}	(0.000218)
Poor health in period t	0.00515^{***}	(0.000635)
Years of education		
Excellent health in period t	0.00269^{***}	(0.000148)
Very good health in period t	0.000133^{***}	(0.0000354)
Good health in period t	-0.000370^{***}	(0.0000320)
Fair health in period t	-0.000815^{***}	(0.0000506)
Poor health in period t	-0.00164^{***}	(0.0000980)
1895-1909 cohort		
Excellent health in period t	-0.00710	(0.00533)
Very good health in period t	-0.000925	(0.000666)
Good health in period t	0.000556	(0.000415)
Fair health in period t	0.00179	(0.00130)
Poor health in period t	0.00568	(0.00129)
1910-1929 cohort		
Excellent health in period t	0.00356^{**}	(0.00165)
Very good health in period t	0.000495^{**}	(0.000230)
Good health in period t	-0.000283^{**}	(0.000131)
Fair health in period t	-0.000955^{**}	(0.000441)
Poor health in period t	-0.00281^{**}	(0.00131)
1930-1949 cohort		
Excellent health in period t	0.00214^{*}	(0.00113)
Very good health in period t	0.000295^{*}	(0.000155)
Good health in period t	-0.000170^{*}	(0.0000897)
Fair health in period t	-0.000569^{*}	(0.000298)
Poor health in period t	-0.00169^{*}	(0.000897)

Table A-16: Marginal effects for death next wave

Very Good	0.0113***	(0.00105)
Good	0.0230***	(0.00122)
Fair	0.0463***	(0.00129)
Poor	0.137***	(0.00199)
Black	0.000703	(0.00152)
Hispanic	-0.0151***	(0.00185)
Male	0.0380***	(0.00119)
Health Insurance coverage=1	-0.0000199	(0.00395)
Age	0.00311***	(0.0000820)
Partnered	0.00875**	(0.00342)
Single	0.0118***	(0.00119)
Years of education	-0.000569***	(0.000171)
1895-1909 cohort	0.0390***	(0.00470)
1910-1929 cohort	0.0235***	(0.00269)
1930-1949 cohort	0.0128***	(0.00213)

Notes: Very Good, Good, Fair, and Poor refer to discretized frailty.

Table A-17: Marginal effects for disability benefits recipiency

Very Good	0.0218***	(0.00230)
Good	0.0455***	(0.00255)
Fair	0.0833***	(0.00262)
Poor	0.145***	(0.00412)
Black	0.00392**	(0.00173)
Hispanic	-0.0102***	(0.00212)
Male	0.0165***	(0.00151)
Health Insurance coverage=1	0.00638***	(0.00207)
Age	0.000367*	(0.000208)
Partnered	0.00933***	(0.00304)
Single	0.00727***	(0.00154)
Years of education	-0.000672**	(0.000269)
Past disability recipient	0.125***	(0.00134)
1930-1949 cohort	-0.00620***	(0.00153)

Notes: Very Good, Good, Fair, and Poor refer to discretized frailty.

Table A-18: Marginal effects for retirement benefits recipiency

Very Good	0.0263***	(0.00600)
Good	0.0296***	(0.00668)
Fair	0.0286***	(0.00642)
Poor	0.0124*	(0.00722)
Black	-0.0214***	(0.00580)
Hispanic	-0.0429***	(0.00717)
Male	-0.0248***	(0.00430)
Health Insurance coverage=1	-0.0575***	(0.00744)
Age	0.0739***	(0.000666)
Partnered	0.0148	(0.0114)
Single	-0.00402	(0.00488)
Years of education	-0.0162***	(0.000794)
FRA dummy	0.0327***	(0.00536)
1910-1929 cohort	0.0949***	(0.0242)
1930-1949 cohort	0.0715***	(0.00513)

Notes: Very Good, Good, Fair, and Poor refer to discretized frailty.

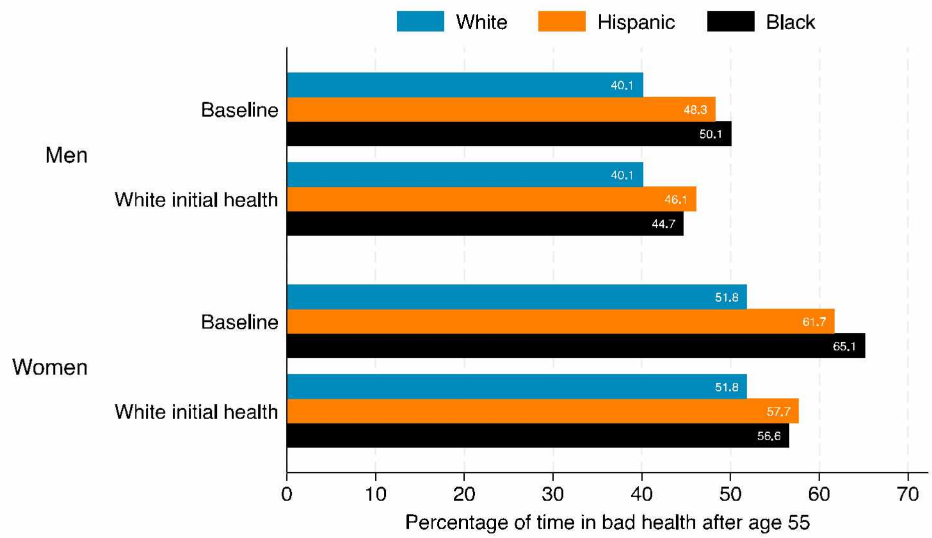
Table A-19: Marginal effects for nursing home residence

Very Good	0.00173**	(0.000870)
Good	0.00611***	(0.000864)
Fair	0.0104***	(0.000798)
Poor	0.0454***	(0.00119)
Black	-0.00383***	(0.000729)
Hispanic	-0.00758***	(0.000927)
Male	0.00292***	(0.000663)
Age	0.00101***	(0.0000489)
Partnered	0.00194	(0.00196)
Single	0.00927***	(0.000630)
Years of education	0.0000771	(0.0000931)
Previously living in a nursing home	0.0587***	(0.00103)
1895-1909 cohort	0.0111***	(0.00246)
1910-1929 cohort	0.00597***	(0.00170)
1930-1949 cohort	0.00381***	(0.00148)

Notes: Very Good, Good, Fair, and Poor refer to discretized frailty.

E Additional Figures for Counterfactual Simulations

Figure A-6: Average fraction of remaining life spent in bad health starting from age 55



Notes: This is computed as the fraction of remaining life spent in one of the two lowest health states ("poor" and "fair" health, or frailty quintiles), conditional on remaining alive.

Figure A-7: Average life expectancy as of age 55

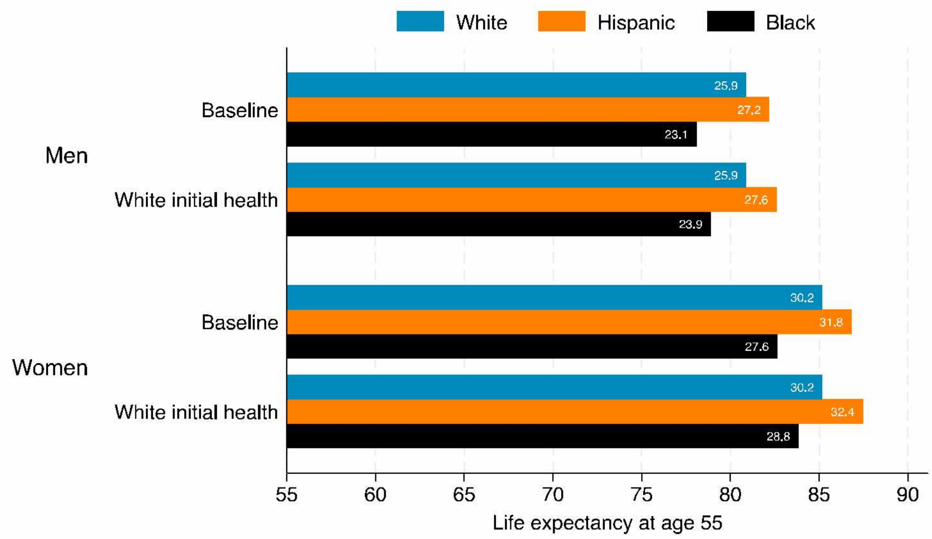


Figure A-8: Average number of years receiving disability benefits after age 55

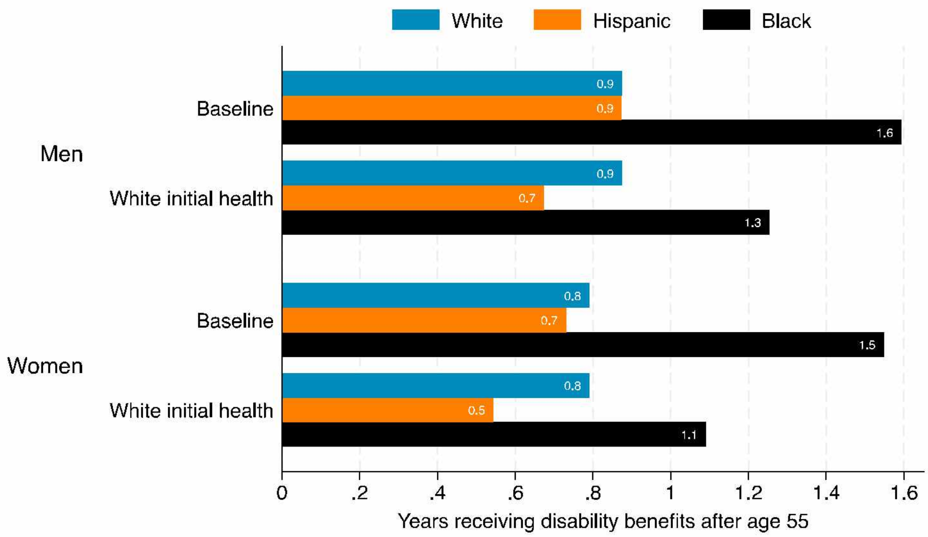


Figure A-9: Average number of years receiving Social Security retirement benefits after age 55

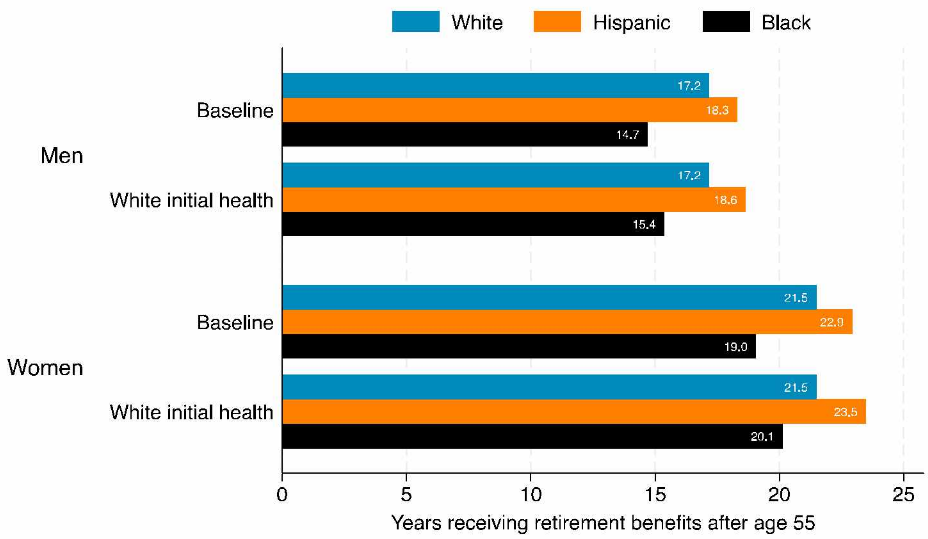
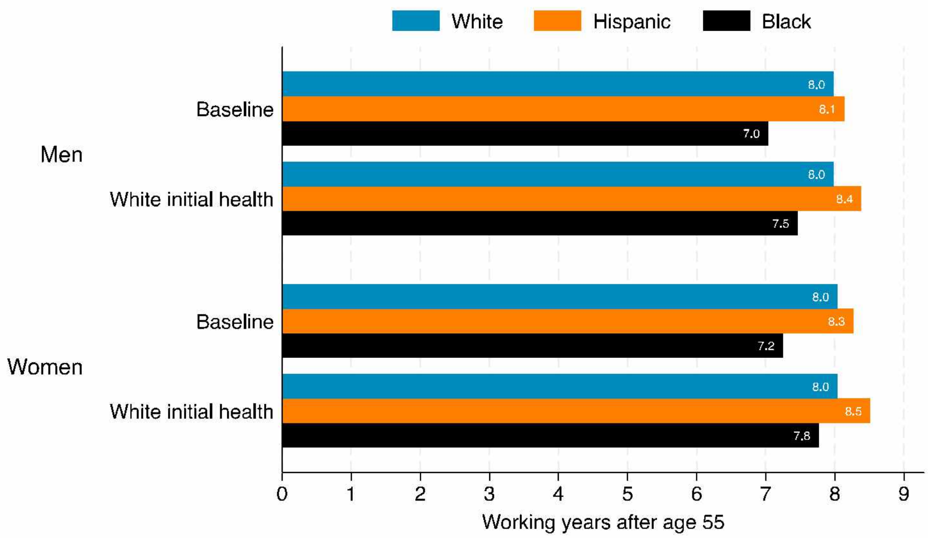


Figure A-10: Average number of working years after age 55



Notes: Working years are defined as years not receiving Social Security or disability benefits.

Figure A-11: Average number of years in a nursing home after age 55

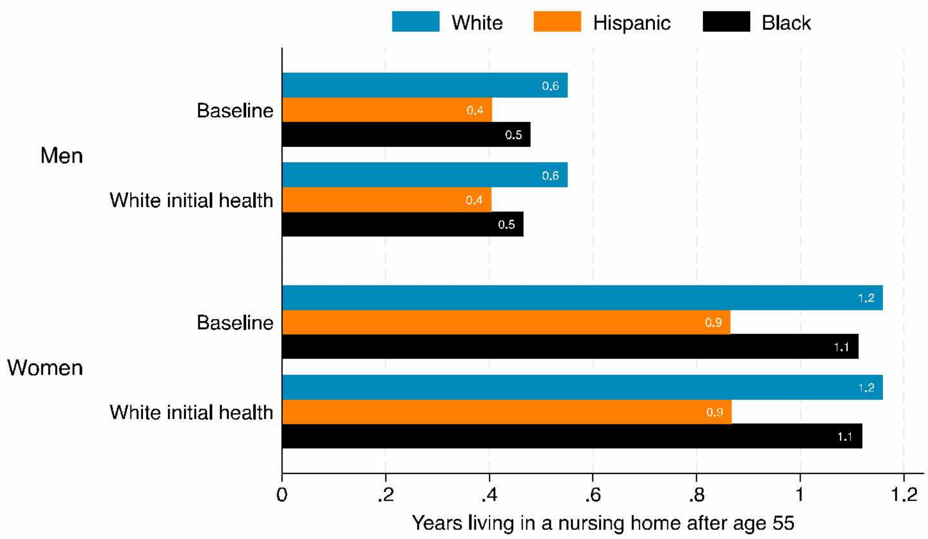
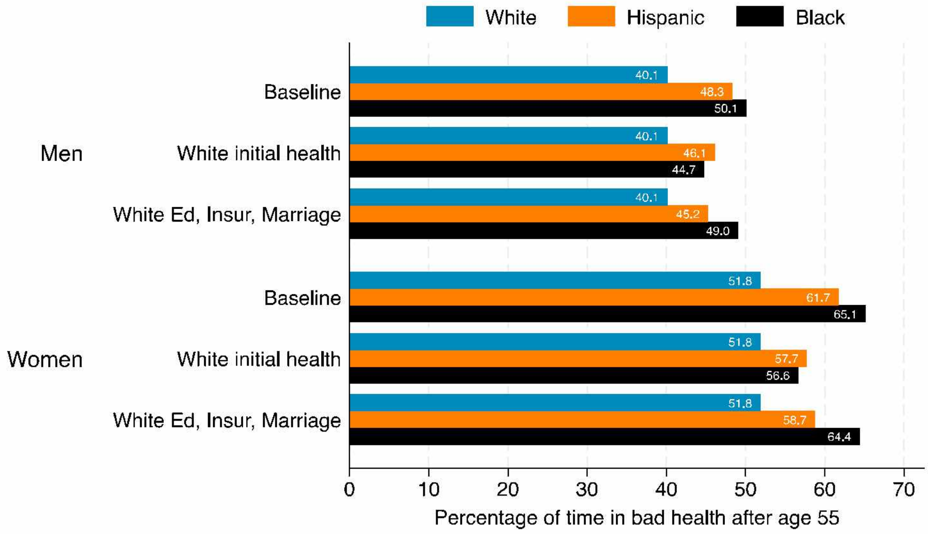


Figure A-12: Average fraction of remaining life spent in bad health starting from age 55



Notes: This is computed as the fraction of remaining life spent in one of the two lowest health states ("poor" and "fair" health, or frailty quintiles), conditional on remaining alive.

Figure A-13: Average life expectancy as of age 55.

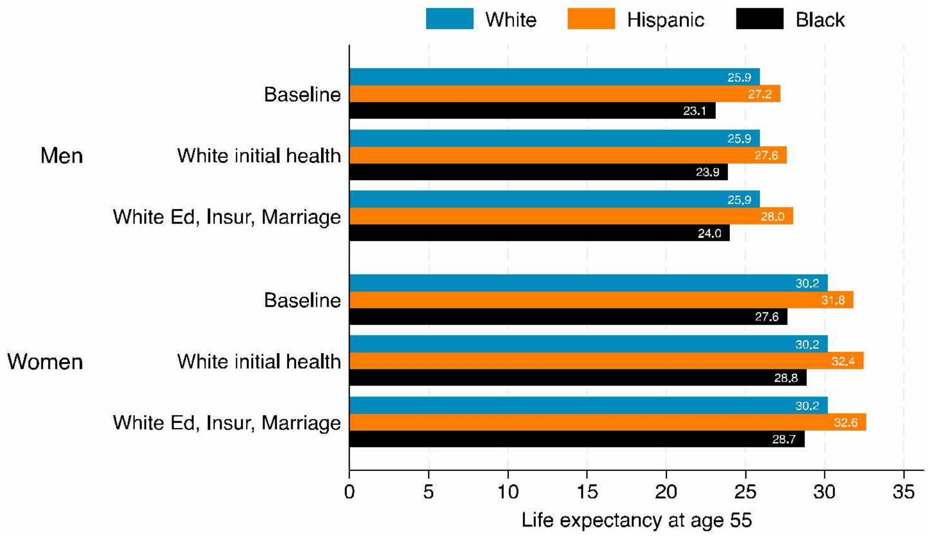


Figure A-14: Average number of years receiving disability benefits after age 55.

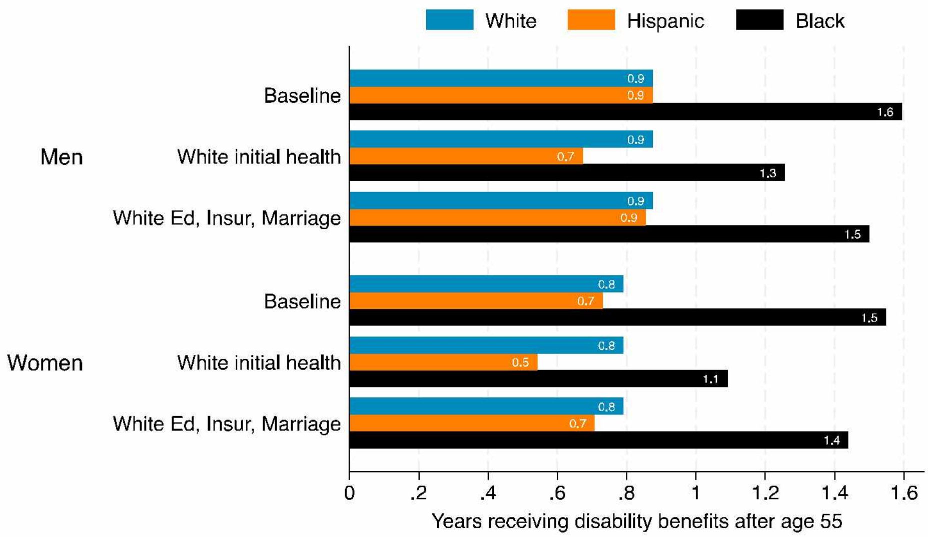


Figure A-15: Average number of years receiving Social Security retirement benefits after age 55

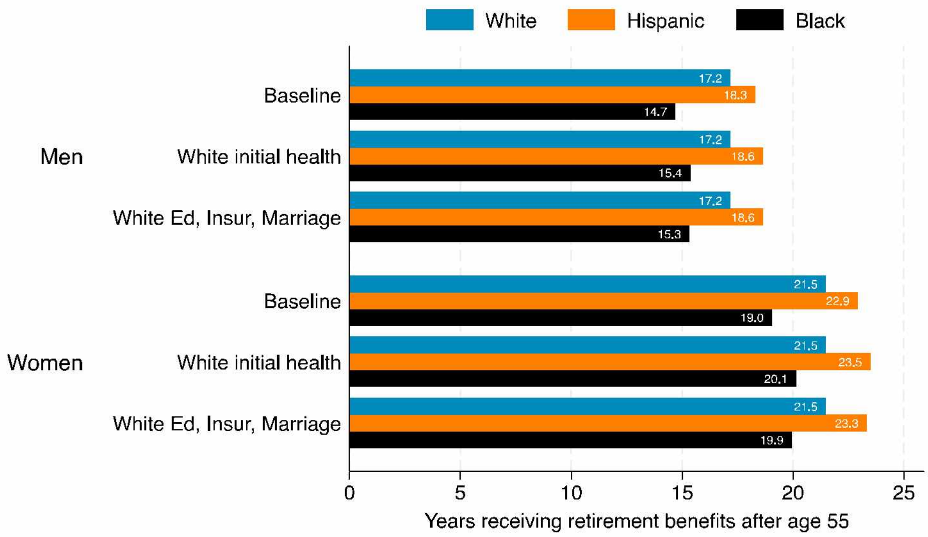
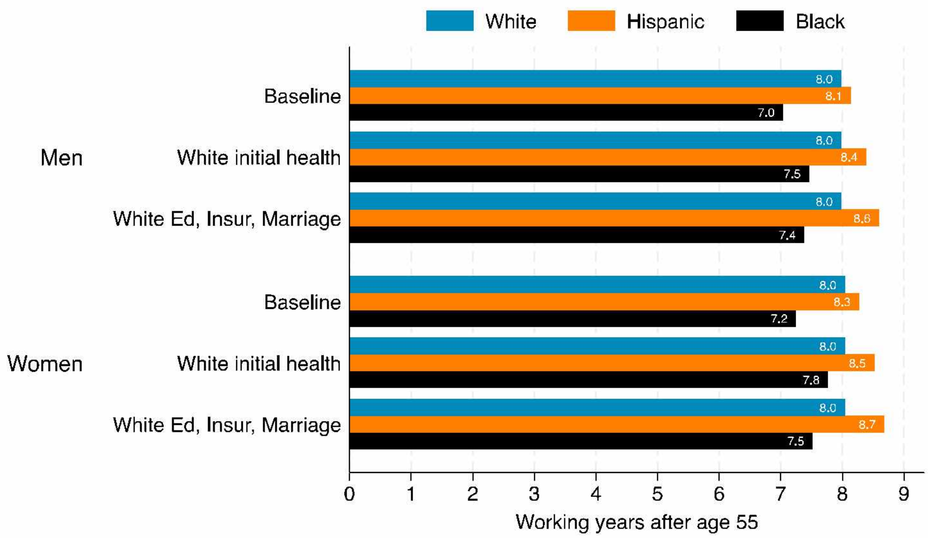


Figure A-16: Average number of working years after age 55



Notes: Working years are defined as years not receiving Social Security or disability benefits.

Figure A-17: Average number of years in a nursing home after age 55