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The Mortality of the U.S. Homeless Population

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Abstract

This paper provides the first national calculation of mortality, the most severe indicator of health and well-being, for the U.S. homeless population. We use a sample of 140,000 people who were sheltered or unsheltered homeless during the 2010 Census, by far the largest and closest to representative sample ever used to study the homeless population. These individuals, along with housed and housed poor comparison groups, are linked to Social Security Administration data on all-cause mortality from 2010-2022 to estimate the magnitude of health disparities associated with homelessness. We find that non-elderly people experiencing homelessness have 3.5 times higher mortality than those who are housed, accounting for differences in demographic characteristics and geography. A 40-year-old homeless person faces a similar mortality risk to a housed person nearly twenty years older and a poor housed person nearly ten years older. The mortality rate of the homeless population relative to the housed is highest when individuals are in their 30s and 40s but falls in relative terms starting around age 50. Within the homeless population, people who are Black, female, and Hispanic have lower relative mortality risk than their white, male, and non-Hispanic counterparts. Employment, higher income, and observed family connections are also associated with lower mortality, but mortality risk is similar for people who were observed as sheltered and unsheltered homeless in 2010. Homeless individuals' mortality rose by 33 percent during the COVID-19 pandemic, an increase that, while similar in proportional terms to the increase for the housed population, affected a much larger share of the homeless population due to their substantially elevated baseline mortality rate. These findings elucidate the persistent hardships associated with homelessness while also identifying more vulnerable segments of an already exceptionally deprived population.

Keywords: Homelessness; Decennial Census; Mortality; Health; COVID-19; health disparities.

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1. Introduction

This paper examines the most severe indicator of hardship, mortality, for one of the most deprived segments of the U.S. population, people experiencing homelessness. People who are unhoused have worse health outcomes than those who are housed, but the extent of these disparities has not been examined nationally or with representative data. Knowledge of this population's mortality can help us understand the risks associated with homelessness and target interventions towards the most vulnerable individuals. Such knowledge can also help us understand the relationship between housing, extreme poverty, and health, topics that have drawn renewed interest in light of recent events such as the rise in unsheltered homelessness, the epidemic of deaths from opioids and other substances among people experiencing homelessness, and the COVID-19 pandemic.

In this paper, we provide the first national calculation of mortality for people experiencing homelessness in the United States. Our main sample consists of 140,000 people who were sheltered or unsheltered homeless during the 2010 Census, by far the largest and closest to representative sample ever used to study this population. We compare homeless individuals' mortality to that of the housed U.S. population overall as well as within sub-groups defined by age, gender, race, Hispanic ethnicity, and disability status. We also calculate mortality risk relative to housed people who are poor to examine homelessness as a risk factor for mortality that is distinct from poverty in general. We further examine mortality differences within the homeless population by type of homelessness, geography, demographic characteristics, income, employment status, and the extent of observed family connections to identify factors associated with heightened or reduced mortality risk. By using the same, or closely comparable, datasets and applying methods uniformly to all groups, we obtain more direct and reliable comparisons than in previous work. This approach also allows us to estimate mortality disparities over time, including during the COVID-19 pandemic, and to account for the full time-varying distribution of characteristics in our comparisons across groups.

We obtain data on the U.S. homeless population from the 2010 Census's Service-Based Enumeration (SBE) operation, which counted people experiencing homelessness in shelters and at outdoor locations, as well as users of soup kitchens and food vans who indicated that they did not have a usual residence. We link these individuals, as well as comparison samples of housed

individuals and housed individuals who are poor, to administrative data on all-cause mortality from Social Security Administration (SSA) records for 2010 through March 2022 using anonymized linkage keys. We estimate a mortality hazard model on the resulting linked dataset and test the robustness of our findings using several approaches to account for demographic differences between groups.

Our main finding is that non-elderly people who have experienced homelessness face 3.5 times higher mortality risk than people who are housed, accounting for differences in demographic characteristics and geography. This disparity far exceeds the mortality gap between Black and white housed individuals, which we estimate to be 1.4, and between poor housed and all housed individuals, which we estimate to be 2.2. Being homeless raises relative mortality risk nearly as much as being disabled, with the latter condition being associated with 4.6 times higher mortality risk for people who are housed. Homelessness is associated with 60 percent greater mortality risk than poverty alone. To further illustrate the magnitude of this disparity, we estimate that a 40-year-old homeless person has a mortality risk similar to a housed person who is nearly twenty years older and a poor housed person who is nearly ten years older.

Our analyses reveal notable patterns in mortality risk by age, race, income, family status, and type of homelessness. Homeless individuals' mortality risk relative to housed individuals differs over the life cycle and is greatest when they are in their 30s and 40s, when it is about four times higher. Beginning in their 50s, however, homeless individuals' mortality hazard begins to converge with people who are housed, a pattern that we hypothesize reflects both excess mortality of exceptionally vulnerable homeless individuals at younger ages and shared health vulnerabilities for elderly homeless and housed individuals. We also find that Black homeless individuals have about 27 percent lower mortality risk than white homeless individuals, a pattern that may be related to the lower prevalence of substance abuse and behavioral health issues among Black homeless individuals, among other factors. We further find that homeless individuals who are not employed, those with lower incomes, and those without observed family connections are especially vulnerable relative to their more advantaged and connected homeless counterparts. Finally, we find a similar mortality risk for people who were initially observed in shelters and those who were unsheltered in our sample, a finding that illustrates the substantial health risks faced by people experiencing homelessness even when they are not sleeping on the streets.

We estimate that average annual mortality risk rose by about 0.52 percentage points for homeless individuals during the first two years of the COVID-19 pandemic, translating to a 33 percent increase over their average from the two years preceding the pandemic, after accounting for the expected increase in mortality rate due to aging. While the proportional rise in mortality risk was similar for people who were housed (29.8 percent) and poor and housed (33.9 percent), the pandemic affected a much larger share of the homeless population because of their substantially elevated baseline mortality risk. Homeless men experienced a larger rise in both absolute and proportional mortality risk during the pandemic (about 0.67 percentage points and 38 percent, respectively) than homeless women (about 0.33 percentage points and 24 percent).

Our findings illustrate, for the first time, the substantial health disparities associated with homelessness using data that are designed to be representative of the U.S. homeless population. Our work also calls attention to segments of this population that are especially vulnerable and helps to establish the most broadly true patterns from among the many, often conflicting ones, found in previous work. In doing so, this paper adds to a growing body of research that aims to establish fundamental facts about the size, characteristics, material circumstances, and housing transition dynamics of the U.S. homeless population.

This paper proceeds as follows. Section 2 reviews available literature on homeless individuals' mortality and the most frequent causes of death for this population. Section 3 describes the Census and American Community Survey (ACS) datasets from which we draw our homeless and comparison samples, as well as the administrative data on mortality, disability status, income, and family connections to which we link these samples. Section 4 describes our methods for linking datasets and estimating mortality hazards and relative risk. Section 5 presents our findings, including results from comparisons of homeless and housed individuals, comparisons of subsets of the homeless population, and changes in mortality risk during the COVID-19 pandemic. We then compare our results with the previous literature. Section 6 further discusses and analyzes key findings, while Section 7 concludes.

2. Background and related literature

Mortality is often cited as an unambiguous and easily quantifiable measure of health and wellbeing for vulnerable segments of the United States population. To this end, a small body of research attempts to estimate mortality rates of homeless people in the United States, as

summarized in Table 1. This task is complicated by the lack of easily accessible national data on homeless individuals with which to trace mortality. As such, most of the existing literature is based on small, non-random samples of homeless individuals in major metropolitan areas like Boston, New York, or Philadelphia, making it difficult to assess the generalizability of previous findings.

Many of the most methodologically sound studies draw their samples, typically 30,000 or fewer individuals, from users of homeless health services, such as the Boston Health Care for the Homeless Program, potentially biasing findings to people who are sick or health-conscious enough to seek help (Baggett et al. 2013, Hibbs et al. 1994, Hwang 1997, Roncarati et al. 2018, Roncarati et al. 2020). The rest of these studies draws their samples from New York City's administrative shelter databases, focusing their analyses on mortality rates among sheltered homeless people in the city (Barrow et al. 1999). While Metraux et al. (2011) do examine the mortality of 160,000 New York City shelter users, they does not provide comparisons to the housed population.

All prior studies also use different data sources and methodologies to obtain homeless and housed mortality rates, raising questions about the validity of comparisons between these groups and limiting the level of detail with which they can account for differences. For instance, Baggett et al. (2013) and Barrow et al. (1999) link Massachusetts Department of Health death occurrence files and data from the National Death Index to their respective homeless samples, but both obtain aggregate housed mortality rates from the Center for Disease Control's mortality files for comparisons to housed individuals in their cities.

Finally, most papers are restricted to a narrow subset of the homeless population due to data availability—for instance, male veterans (Schinka et al. 2018), youth (Auerswald, Lin, and Parriott 2016), or people with post-traumatic stress disorder (Kasprow and Rosenheck 2000). Only two papers examine mortality separately for both sheltered and unsheltered homeless individuals, though others include unsheltered homeless people in their overall sample (Roncarati et al. 2018, Roncarati et al. 2020). The narrow focus of these studies makes it difficult to directly compare the mortality rates of subsets of the homeless population, such as those defined by sheltered, disability, or family status.

Prior studies estimate mortality in two ways: by calculating a crude mortality rate, reported as the number of deaths per 100,000 person-years, and by calculating a standardized

mortality ratio, which divides the mortality rate of the focal group by the mortality rate of a comparison group. All previous research on this topic has found that homeless individuals of every subgroup have higher mortality risk than their housed counterparts. Though estimates of homeless individuals' mortality risk relative to housed individuals vary widely, in part due to small sample sizes and non-representative cohorts, all previous research agrees on two qualitative findings on mortality of unhoused relative to housed populations. First, studies that provide estimates for homeless-to-housed mortality rate ratios by age group assert that mortality risk relative to the housed tends to be higher in younger and middle ages (Baggett et al. 2013, Barrow et al. 1999, Hwang et al. 1997, Hibbs et al. 1994). Though the literature disagrees at which age mortality risk peaks, these papers find a convergence of mortality between the homeless and the housed as age increases past 55 years. Second, all prior studies that look at gender disparities in homeless-to-housed mortality rate ratios find that homeless women appear to have greater risk relative to their housed counterparts than homeless men do relative to their housed counterparts (Baggett et al. 2013, Barrow et al. 1999, Hwang et al. 1997, Henwood, Byrne, and Scriber 2015, Hibbs et al. 1994).

When considering mortality differences over time within the homeless population, prior studies find no apparent seasonal pattern in mortality risk, with homeless individuals seemingly equally likely to die in warmer months as in colder conditions (Hibbs et al. 1994, Hwang et al. 1997). There is mixed evidence, too, on the relationship between the amount of time spent homeless and mortality risk. Barrow et al. (1999) find that men who self-report having experienced extended periods of homelessness have higher mortality risk than other homeless individuals, and Metraux et al. (2011) find that shelter users who experience episodic homelessness (multiple shelter stays of brief duration) and long-term homelessness (limited shelter stays of extended duration), as indicated by enrollments in administrative shelter databases, face heightened mortality risk subsequent to exiting the shelter. However, Kasprow and Rosenheck (2000) find no support for differences in mortality risk by length of time spent homeless, as measured by interview responses collected by the Department of Veteran Affairs.

Several prior studies find that white adults face higher mortality risk than those who are not white, a reversal of the pattern observed in the general housed population (Baggett et al. 2013, Hibbs et al. 1994, Roncarati 2018, Metraux et al. 2011, Roncarati et al. 2020). Hibbs et al. (1994) and Baggett et al. (2013) both hypothesize that this trend may stem from "underlying

racial differences in the pathways to homelessness," with Black Americans being more likely to become homeless due to structural and economic factors, such as discrimination or poverty, while white homelessness is more heavily associated with personal factors such as physical or mental illness, trauma, or substance abuse. This hypothesis is supported by both papers' finding that substance abuse, a condition associated with heightened mortality, was more prevalent among white homeless men (Hibbs et al. 1994) and that white adults accounted for a disproportionate share of deaths due to drug overdose (Baggett et al. 2013).

Prior work has found mixed evidence on the relationship between gender and mortality. Most studies find that homeless men face a higher mortality risk than homeless women, a pattern that mirrors trends in the general housed population (Roncarati 2018, Hwang et al. 1997, Barrow et al. 1999). Metraux et al. (2011), however, find that while homeless women in families have lower risk relative to homeless men in families, homeless single women have a higher mortality hazard relative to homeless single men, a finding that may point to family connections as a mitigating factor for mortality risk.

Alongside mortality differences by demographic characteristics such as gender and race, a few prior studies have also focused on characteristics associated with the most vulnerable subsets of the homeless population—namely, those with a history of substance abuse, unsheltered status, or few family connections. Papers that separately study mortality risk by drug use find that substance abusers face heightened mortality risk relative to other homeless subgroups, and those that study mortality by sheltered status find that unsheltered homeless individuals face higher mortality than do sheltered homeless individuals (Hibbs et al. 1994, Barrow et al. 1999, Roncarati et al. 2018, Roncarati et al. 2020). Finally, Metraux et al. (2011) find that adults in families have substantially lower mortality risk than single adults.

A small literature also seeks to determine the leading causes of death among homeless individuals in the United States. The primary cause of death for homeless adults under 45 appears to have changed from HIV/AIDS prior to the mid-2000s (Baggett et al. 2013, Hwang et al. 1997, Roncarati et al. 2018, Roncarati et al. 2020) to drug overdose, especially by fentanyl, other opioids, and methamphetamine, in more recent years (Baggett et al. 2013, Roncarati et al. 2018, Roncarati et al. 2020, Hwang et al. 1997, Barrow et al. 2011, Schinka et al. 2018, Cawley et al. 2022). The second most common cause of death for adults below the age of 45 is externally caused traumatic injuries, such as traffic accidents (Hwang et al. 1997, Roncarati et al. 2018,

Roncarati et al. 2020, Schinka et al. 2018, Cawley et al. 2022). Hwang et al. (1997) also cites homicide as the second-most-common cause of death for homeless adults ages 25 to 44. For homeless adults aged 45 to 64, both before the mid-2000s and after, heart disease and cancer are the leading causes of death.

Cawley et al. (2022) examine mortality rates and causes of death for people experiencing homelessness in San Francisco during the COVID-19 pandemic. They find that while mortality increased for the homeless population in San Francisco during the pandemic, drug toxicity rather than COVID-19 was the leading cause of death for homeless individuals during this period. They hypothesize that hospital overcrowding during the pandemic made it difficult to obtain care for life-threatening situations like drug toxicity and traumatic injury, a hypothesis echoed by Brown et al. (2022), who also find COVID-19 deaths to be rare among homeless individuals during the pandemic.

Other studies, though not explicitly studying cause of death, examine the health of people experiencing homelessness and describe the prevalence of conditions likely associated with mortality. The only national estimates on behavioral health and substance use conditions in the homeless population come from a 1996 survey, the National Survey of Homeless Assistance Providers and Clients (NSHAPC) (Burt et al. 1999). Eighty-six percent of NSHAPC's homeless respondents reported having had problems with alcohol use, drug use, or mental health in their lifetime, with 74 percent reporting that these problems occurred in the preceding year. More recently, Meyer et al. (2021) find that 36.1 percent of sheltered homeless adults surveyed in the American Community Survey (ACS) between 2011 and 2018 experienced at least one physical or cognitive limitation (difficulty walking or climbing stairs, hearing, seeing, remembering, or making decisions), compared to 23.1 percent of poor housed adults. Notably, nearly 25 percent of sheltered homeless individuals reported difficulty remembering or making decisions, more than twice the share of poor housed adults and about 5.5 times the share of all housed adults.

Numerous localized studies confirm the heightened prevalence of behavioral and mental health conditions and substance abuse disorders among people experiencing homelessness. Trick et al. (2021) report high prevalence of behavioral health conditions in this population in Cook County, Illinois, especially among those who are less connected to services, a finding that is consistent with earlier work indicating a high rate of schizophrenia and other psychiatric conditions in Los Angeles's homeless population (Koegel et al. 1999). Trick et al. (2021) also

report that the most frequently cited reasons for homeless individuals' emergency room (ER) visits are schizophrenia or auditory hallucinations, foot pain, and suicidal ideation. Several studies describe the increasing prevalence of substance use disorders among homeless individuals since the 1980s and note that the most frequently abused substances have changed in that time. While alcohol was predominant in the 1980s and earlier, drug use became increasingly prevalent in subsequent years, with the predominant substance shifting from cocaine in 2000 to methamphetamine, fentanyl, and other opioids in more recent years (Fischer and Breakey 1991, North et al. 2004, Cawley et al. 2022, Baggett et al. 2013).

Finally, a small body of work addresses the premature aging of the homeless population. Homeless individuals experience accelerated aging, evidenced by the early onset of chronic medical conditions and functional and cognitive impairments typically seen in housed adults aged 75 and older (Brown et al. 2022, Baggett et al. 2013, Hwang et al. 1997, Schinka et al. 2016, Garibaldi et al. 2004, Gelberg et al. 1990). For instance, older homeless adults are more likely than older housed individuals to have functional and mobility impairment, frailty, visual impairment, and urinary incontinence, and the prevalence of these and other "geriatric" conditions is equal to or higher than that seen in housed and housed poor adults twenty years older (Brown et al. 2012, Brown et al. 2017).

2. Data

2.1 Census data on the U.S. homeless population

Our homeless sample is comprised of individuals counted during the 2010 Census's Service-Based Enumeration (SBE), an operation that took place March 29-31, 2010. The SBE included in the Census people sleeping in homeless shelters, people using soup kitchens or food vans who said they lacked a residence, and people sleeping outdoors at sites called Targeted Non-Sheltered Outdoor Locations (TNSOLs). We include all individuals with sufficient personal information to be linked to death records in our analysis. The linked subset consists of 140,000 individuals who are weighted to account for the probability of linkage.

The SBE frame was based on the address list of homeless service locations from the 2000 Census and augmented using internet research, queries to local officials and service providers, and a series of validation and advance visit operations. Prior work has shown that the coverage

of the sheltered homeless population in the Census was surprisingly good, with about 90-95 percent of shelter users being included in its count, although it is worth noting that the Census's shelter definition excludes some facilities classified by HUD as homeless shelters (Meyer, Wyse, and Corinth 2022). The SBE also arrived at an unsheltered homeless estimate that was similar to the Department of Housing and Urban Development (HUD)'s point-in-time (PIT) estimate of the unsheltered homeless population.

Our homeless sample therefore consists of people who were literally homeless at a point in time in late March 2010. Because the study period continues through 2022, and because people frequently transition between homeless and housed statuses, it is likely that many or most of those in our sample were housed for some of the study period. HUD estimates that about one-quarter of people experiencing homelessness at a point in time are chronically homeless, i.e. experiencing frequent or extended homeless spells, while the rest are experiencing shorter and/or less frequent homeless spells (HUD 2022). Even when housed, however, prior work has shown that this population faces markedly worse material deprivation than the average housed poor individual, with extremely low incomes and high reliance on the safety net persisting for at least the decade surrounding the 2010 Census enumeration date (Meyer et al. 2023). Moreover, we find no evidence of heightened mortality risk for this population in 2010 and 2011, the years closest to when we observe them as homeless, relative to later years, a finding that suggests our results are applicable to people contemporaneously experiencing homelessness.

2.2 Administrative data on mortality, income, and family and disability status

We obtain death dates from the Census Bureau's Numerical Identification File (Numident), which is derived from Social Security Administration (SSA) records and frequently updated. The Numident has been shown to be a "high-quality and timely source of data to study all-cause mortality" (Finlay and Genadek 2021). It does not indicate cause of death, however.

We draw on several additional sources of administrative data to examine heterogeneity in mortality risk by income and employment, family status, and disability status. Specifically, we use Internal Revenue Service (IRS) 1040 extract files and W-2s (2005-2009) to determine income, employment status, and identify the presence of co-filing spouses and dependents prior to our study period. We also draw on administrative data from the Centers for Medicare and

Medicaid Services (CMS) to identify 2009 recipients of Disability Insurance (DI) in Medicare records and Supplemental Security Income (SSI) in Medicaid records.

2.3 Census and ACS data on housed comparison groups

We compare the mortality of homeless individuals to that of the overall housed population and poor housed individuals. Our overall housed comparison group consists of a one percent random sample of housed adults from the 2010 Census. The housed poor comparison group is drawn from the 2009-2010 American Community Survey (ACS), which indicates household income relative to the poverty line. To obtain a large sample of poor individuals while keeping the selection date as close to the Census as possible, we keep individuals interviewed in the last three months of the 2009 ACS or the first three months of the 2010 ACS who were alive on April 1, 2010, the beginning of our study period.

3. Methods

3.1 Linking datasets

Our approach requires us to link birth and death information from SSA records to the homeless and comparison samples from the Census and ACS. We also link administrative data on transfer programs and tax records to determine disability status, connections to others, and income. We link these datasets using unique anonymized identifiers known as Protected Identification Keys (PIKs), which are assigned by the Census Bureau's Personal Identification Verification (PVS) system. PVS uses name, date of birth, gender, and address (or, in the case of homeless individuals, enumeration site address) to search for matching records in a SSA reference file.[1] PVS assigned a linkage key to 69 percent of those counted in homeless shelters, 42 percent of those counted at food vans and soup kitchens, and 17 percent of those counted at outdoor locations (TNSOLs) (Meyer et al. 2021). Linkage rates are close to 90 percent for the housed comparison groups. Most homeless individuals who were not assigned a linkage key did

[1] PVS uses addresses to narrow the number of potential matches for a Census record in the reference file, but if this approach does not yield a linkage key, PVS will proceed to search for matches using name, date of birth, and gender only (Layne and Wagner 2014). In this way, PVS can assign linkage keys to people in the Census even if its reference file does not include their enumeration site address, as would be the case for most people experiencing homelessness.

not provide sufficient personal information to enumerators, in many cases because they were sleeping during the count or were enumerated by sight at a bustling service location (Meyer et al. 2022). We adjust for non-linkage using inverse probability weights (IPW) where the probability of linkage is estimated as a probit function of age, race, gender, Hispanic origin, state, and homeless location type.

3.2 Defining our homeless and comparison groups

In our main results, we estimate mortality hazard rates and survival rates for three groups (homeless, housed, housed and poor) of non-elderly adults, defined as those ages 18-54 in 2010 (ages 30-66 at the end of the study period). We focus on this age group in our main results because homelessness is rare among the elderly; in 2010, only 6.6 percent of the adult homeless population was 65 or older, compared to 17.3 percent of the overall housed adult population and 12.2 percent of the housed poor population. We do, however, produce results for some key outcomes with a sample that includes elderly people in all three groups to document differences in the mortality hazard by age.

Tables 2 and 3 display summary statistics for the non-elderly sample of homeless individuals and comparison groups. The non-elderly homeless sample consists of about 140,000 linked individuals and our housed comparison group includes about 1.3 million linked individuals. The housed poor sample consists of 110,000 linked individuals. Among the non-elderly, homeless individuals are older and are disproportionately likely to be between 45-49 and 50-54 years old. The homeless are also more likely to be male (especially compared to the housed poor) and more likely to be Black than the comparison groups and are concentrated in the Northeast and West, reflecting the substantial homeless populations in New York and California.

3.2 Mortality hazard model

We specify the mortality hazard $\lambda_i(t)$ using a discrete time proportional hazard model with a non-parametric baseline hazard:

$$\lambda_i(t) = \lambda_0(t)\exp\left(z_i(t)'\beta\right)$$

In this equation, $\lambda_0(t)$ is the baseline hazard at time t (which is unknown, but estimated), where t indexes semi-annual (six-month) periods between April 2010 and March 2022. $z_i(t)$ is a vector of time-dependent explanatory variables (covariates) for individual i, and β is a vector of

unknown parameters. The covariates included differ across specifications. We also include group interactions with the baseline hazard parameters in some specifications.

The discrete time hazard model with a non-parametric baseline is a natural choice in our setting for several reasons. First, while the underlying data-generating process is continuous, our data are discrete, with ties (same-day deaths) occurring not infrequently. The discrete model allows us to estimate the model without relying on approximations that would be required if using the Cox partial likelihood estimation method. Nevertheless, the estimates from our model are parameters of a continuous time hazard and thus retain an easy interpretation. Finally, we employ a non-parametric baseline because approaches that assume a parametric form for the baseline hazard provide inconsistent estimates when the assumed baseline hazard is incorrect, which likely leads to bias when events like the COVID-19 pandemic or other period effects give the hazard an unusual shape (Meyer 1990).

3.3 Mortality accounting for demographic differences between groups

We compare groups accounting for differences in their demographic characteristics in two ways. Our first approach is to estimate a hazard model with controls for covariates (we estimate several different specifications with different sets of controls) with key covariates being indicators for groups and a common baseline hazard. One can then interpret the coefficient on a group dummy as the proportional difference in the hazard between that group and a base group, accounting for covariate differences. The advantage of this approach is that it provides a simple summary measure of the relative hazard rate. The drawback is that it assumes a common baseline mortality hazard across all groups, which may not be correct.

Our second approach allows the baseline hazard to vary more flexibly between groups. Under this approach, we estimate a hazard model including the covariates but also interacting group indicators with the baseline hazard parameters. We then use these estimates and the distribution of covariates for the homeless population to simulate a hazard and survivor function for the homeless and our comparison groups. This approach provides us with predicted hazard rates and survivor functions for each group under the counterfactual scenario where they had the same covariates as the homeless group. In addition to allowing the baseline hazard function to vary between groups, this approach has the advantage of allowing us to estimate differences in

twelve-year survival accounting for demographic differences, not just semi-annual hazards, and to see the evolution of differences in mortality hazard rates over time.

Both approaches described above constrain the effect of a covariate to be the same for homeless and housed groups. This assumption may not be plausible in all cases. For example, comparisons of means for several outcomes suggest that among the homeless, groups that are more disadvantaged in the overall population fare better in certain respects than those who are more advantaged in the overall population. Meyer et al. (2023) find that among homeless individuals, those who are Black have higher incomes and are more likely to be employed than those who are white. In this case, the assumption that race has the same effect on mortality for the homeless and the housed may be incorrect, suggesting that controlling for race may not make the homeless and our comparison groups more comparable.

4. Results

4.1 Mortality disparities between the homeless and housed populations

In this section, we consider differences in mortality risk between people who are homeless and people who are housed, including a poor subset of the housed, and compare our findings to the previous literature. We estimate the magnitude of disparities between these groups with and without accounting for demographic and geographic differences. We also estimate relative mortality risk for subsets of the population defined by gender, race, Hispanic ethnicity, disability status, and age.

4.1.1 Empirical mortality hazard and survivor functions

Figure 1 displays the empirical mortality hazard, defined as the probability of death in a six-month period conditional on being alive at the beginning of that period, for the non-elderly homeless population and for the housed and housed poor comparison groups. The mortality hazard increases over time as the samples age, rising from 0.38 percent in the first period to about 1.19 percent in the final period for the homeless, 0.09 to 0.30 percent for the housed, and 0.18 to 0.47 percent for the housed poor. Our homeless sample has a mortality hazard that is 3.9 to 4.9 times higher that of the housed population over the twelve years of our study period.

Unlike previous studies, however, we also compare the mortality of homeless individuals to that of the housed poor. We find that our homeless sample has a mortality rate that is 2.1 to

3.2 times higher than that of the housed poor over our study period. Housed poor individuals themselves have a mortality rate that is 1.4 to 2.1 times higher than the housed population more broadly, but as we show in the next section, this gap widens when we account for age and gender.

Figure 2 displays the empirical survivor function for the three groups, defined as the share of those alive at the beginning of our study who are alive at end of each six-month period. After 12 years, 96.1 percent of the housed population is still alive, compared to 93.8 percent of the housed poor and just 84.2 percent of the homeless population.

4.1.2 Mortality hazard rate when accounting for differences between groups

Figure 3 summarizes the mortality hazard rate of the homeless and housed poor groups relative to the housed and shows how the relative hazard changes when we account for demographic and geographic differences between groups. Specifically, the figure displays the estimated coefficient on group indicators from the first estimation approach described in Section 3, where we regress mortality on group indicators for the homeless and housed poor samples and a common set of duration indicators for the three groups, as well as various sets of controls.

Without controls, the mortality hazard of homeless individuals is about 4.4 times that of the housed, but when we account for age and gender differences the relative hazard falls to 3.4—an estimate that lies within the wide range of relative mortality ratios between homeless and housed individuals produced by prior studies (Hwang et al. 1997, Hibbs et al. 1994, Baggett et al. 2013, Barrow et al. 2011). Adding race, ethnicity, and geographic controls has little effect on the relative mortality rate, suggesting that age and gender are the key demographic differences between samples affecting relative mortality rates. Without controls, the housed poor are 1.6 times as likely to die as the broader housed population, but after accounting for age and gender their relative mortality risk rises to 2.1. Accounting for age and gender, we estimate that people who have experienced homelessness are about 60 percent more likely to die than those who are poor but housed, suggesting that homelessness is an important risk factor for mortality that is distinct from poverty alone.

Figure 3 also indicates the mortality risk of the sheltered and unsheltered homeless relative to the housed population. Without controls, the mortality hazard is slightly higher for the

unsheltered than the sheltered, but once we account for the fact that the former group is older and more male, we find that these two subsets of the homeless population face similar mortality risk.

In Figure 4, we display the age- and gender-adjusted mortality hazard for the homeless and our two comparison groups. These results correspond to the second approach described in Section 3, where we estimate a model with group-specific baseline hazard parameters and simulate the mortality hazard for housed and housed poor groups using the distribution of characteristics of the homeless sample. The main difference between the empirical and covariate-adjusted hazards is that the housed poor have a higher mortality hazard when we account for age and gender, as we saw in Figure 3, reflecting the fact that when we align their characteristics with the older, more male homeless population, their mortality hazard increases. Table 4 reports cumulative mortality over the 12 years after March 2010 using the empirical and covariate-adjusted hazards. When considering cumulative rather than period-specific mortality, we find people in our homeless sample were 3.2 times as likely to die during the study period as the housed and about 1.6 times more likely to die than those who are housed but poor, when we account for age and gender.

Figure 4 illustrates in stark terms the considerable health disparities associated with poverty and homelessness. People who are poor but housed are about twice as likely to die as the average housed person, and people who have experienced homelessness face a mortality risk that is about 60 percent higher than those who are poor but housed.

4.1.3 Gender and mortality

Figure 6 displays the mortality risk of homeless and poor housed individuals relative to the housed by gender, controlling for age. The first set of points in this figure indicates the hazard by gender and housing status relative to housed men. This set allows us to see how the mortality hazard differs by gender for a given housing status and across housing statuses for a given gender. To make it easier to see how the mortality hazard differs by housing status among women, the second set of points indicates the relative hazard of homeless and housed poor women relative to housed women.

We find that men have higher mortality risk than women with a given housing status. For example, housed men have mortality hazard that is 35 percent higher than housed women, and homeless men have mortality hazard that is 29 percent higher than homeless women. At the same

time, homeless women face mortality risk that is four times that of their housed counterparts, whereas homeless men are only about 3.3 times as likely to die as housed males, estimates that reflect the higher mortality risk of housed men compared to housed women.

While prior studies confirm both of these patterns by gender, they estimate that the homeless-to-housed mortality risk is even higher for women relative to men than what we find (Baggett et al. 2013, Barrow et al. 1999, Hwang et al. 1997, Henwood et al. 2015, Hibbs et al. 1994). For example, Barrow et al. (1999) find that the homeless-to-housed mortality ratio is 3.7 for women and 2.2 for men, while Baggett et al. (2013) obtain estimates of 6.2 for women and 5.1 for men..[2] For young homeless adults between 18 and 24 years old, Hwang et al. (1997) find an even larger disparity by gender: homeless women are 11.8 times more likely to die than housed women in their study, while homeless men are comparatively only 5.9 times as likely to die. Our findings suggest that gender differences in mortality risk found in some past studies may not generalize to a broader population.

4.1.4 Race and mortality

Figure 7 displays the mortality risk of homeless and poor housed individuals relative to the housed by race, controlling for age. The first set of points in this figure indicates the hazard by race and housing status relative to housed people who are white, while the second and third sets of points indicate the relative hazard of homeless and housed poor people who are Black and of other races, respectively, relative to housed people of the same race.

For housed and poor housed individuals, mortality risk is highest for people who are Black, followed by those who are white, and then then those of other races. Among the homeless population, however, white individuals have the highest mortality risk, followed by people who are neither white nor Black. In a reversal of the pattern observed in the housed population, Black individuals have the lowest relative mortality risk among the homeless population. This finding is consistent with estimates provided by previous work (Hibbs et al. 1994, Metraux et al. 2011, Baggett et al. 2013).

Comparing homeless individuals' mortality risk to that of the housed of the same race, we find that white homeless individuals and those of other races have the most elevated mortality

[2] Where aggregate rate ratios for all ages were not available for men and women, we calculated, where possible, the ratios belonging to these ranges weighted by age and gender using the data provided by these studies.

risk relative to their housed counterparts, at 4.7 and 4.6 times, respectively. Black homeless individuals are 2.3 times as likely to die as their housed counterparts, a fact that reflects both the relatively low mortality hazard of Black individuals within the homeless population and the elevated mortality risk of Black housed individuals compared to those who are white and of other races. This finding, too, is consistent with previous work (Hibbs et al. 1994, Metraux et al. 2011, Baggett et al. 2013).

4.1.5 Hispanic ethnicity and mortality

Figure 8 displays relative mortality risk by housing status and Hispanic ethnicity. Hispanic individuals have lower mortality risk than non-Hispanics in each of the three housing statuses.[3] For example, a homeless Hispanic person has, on average, 23 percent lower mortality risk than a non-Hispanic person, controlling for age. Non-Hispanics who are homeless have slightly higher mortality risk relative to their housed counterparts (3.8 times) than do homeless Hispanics (3.5 times). No previous study, to our knowledge, has looked at differences in mortality risk by Hispanic ethnicity in the homeless population.

4.1.6 Disability status

Figure 9 displays relative mortality risk by housing status and disability status. A person is defined as disabled if Medicare records indicate that they were a Disability Insurance (DI) recipient in 2009 or if Medicaid records indicate that they were a Supplemental Security Income (SSI) recipient in 2009. As Table 2 indicates, a much larger share of the homeless population was disabled before the beginning of our study (20.6 percent) than of the housed poor (10.7 percent) or of the broader housed population (3.9 percent). It is worth noting, however, that Meyer et al. (2023) find that DI and SSI receipt increase at a faster rate for the Census homeless population after 2010 than for the housed and housed poor populations, meaning that a larger share of homeless individuals indicated as non-disabled in our study became disabled (or were connected to disability services) during our study period.

People who are disabled face substantially higher mortality risk than non-disabled individuals with the same housing status, controlling for age. A housed disabled person is 4.5

[3] Hispanics' lower mortality risk is not a novel finding. Hispanic individuals are frequently found to experience similar or better health outcomes than non-Hispanic individuals in the United States despite socioeconomic disadvantage, a pattern that is sometimes called the "Hispanic mortality paradox" (Ruiz, Steffen, and Smith 2013).

times as likely to die in a six-month period as a non-disabled housed person, while a housed poor disabled person is 2.8 times as likely to die as a non-disabled housed poor person. A homeless disabled person is 1.6 times as likely to die as a non-disabled homeless person. Notably, disabled housed and housed poor individuals have even higher mortality risk than non-disabled homeless individuals.

Mortality risk is very similar for all three groups of disabled individuals. Disabled homeless individuals are 32 percent more likely to die than housed individuals with disabilities. By contrast, a non-disabled homeless person is about 4 times as likely to die as a non-disabled housed person. This latter fact may reflect in part the prevalence of disabilities in the homeless population not captured by our measure, as suggested by the steep increase in disability program receipt after 2010 found in Meyer et al. (2023). Nevertheless, it appears that mortality disparities by housing status are concentrated almost exclusively among people who were not enrolled in disability assistance programs at the beginning of our study period.

Our study is the first, to our knowledge, to look at mortality hazard by disability status in the U.S. homeless population.

4.1.7 Age and mortality

Figure 10 displays relative mortality risk by housing status and age, where we have selected age bins to facilitate comparisons to prior literature. Homeless individuals in the youngest age category, 18-24, have the lowest mortality risk relative to their housed counterparts; they are slightly less than twice as likely to die in a six-month period. Relative mortality risk is highest for homeless individuals ages 45-54, who are about 4.2 times as likely to die as their housed counterparts.

These findings are largely consistent with prior work, which finds a peak in the relative homeless-to-housed mortality risk between the ages of 25 and 49 (Hibbs et al. 1994, Barrow et al. 1999, Baggett et al. 2013). Our estimate of homeless-to-housed mortality risk for those ages 18 to 24, however, is smaller than prior studies' estimates, which range from 2.7 to 11.8 times that of the housed young population (Hibbs et al. 1994, Hwang et al. 1997, Barrow et al. 1999, Baggett et al. 2013).[4] Hwang et al. (1997), in particular, find that homeless adults aged 18 to 24 had the highest mortality risk relative to the housed in their sample.

[4] This range includes relative mortality risks estimated separately for men and women of this age range.

Figure 11 presents estimates of the mortality hazard by housing status in two-year age bins relative to housed 30- to 31-year-olds. While all three groups have increasing relative mortality risk as they age, their relative mortality risk begins to converge after the age of 50, a fact that is more readily apparent in Figure 12, which displays the ratio of estimated homeless and housed poor coefficients relative to the housed coefficient in the mortality hazard model. In their late 70s, homeless individuals face the same mortality risk as housed poor individuals and are about 40 percent more likely to die than their housed counterparts.

Our estimates could reflect the declining relative frailty of the surviving homeless population as the highest-risk individuals die, or, relatedly, risks such as cardiovascular disease that rise with age that affect housed and unhoused individuals similarly. We also note that safety net eligibility is changing over time and as people age. We do not account for the safety net here, but Wyse and Meyer (2023) find that the effect on mortality of safety net programs for the elderly, such as Medicaid and Social Security, does not appear to be large, at least as indicated by changes around eligibility ages and policy implementation dates.

Figure 11 also allows us to estimate the age at which each group will face a given level of mortality risk relative to the baseline group (30- to 31-year-old housed individuals). The dashed line on this figure indicates the mortality risk of a 40-year-old homeless person and its intersection with the comparison groups' lines indicates the age at which people in those groups will face the same mortality risk. We see that a 40-year-old homeless individual faces mortality risk that is similar to that of a 58-year-old housed person and a 48-year-old housed poor person. In other words, homelessness is associated with a health detriment equivalent to nearly twenty years of aging.

4.2 Identifying the most vulnerable subsets of the homeless population

In this section, we consider differences in mortality risk among subsets of the homeless population with the goal of identifying the most vulnerable groups. We are particularly interested in the distinction between people who in 2010 were experiencing unsheltered homelessness and those who were counted by the Census in shelters. We also consider differences by state of residence, income and employment status, and the extent of observed family connections.

4.2.1 Mortality risk by type of homelessness

Figure 13 shows the mortality hazard in each period for sheltered and unsheltered men and sheltered and unsheltered women, controlling for age.[5] Both sheltered and unsheltered men are about half a percentage point more likely to die in a six-month period than sheltered and unsheltered women. As in Figure 3, conditional on gender and age, sheltered and unsheltered people have very similar mortality hazard rates, conflicting with prior work finding that unsheltered individuals have higher mortality risk than sheltered individuals (Roncarati et al. 2018, Roncarati et al. 2020). This result may reflect the fact that our sample is designed to be representative of the overall homeless population, not just of health services users as in Roncarati et. al (2018, 2020). We caution, however, that our study indicates sheltered or unsheltered status in the year 2010, and we are unable to ascertain people's living situations at other points in time.

This finding is surprising, too, because we know based on prior work that people who were sheltered homeless during the 2010 Census had greater incomes, employment, and connections to the safety net than unsheltered people of the same gender. For example, Meyer et al. (2023) found that about 55 percent of sheltered women had formal employment in 2010, compared to 42 percent of unsheltered women. About 50 percent of sheltered males and 40 percent of unsheltered males were formally employed that year. Yet despite important apparent differences in these populations' material well-being, this health outcome appears to be similar.

Figure 14 indicates mortality risk relative to the sheltered white group by sheltered status, race, and gender. Black homeless individuals have lower mortality risk than those who are white even conditional on gender and type of homelessness. White women who are unsheltered have slightly lower mortality risk than sheltered homeless white women, while sheltered and unsheltered white men have nearly the same mortality hazard.

Figure 15 displays mortality risk by age relative to the youngest sheltered homeless cohort (ages 18-24), controlling for gender. Once again, sheltered and unsheltered individuals have similar mortality risk by age group.

4.2.2 Mortality risk in New York, California, and other states

Figure 16 displays the relative mortality hazard rate by state of residence (New York, California, or other states), controlling for demographic characteristics, type of homelessness,

[5] Specifically, we use the age distribution of sheltered males to simulate the covariate-adjusted hazard for the other three groups.

and income according to 2005-2009 tax records. People who are homeless in New York have a mortality risk that is about 13.4 percent lower than those in other states, while the mortality risk for California's homeless population is not statistically significantly different from the risk for homeless individuals in states besides New York.

New York residents' lower mortality risk does not reflect differences in demographic characteristics, income, or type of homelessness, because we have controlled for these variables in our estimation. Their lower mortality risk also does not appear to reflect differences in disability status or safety net engagement. Meyer et al. (2023) find that homeless individuals in New York and in the rest of the country have similar rates of disability program receipt (23 percent and 19 percent, respectively) and similar rates of receipt of other major safety net programs (93 and 89 percent).[6] One possible explanation lies in the generosity of homelessness services in New York, where a court-mandated "right to shelter" policy has increased the availability and quality of shelter beds, especially for families (O'Flaherty 2019). Better services could improve the health of people experiencing homelessness. Higher shelter quality could also affect the relative affluence of the average shelter resident by making shelters preferable to some extremely undesirable housed situations, resulting in a sheltered homeless population that is drawn from a slightly less disadvantaged population.[7]

4.2.3 Mortality risk by employment and income status

Figure 16 also shows how mortality risk differs by employment status and income among people experiencing homelessness. We define someone as employed if they had formal earnings in 2009 according to IRS 1040 and W2 datasets.[8] We define someone as being in the top half of

[6] These shares reflect receipt of benefits through the Supplemental Nutrition Assistance Program (SNAP), housing benefits through the Department of Housing and Urban Development (HUD), Medicare or Medicaid, or service-connected disability through the Veterans Benefit Administration. A key exception in New York's safety net generosity concerns Medicaid, which was available to all poor adults at the beginning of our study period in the state but only became available to poor adults in most other states after 2014, under provisions of the Affordable Care Act (ACA). However, Wyse et al. (2023) do not find evidence that Medicaid enrollment reduces homeless individuals' mortality risk, suggesting that a causal relationship between Medicaid availability and lower mortality risk in New York is weak, if present.

[7] Families in New York must be vetted before being admitted to the shelter system and O'Flaherty (2019) notes that "most families who apply are rejected," meaning they were determined to have access to other housing options.

[8] More specifically, for people who link to a 1040, we define earnings as the sum of 1040 wage and salary income, estimated non-negative 1040 self-employment income (when a self-employment schedule was filed), and W2 deferred compensation, minus any W2 wages and tips associated with a co-filer. For people who do not link to a 1040 but do link to a W2, earnings are equal to wages and tips across W2s. For people who link to neither, earnings are zero.

the income distribution by taking the average of their inflation-adjusted pre-tax cash income according to tax records over 2005-2009 and comparing this to the median for people with the same sheltered status.[9]

We find that people who are employed and people in the top half of the income distribution are about 34.6 and 32.7 percent less likely to die in a six-month period than those who are not employed and those in the bottom half of the income distribution. These findings show that even among people who have experienced homelessness, those who are more economically disadvantaged and more disconnected from the formal labor market have far worse health outcomes.

4.2.4 Mortality risk by family connections

The third set of results on Figure 16 show how mortality risk differs by the extent of family connections in our datasets. We classify individuals as having or having once had a spouse if they ever had a co-filer on a 1040 in 2005-2009, and we classify them as having a child if they ever included a dependent on a 1040 in those years. We also attribute connections to others if someone was recorded in Census housing, likely by a friend or relative, in addition to being counted as homeless. Meyer et al. (2022) document widespread double-counting of people experiencing homelessness in the Census and find that duplicate records often reflect those individuals' inclusion on the Census form of a housed family member, e.g. the parent of an adult homeless individual. In addition to demographic characteristics, we control for income to ensure that our estimates are not confounded by the fact of tax filing, which is in turn associated with higher income, as well as the presence of co-filing spouses and dependents.

Having at least one observed family connection is associated with 17.3 percent lower mortality risk for people experiencing homelessness. Homeless individuals who have a current or former spouse face a mortality risk that is 21.3 percent lower than those who do not, and people who have children are 21.6 percent less lower mortality risk than those who do not. Homeless individuals who were recorded on a housed family member's Census form are 13.6 percent less likely to die than those who were not. Family connections appear to be an important protective

[9] For people who link to a 1040, pre-tax income is equal to the sum of total money income and VA service-connected disability compensation. For people who do not link to a 1040, pre-tax income is equal to the sum of wages and tips and deferred compensation in W2s, VA service-connected disability compensation, and IRA and employer-sponsored retirement distributions across 1099-Rs.

factor against mortality for people who have experienced homelessness, albeit one that is not as potent as our measures of income and employment.

4.3 Mortality during the COVID-19 pandemic

The empirical hazard in Figure 1 suggests a steep rise in mortality hazard during the COVID-19 pandemic. In this section, we formally examine the pandemic-era rise in mortality and compare its magnitude across groups. Specifically, we consider the absolute and proportional change in average annual mortality risk in the two years prior to the pandemic (April 2018-March 2020) and the first two years of the pandemic (April 2020-March 2022). We calculate these changes using both the empirical mortality hazard and the covariate-adjusted mortality hazard, which uses the distribution of age and gender among the homeless to provide a comparable hazard for the three groups.[10]

In describing the COVID-era rise in mortality hazard, we wish to account for the fact that aging would have caused our cohorts' mortality hazards to rise over these four years regardless of the COVID-19 pandemic. To do so, we regress the mortality hazard in six-month periods indexed by j = 1, …, 20 on a constant and a time trend. We then take the estimated coefficient on this time trend and multiply it by eight to obtain the estimated effect of aging on the average annual mortality hazard, which we subtract from the observed rise in the mortality hazard to obtain an aging-adjusted estimate of the hazard increase.[11]

Table 5 displays the results from this procedure. We find that all three groups experienced an approximately 30-35 percent increase in their average annual mortality hazard in the two years of the pandemic relative to the two preceding years and in excess of the change we would have expected due to aging. At the same time, the absolute increase was much larger for the homeless than other housing status groups given their substantially elevated baseline mortality risk. Figure 5 displays the observed mortality hazard alongside the predicted hazard accounting for the time trend. The gap between predicted and observed hazard illustrates the magnitude of excess mortality.

[10] We use the groups' survivor functions to calculate annual analogues of the bi-annual hazards indicated in Figures 1 and 4.

[11] Multiplying this estimate by four gives us the effect of aging on average biannual hazard between the midpoint of our pre-pandemic period and the midpoint of our post-pandemic period. We then multiply the estimate by two to convert the estimate's effect on the biannual hazard to its effect on an annual one.

We also calculate differences in the pandemic-era mortality rise by gender and type of homelessness and display these findings in Table 6. Sheltered and unsheltered males saw a much larger absolute and proportional rise in their mortality risk (35 and 28 percent, respectively) during the pandemic beyond what we would have expected due to aging. Sheltered and unsheltered females saw a 24 and 21 percent increase in their risk of dying in a year. Again, the distinction between genders in mortality risk is much more pronounced than the distinction between sheltered and unsheltered homelessness. An important caveat is that type of homelessness reflects status in 2010 and may not reflect people's living situations during the pandemic.

Because we lack information on cause of death, however, we caution against attributing excess mortality to COVID-19 directly. Previous research has indicated that excess mortality during the pandemic could be attributed to rising fentanyl, other opioid, or methamphetamine use over the last two decades—or, relevantly, to difficulties in obtaining medical services for life-threatening situations like overdoses and traumatic injuries due to hospital overcrowding (Cawley et al. 2022, Baggett et al. 2011). Cawley et al. (2022) in particular found that the substantial rise in homeless individuals' mortality in San Francisco during the pandemic was driven by difficulties in obtaining care for emergencies from an overburdened medical system, and that COVID-19 was not a leading cause of death for homeless individuals in their sample. Our measure of excess mortality accounts for deaths from the virus itself but also from indirect effects like a disruption in health services. Our estimates should therefore be interpreted as the combined effect of the pandemic and any associated changes in all-cause mortality risk.

5. Discussion

Because ours is the largest, most representative study of homeless mortality to date, our findings can help establish the most broadly true patterns in the mixed array of findings from prior work. For instance, while many of the groups that face higher mortality risk in the housed population also face higher risk in the homeless population, race is an important exception. We find, in support of prior studies, that Black homeless individuals have lower mortality risk than those who are white, adding to a growing body of evidence suggesting that Black individuals who experience homelessness fare better than those who are white on a range of indicators of well-being (Hibbs et al. 1994, Baggett et al. 2013, Metraux et al. 2011, Meyer et al. 2023). This pattern may suggest different pathways into homelessness for people of different races. For

example, the lower prevalence of substance abuse and behavioral health conditions among Black homeless individuals, as found by Hibbs et al. (1994), could explain their relatively lower mortality risk. Black individuals' lower mortality risk could also reflect the fact that white individuals, on average, have access to better-resourced social and family networks to protect against homelessness, meaning that only those with especially difficult personal circumstances— for instance, a history of behavioral and mental health disorders or substance abuse, both of which are associated with heightened mortality— become homeless, while Black individuals are more susceptible to becoming homeless due to economic hardship alone (Hibbs et al. 1994, Baggett et al. 2013).

The richness of our data allows us to identify factors associated with heightened mortality risk, which in turn may point to strategies for mitigating these groups' mortality risk. For instance, family connections appear to be almost as protective against mortality as higher income and employment, a finding that accords with Metraux et al. (2011) and suggests the need for additional support to people who are least connected to social and family networks. This finding also suggests that family engagement may be a useful strategy for reducing mortality risk.

Our results also indicate segments of the homeless population that face higher mortality risk than one might expect based on anecdotal evidence or patterns in the housed population. For example, our finding of no major difference in mortality risk between unsheltered and sheltered homeless individuals, controlling for gender, highlights the significant health risks associated with homelessness even among people sleeping in shelters, a group that figures less prominently in policy debates than their more visible unsheltered counterparts. We also find that non-disabled homeless individuals face mortality risk that is much closer to those who are disabled than one would expect based on the housed population. Disabled homeless individuals are just 1.6 times more likely to die than non-disabled homeless individuals, compared to 4.7 times in the housed population. This finding illustrates the relatively poor health even of non-disabled people experiencing homelessness and suggests the need to target both groups in interventions to reduce homeless individuals' mortality risk.

While our analyses indicate strong associations between homelessness, individual characteristics, and mortality, we caution that our study does not allow us to identify a causal or directional relationship between homelessness and elevated mortality risk. Behavioral health and substance abuse, for instance, could drive both homelessness and heightened mortality risk, or

mortality risk and homelessness could both be consequences of the exceedingly severe long-term material deprivation this population experiences. Homelessness itself could also cause elevated mortality risk, whether through hardships of street and shelter living or some other channel, such as difficulties in maintaining continuity of care for medical conditions. While our results may help pin down the effects of causal relationships, they should not be taken as causal in themselves.

6. Conclusions

In this study, we provide the first national estimates of mortality, one of the most fundamental indicators of health and well-being, for people experiencing homelessness in the United States. We base our analyses on by far the largest and most representative data ever used to study this topic and examine the magnitude of health disparities between housed and unhoused individuals by age, gender, race, Hispanic ethnicity, and disability status. Within the homeless population, we examine mortality differences by sheltered status, income, employment, and the extent of observed family connections to identify the most vulnerable individuals and describe factors associated with heightened or decreased mortality risk.

In addition to the size, national scope, and representativeness of our data, our approach benefits from several advantages over prior efforts to compare the mortality of housed and unhoused individuals. Ours is the first study to compare housed and homeless mortality using data from the same sources and applying a common methodology to both, allowing for more detailed and reliable comparisons. We also link the individuals in our study to administrative data to access rich longitudinal information on income, employment, disability status, and safety net participation, which allows us to compare mortality risk between many different subsets of the homeless population and to characterize the patterns of long-term material deprivation that accompany elevated mortality risk. We supplement our analyses using a nationally representative sample of poor housed individuals from a closely comparable data source to learn about homelessness as a risk factor for mortality distinct from poverty in general. We view our findings as complementary to an extensive and growing body of clinical and public health research into the conditions that disproportionately afflict this population and interventions that improve their health.

We find that people who have experienced homelessness face a mortality risk that is 3.5 times that of the housed, accounting for differences in demographic characteristics and geography. For comparison, we estimate that the mortality ratio between Black and white individuals in the housed U.S. population is 1.4 and the ratio between people of all incomes and those who are poor is 2.2. Relative to a housed person, a homeless person has almost the additional mortality risk of someone who is disabled – among people who are housed, the mortality ratio between the disabled and non-disabled is 4.6. Our estimates imply that a 40-year-old homeless person has the same mortality risk as a housed person who is nearly twenty years older. These disparities reflect more than economic disadvantage. People who have experienced homelessness face mortality risk that is even 1.6 times higher than the elevated risk faced by people who are housed and poor.

The COVID-19 pandemic coincided with a 33 percent increase in mortality for people experiencing homelessness beyond what we would have expected due to the aging of our cohort. While housed and housed poor people saw a similar proportional rise in their mortality risk, the pandemic affected a much larger share of the homeless population because of their already elevated baseline mortality rate. Homeless men seem to have been hit especially hard: their mortality risk rose by 35-38 percent, compared to 22-24 percent for homeless women. The direct causes of excess mortality during the pandemic are not apparent from our data, however, and could include both the virus itself and the difficulties of obtaining services for emergencies like injury and drug toxicity in an overburdened health system.

Many of the groups that face higher mortality risk in the housed population – men, non-Hispanics, people with lower incomes, people who are disabled – also face higher risk in the homeless population, but race differences provide a notable exception. Among people who are housed, someone who is Black is 40 percent more likely to die than someone who is white, but among people who have experienced homelessness, someone who is Black is 27 percent less likely to die than someone who is white, controlling for age. This pattern mirrors prior work showing that Black homeless individuals are better off in many respects than white homeless individuals, having higher incomes, employment, and greater engagement with the safety net (Meyer et al. 2023). These findings are worth examining in more depth, as they may suggest a pattern of different pathways to homelessness for people of different races.

We find that homeless individuals' relative mortality risk changes over the life cycle and is greatest when they are in their 30s and 40s, when their mortality risk is about four times that of a same-aged, housed person. Relative risk falls sharply with age beginning around age 50, and for the most elderly people in our sample, those in their 70s, mortality risk is similar to the housed poor and falls to 1.4 times the housed population more broadly.

Income, employment, and family connections are associated with lower mortality risk; having been observed in a shelter (as opposed to unsheltered) in the 2010 Census is not. Those with higher incomes and those who were employed in the years before our study are about 30 percent less likely to die than their counterparts. People who have or had spouses, have children, or who were included on a family member's housed Census form all have mortality risk that is about 20 percent lower than their counterparts. Perhaps surprisingly, we find very little difference in mortality risk between people we initially observe in homeless shelters and those who are unsheltered, conditional on gender. This last finding highlights the substantial health risks faced even by people experiencing homelessness in shelters, a group of people that are less visible and often receive less attention than people who sleep on the streets, but who nevertheless experience substantial health disparities.

This paper joins a growing body of work through the Comprehensive Income Dataset (CID) project that aims to establish fundamental facts about homelessness in the United States by linking datasets that have not in the past been used to study this population to administrative data to unlock new insights. Recent work has improved our understanding of the size of the U.S. homeless population, established the surprisingly good coverage of people experiencing homelessness in the Census, and revealed long-term extremely low incomes and high reliance on the safety net. Ongoing and planned work aims to understand the effects of safety net programs on homeless individuals' mortality and material well-being and to learn about the dynamics of transitions between housing, institutional settings, and homelessness. In providing the first national estimates of homeless mortality in the U.S., this paper not only adds to the emerging picture of the persistent hardships and stark health disparities associated with homelessness, but also sheds light on some of the most vulnerable subsets of an already exceptionally vulnerable population and contributes to efforts to more effectively mitigate the mortality risks faced by people experiencing homelessness.

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8. Appendix

8.1 Potential bias from unidentified decedents

Deceased individuals whose identities cannot be determined do not appear in our Numident death records, potentially understating our mortality estimates. This possibility is likely to occur disproportionately among those experiencing homelessness, as these individuals do not have a fixed address and may be less connected to other people in comparison to housed individuals. At the same time, as Meyer et al. (2023) emphasize, even the homeless are connected to employers and government social services at a high rate, with more than 95 percent either engaged in formal work or receiving social insurance or welfare benefits.[12] To investigate the scope of potential understatement of mortality among the homeless, we explored the extent of unidentified decedents in the U.S., also sometimes referred to as John and Jane Doe deaths.

Two primary federal databases supported by the Department of Justice contain data related to missing and unidentified people in the United States: the National Crime Information Center (NCIC) database and the National Missing and Unidentified Persons System (NamUs). While access to the NCIC database is restricted to authorized agencies, NamUs is open to be viewed by the public. Both, though they are separate and unconnected systems, contain information on long-term unidentified persons, defined as cases where the decedent's identity has not been determined for more than 30 days. Notably, while all cases contained in NCIC should theoretically be captured by NamUs (though this is not always the case), NamUs also accepts and maintains additional records of missing and unidentified persons that may not be found in NCIC because, for instance, they may not yet have been filed with law enforcement, and because NamUs aggregates information from law enforcement, criminal justice agencies, coroners, and families of missing persons alike (U.S. Government Accountability Office 2016). NamUS numbers of unidentified remains tend to be higher, consistent with this broader sourcing, and so are likely a more reliable upper bound.

Ideally, we would like to obtain an estimate of the number of unidentified decedents each year and the share of these who were experiencing homelessness, but neither federal database

[12] Specifically, Meyer et al. (2023) find that 97 percent of Census shelter users and 93 percent of those who are unsheltered are enrolled in at least one safety net program (Medicaid, SNAP, OASDI, SSI, or Veterans' Connected Disability) or were formally employed in the year observed as homeless.

allows us to calculate these numbers directly. In 2023, however, NamUs began publishing a monthly report indicating the number of unidentified persons cases created and resolved each month (National Institute of Justice 2023). In January of that year, 106 cases were created and 41 resolved, indicating a net increase of 65 persons, or 780 per year if extrapolated across twelve months. We obtain an estimate of the share of unidentified decedents who were experiencing homelessness by restricting records in the NamUs database to those in which the word "homeless" appears in the Circumstances of Recovery section of the record.[13] This suggests about 2.7 percent, or 384 of NamUs's stock of 14,382 unidentified decedents (those found in 1915 to 2022) were experiencing homelessness at the time of death. Consistent with our earlier conjecture, this share is more than an order of magnitude higher than the homeless share of the population. Multiplying this share by the annual estimate of 780 unidentified persons gives a back-of-the-envelope estimate of about 21 unidentified homeless decedents each year. This number is dwarfed by the approximately 3,500-7,000 people in our homeless sample who die each year.

Incompleteness of the NamUs database and the presence of homeless decedents missed by our database filtering procedure could cause this number to be an underestimate, but this bias would have to be extremely large to be a cause of concern for the findings in this paper. We may also wish to consider the number of gross, not net, additions to the NamUs database each year, if we think that resolved cases reflect long-deceased individuals, although such an adjustment would increase our estimated annual number of unidentified homeless individuals to just 34. Given the magnitude of available estimates, unidentified deaths seem likely to be a small source of bias in our findings.

[13] These cases generally appear to be ones in which an individual was mentioned to be homeless by other people at the scene familiar with the individual, an individual appeared to be homeless due to appearance and belongings, or a person was found near a homeless encampment.

Tables

Table 1:

Prior Estimates of Homeless Individuals' Relative Mortality Risk					
Author(s) and Year	**Location and Collection Period**	**Mortality Period**	**Sample Demographics and Mortality Data**	**Comparison Group, Mortality Data**	**Estimates (Standardized Mortality Rates)**
Baggett et al. (2013)	Boston, 2003-2008	2003-2008	28,033 sheltered and unsheltered, ages 18-64, the universe served by Boston Health Care for the Homeless Program (BHCHP) between 2003-2008. Mortality data from Massachusetts Department of Public Health death occurrence files.	2003-2008 Massachusetts population. Mortality rates obtained from CDC WONDER.	Race-adjusted totals: Ages 25-44: 8.6 (men), 9.6 (women) Ages 45-64: 4.5 (both genders) Ages 65-84: 1.1 (both genders)
Barrow et al. (1999)	NYC, 1987	1987-1994	1,260 sheltered in 1987, ages 18+, randomly selected from bed rosters in 22 municipally run congregate shelters in NYC and systemically selected from food and clothing lines in 4 shelters. Mortality data from the National Death Index.	1987-1994 U.S. and NYC populations. Mortality rates obtained from the CDC's mortality files.	Total age-adjusted totals in NYC: 2.2 (men), 3.7 (women)
Metraux et. al. (2011)	NYC, 1990-2002	1990-2007	160,525 sheltered adults, ages 18-74, with a record of first entering a homeless shelter run by NYC DHS from 1990-2002 and who had SSNs (universe); among families, one adult selected who was designated by DHS as head of household. Mortality data from Social Security Death Index.	None to housed population; only compares those who are homeless in families to those who are homeless as single adults.	Age- and sex-adjusted totals (no comparisons to general population): Males (family/single): 0.56 Females (family/single): 0.28
Roncarati (2018)	Boston, 2000	2000-2009	445 unsheltered adults in Boston, ages 18-81, seen face-to-face by BHCHP street team in 2000 (universe). Mortality data from Massachusetts Department of Public Health death occurrence files and, at times, the National Death Index.	Massachusetts housed population; sheltered adult homeless cohort. Mortality rates obtained from CDC WONDER.	Age-standardized totals: Relative to MA general population: 9.8 Relative to sheltered homeless: 2.7
Hibbs et. al. (1994)	Philadelphia, 1985-1988	1985-1988	6,308 sheltered and unsheltered, ages 15-74, all served by one or both of two agencies for the homeless (mental health program and Philadelphia Office of Services for Homeless Adults) between 1985 and 1988 (universe). Mortality data from Pennsylvania Department of Health.	Philadelphia housed population. Mortality rates obtained from census data from Pennsylvania Department of Health.	Age-weighted (but not race-weighted) totals: Relative to general Philadelphia Population: 3.5
Hwang et al. (1997)	Boston, 1988-1993	1988-1993	17,292 sheltered and unsheltered, ages 18-64, all served by BHCHP between July 1988 and December 1993. Mortality data from Massachusetts death registry.	Boston housed population. Mortality rate data source for housed population unclear.	Non-adjusted totals: 18-24: 5.9 (men), 11.8 (women) 25-44: 3.0 (men), 3.9 (women) 45-64: 1.6 (men), 1.5 (women)

Tables

Table 2:

Summary Statistics: Demographic Characteristics and Region

	Homeless (Census)		Housed Poor (ACS)		Housed (Census)	
Age in 2010	Ages 18+	Ages 18-54	Ages 18+	Ages 18-54	Ages 18+	Ages 18-54
Mean	45.1	39.6	41.9	33.6	47.3	37.1
Ages 18-24	0.101	0.132	0.236	0.310	0.121	0.181
25-29	0.078	0.103	0.108	0.142	0.088	0.132
30-34	0.078	0.102	0.091	0.120	0.084	0.126
35-39	0.086	0.112	0.084	0.111	0.086	0.129
40-44	0.119	0.155	0.082	0.108	0.091	0.136
45-49	0.151	0.197	0.082	0.108	0.099	0.149
50-54	0.153	0.200	0.077	0.102	0.098	0.148
55-59	0.110		0.063		0.087	
60-64	0.059		0.054		0.074	
65-69	0.029		0.033		0.055	
70 and older	0.037		0.089		0.118	
Gender, Race, and Ethnicity						
Female	0.312	0.327	0.586	0.574	0.519	0.508
White	0.523	0.511	0.655	0.641	0.768	0.735
Black	0.379	0.388	0.212	0.218	0.124	0.137
Other Race	0.098	0.102	0.133	0.141	0.108	0.128
Hispanic	0.153	0.161	0.216	0.230	0.129	0.155
Region						
Northeast	0.230	0.231	0.159	0.153	0.185	0.182
Midwest	0.174	0.176	0.216	0.222	0.221	0.219
South	0.279	0.282	0.408	0.404	0.366	0.367
West	0.318	0.312	0.217	0.221	0.228	0.233
Weighted Count	341,800	261,500	14,110,000	10,740,000	2,182,000	1,454,000
N	181,000	140,000	158,000	110,000	2,000,000	1,313,000

Notes: Weighted counts reflect inverse probability weighting adjustment to account for non-linkage for all three groups. For housed poor, weighted count also reflects survey weights, and for overall housed, weighted count is adjusted to reflect one percent random sampling from the 2010 Census housed population. All reported ages reflect age in 2010.

Tables

Table 3:

Summary Statistics: Disability, Economic Status, Family Connections, and State

	Homeless (Census)		Housed Poor (ACS)		Housed (Census)	
Age in 2010	Ages 18+	Ages 18-54	Ages 18+	Ages 18-54	Ages 18+	Ages 18-54
SSI receipt (2009)	0.205	0.189	0.113	0.093	0.030	0.028
DI receipt (2009)	0.092	0.081	0.066	0.052	0.032	0.023
SSI or DI	0.229	0.206	0.135	0.107	0.049	0.039
Employed in 2009	0.443	0.489				
Top Half of Prior Income	0.494	0.491				
Has Spouse or Former Spouse	0.149	0.143				
Also Recorded in Housing	0.306	0.286				
Has Child	0.266	0.307				
Any Indicator of Family Connection	0.501	0.507				
New York	0.115	0.117	0.066	0.063	0.065	0.065
California	0.185	0.180	0.117	0.118	0.119	0.123
Other State	0.700	0.704	0.817	0.818	0.816	0.812
Sheltered Homeless	0.469	0.492				
Weighted Count	341,800	261,500	14,110,000	10,740,000	2,182,000	1,454,000
N	181,000	140,000	158,000	110,000	2,000,000	1,313,000

Notes: Weighted counts reflect inverse probability weighting adjustment to account for non-linkage for all three groups. For housed poor, weighted count also reflects survey weights, and for overall housed, weighted count is adjusted to reflect one percent random sampling from the 2010 Census housed population. All reported ages reflect age in 2010.

Tables

Table 4:

Cumulative Mortality April 2010-March 2022 (Ages 18-54 in 2010)

Based on Empirical Survivor Function (No Controls)

	Homeless	Housed Poor	Housed
Share died	0.1575	0.0619	0.0385
Probability of dying relative to housed	4.09	1.60	1.00
Probability of dying relative to housed poor	2.55	1.00	0.62

Based on Covariate-Adjusted Survivor Function (Age and Gender Controls)

	Homeless	Housed Poor	Housed
Share died	0.1620	0.1037	0.0503
Probability of dying relative to housed	3.22	2.06	1.00
Probability of dying relative to housed poor	1.56	1.00	0.48

Tables

Table 5:

Average Annual Mortality Hazard by Group in Two Years Before and During COVID-19 Pandemic (Ages 18-54 in 2010)

Empirical Mortality Hazard (No Controls)			
	Homeless	Housed Poor	Housed
April 2018-March 2020	0.0157	0.0061	0.0038
April 2020-March 2022	0.0226	0.0088	0.0054
Change without accounting for aging of population			
Absolute increase	0.0069	0.0027	0.0016
Proportional increase	43.87%	44.84%	41.77%
Change accounting for aging of population			
Absolute increase	0.0052	0.0021	0.0011
Proportional increase	33.25%	33.91%	29.76%
Covariate-Adjusted Mortality Hazard			
	Homeless	Housed Poor	Housed
April 2018-March 2020	0.0163	0.0105	0.0050
April 2020-March 2022	0.0239	0.0154	0.0071
Change without accounting for aging of population			
Absolute increase	0.0076	0.0049	0.0021
Proportional increase	46.39%	46.68%	42.32%
Change accounting for aging of population			
Absolute increase	0.0057	0.0037	0.0015
Proportional increase	35.12%	35.17%	30.13%

Notes: Covariate-adjusted mortality hazard controls for difference in age and gender distribution between groups. Increase accounting for aging of population is equal to the increase without accounting for aging minus eight times the estimated coefficient from a regression of the hazard in the first 20 periods on a time trend, which yields an estimate of the change in the average annual hazard between these two time periods attributable to the aging of our cohort.

Tables

Table 6:

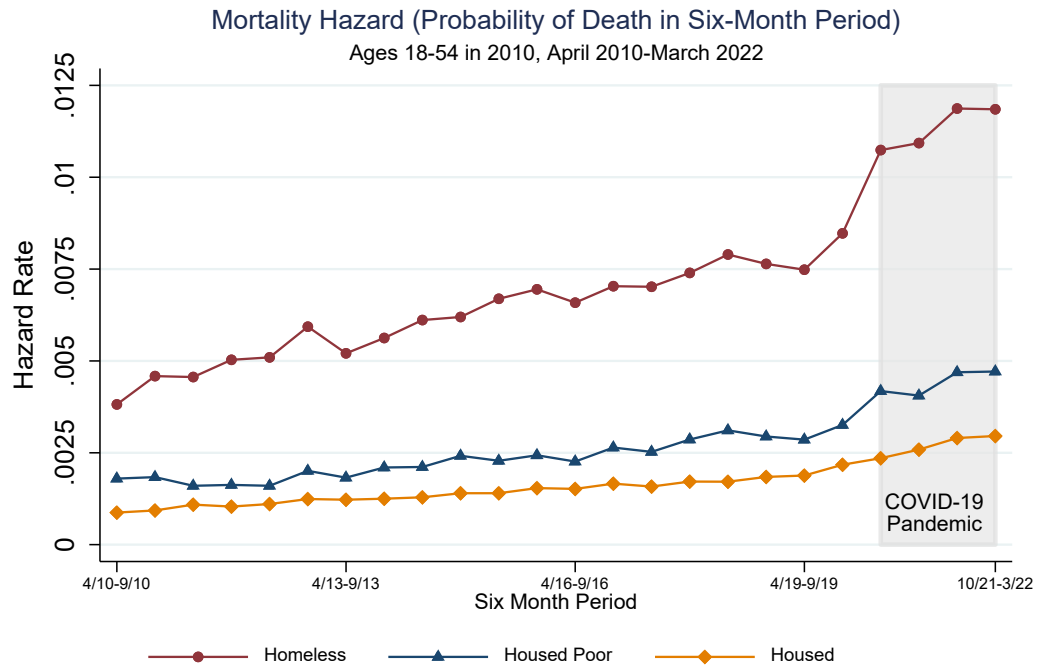
Average Annual Mortality Hazard by Homeless Sub-Group in Two Years Before and During COVID-19 Pandemic (Ages 18-54 in 2010)

Covariate-Adjusted Mortality Hazard				
	Sheltered Males	Unsheltered Males	Sheltered Females	Unsheltered Females
April 2018-March 2020	0.0176	0.0179	0.0140	0.0150
April 2020-March 2022	0.0262	0.0260	0.0189	0.0200
Change without accounting for aging of population				
Absolute increase	0.0086	0.0081	0.0049	0.0050
Proportional increase	49.00%	45.44%	35.17%	33.59%
Change accounting for aging of population				
Absolute increase	0.0067	0.0063	0.0033	0.0034
Proportional increase	38.35%	35.22%	23.71%	22.42%

Note: Covariate-adjusted mortality hazard controls for difference in age and gender distribution between groups. Increase accounting for time trend is equal to the increase without accounting for time trend minus eight times the estimated coefficient from a regression of the hazard in the first 20 periods on a time trend, which yields an estimate of the change in the average annual hazard between these two time periods attributable to the aging of our cohort.

Figures

Figure 1:



Sources: 2010 Decennial Census, 2022 SSA Numident.

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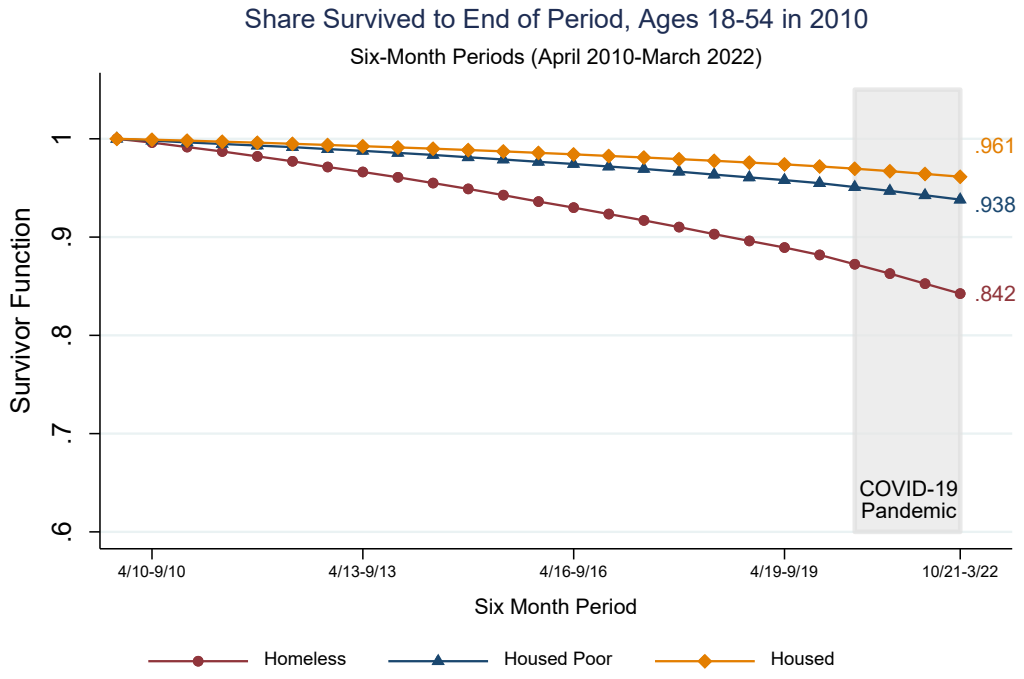

Sources: 2010 Decennial Census, 2022 SSA Numident.

Figures

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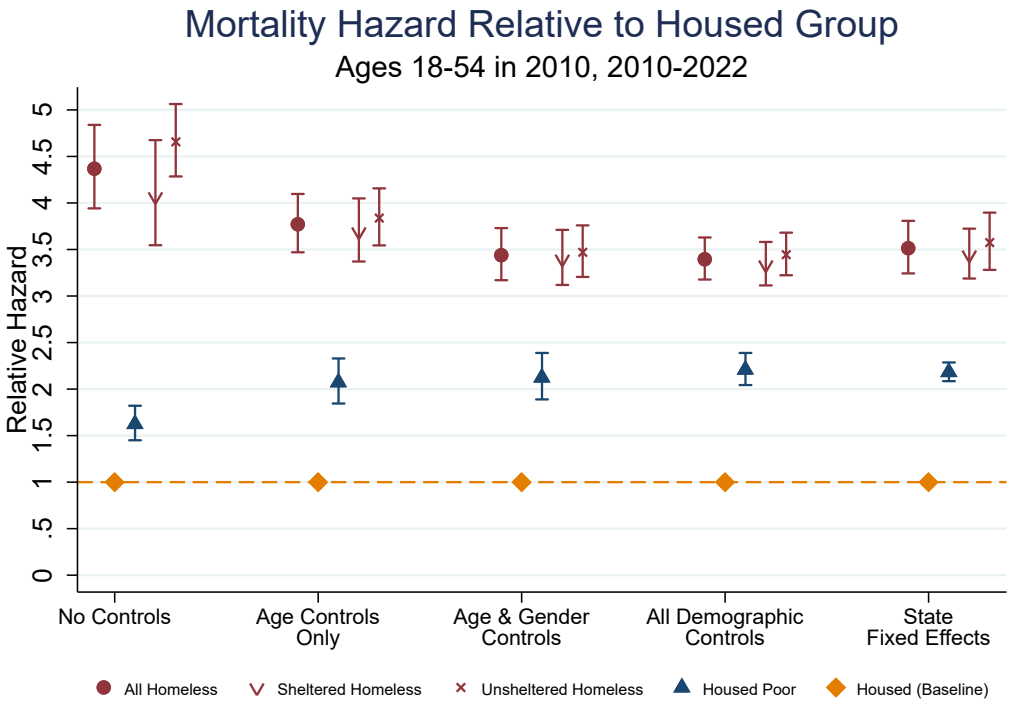

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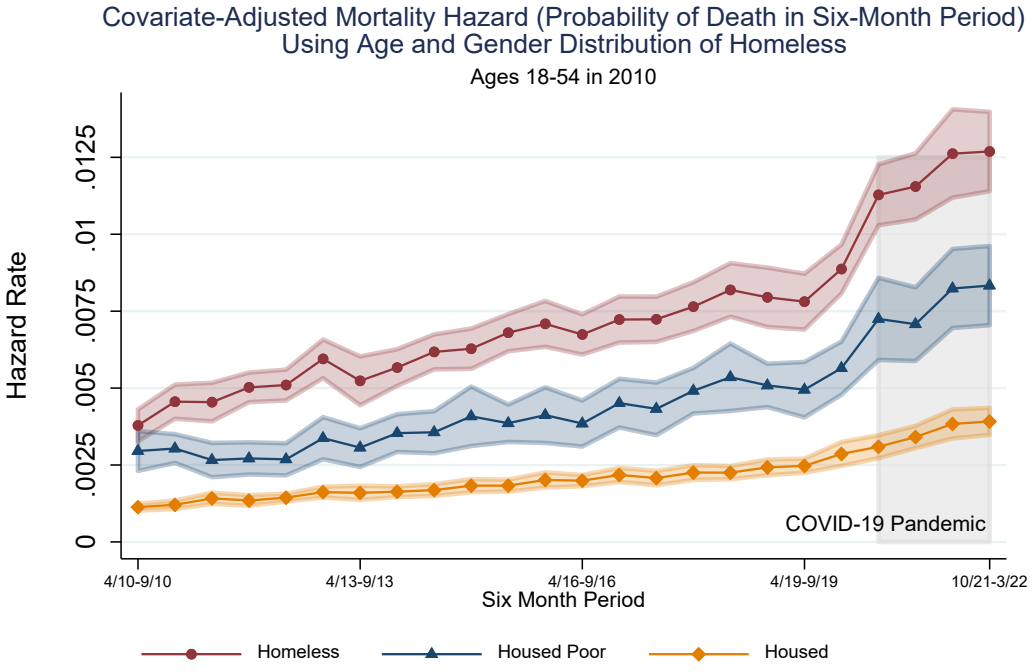
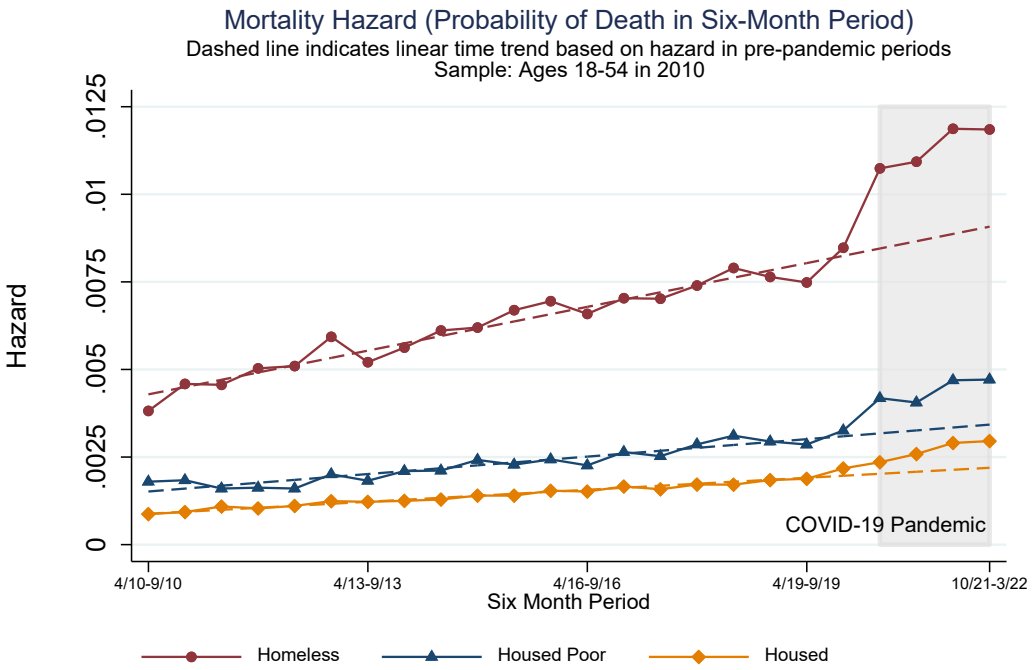


Sources: 2010 Decennial Census, 2022 SSA Numident.

Figures

Figure 5:



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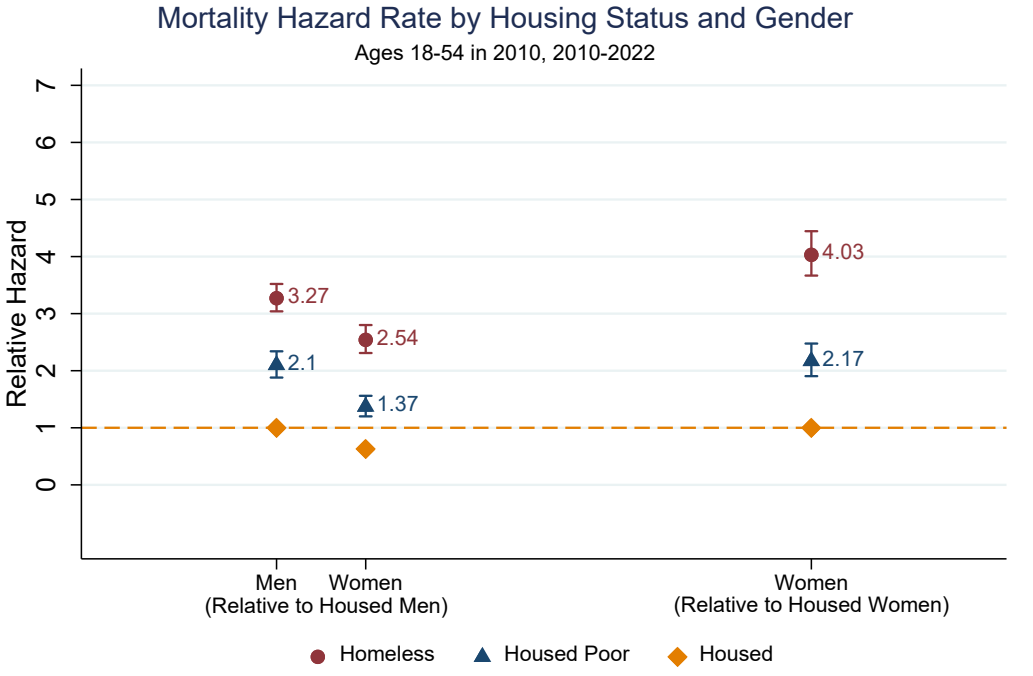
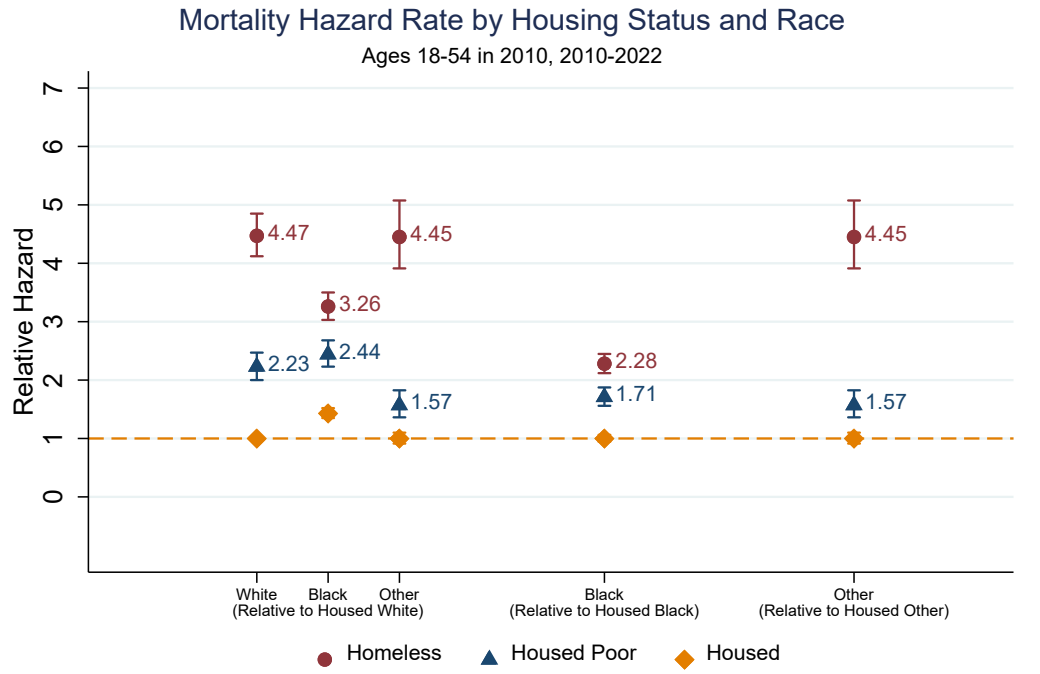


Note: Plot displays coefficient from hazard model including age controls.

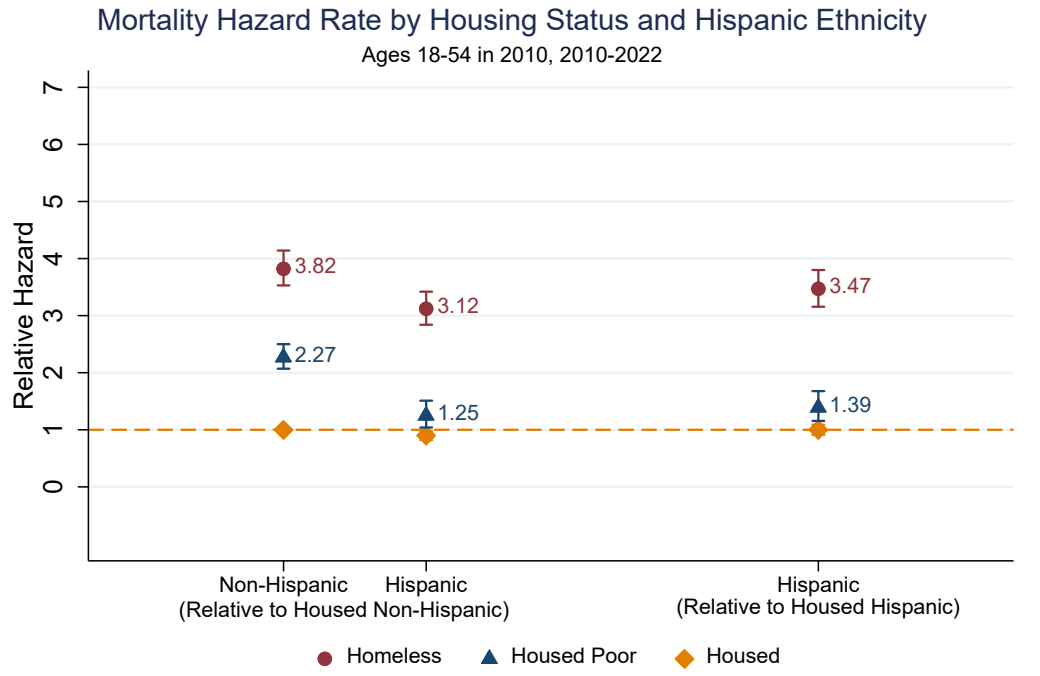
Figures

Figure 7:



Note: Plot displays coefficient from hazard model including age controls.

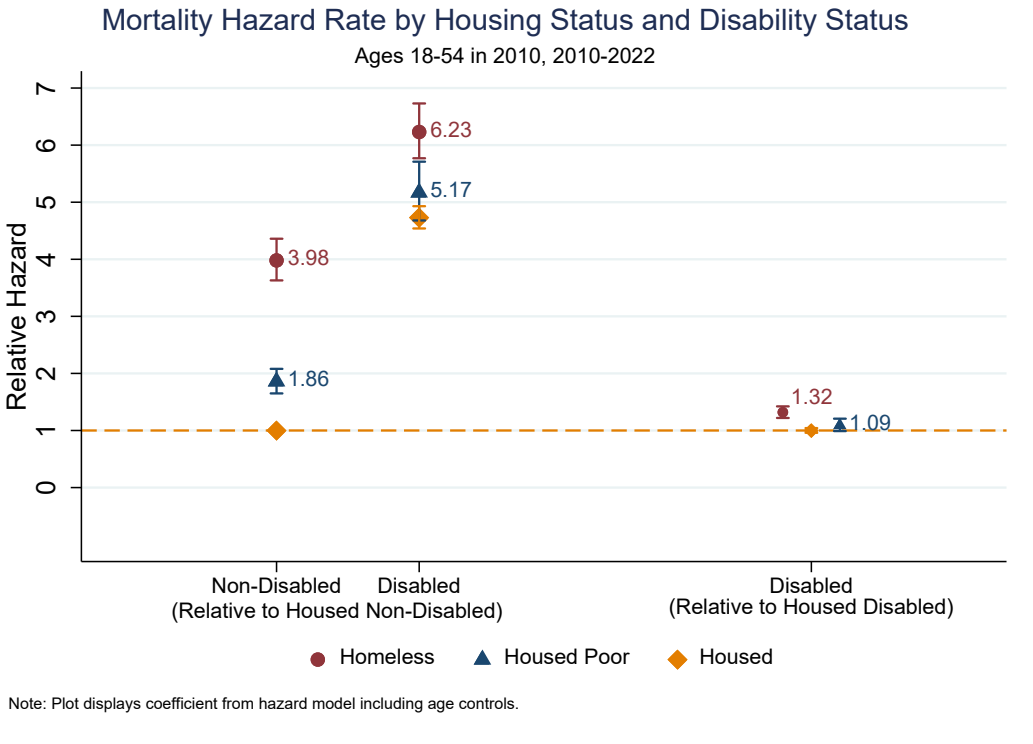
Figure 8:



Note: Plot displays coefficient from hazard model including age controls.

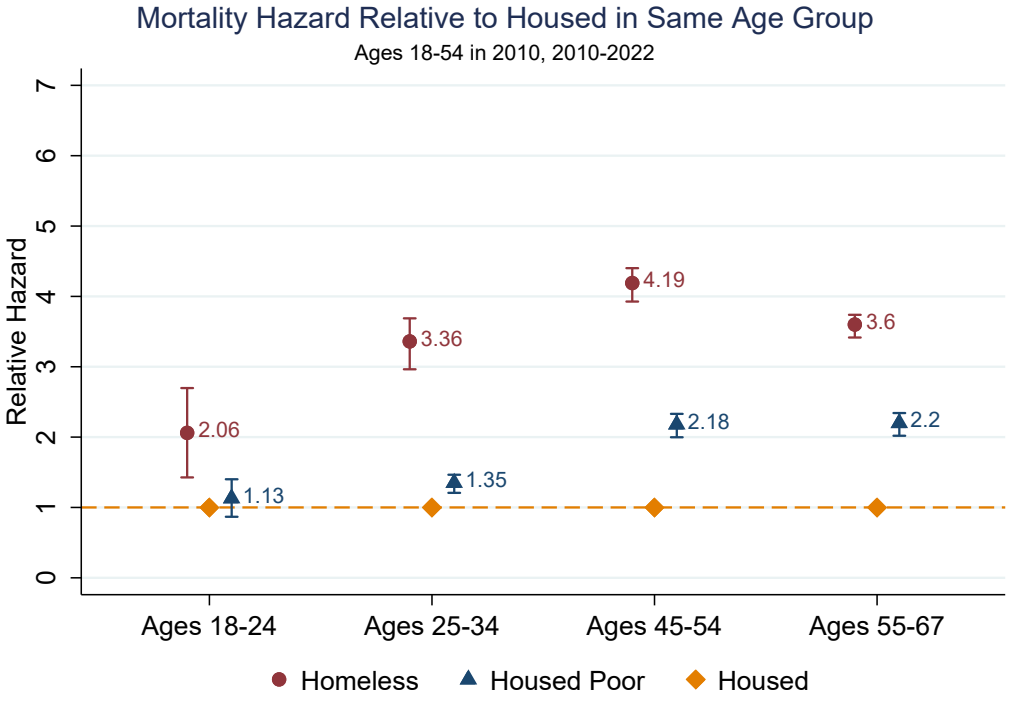
Figures

Figure 9:



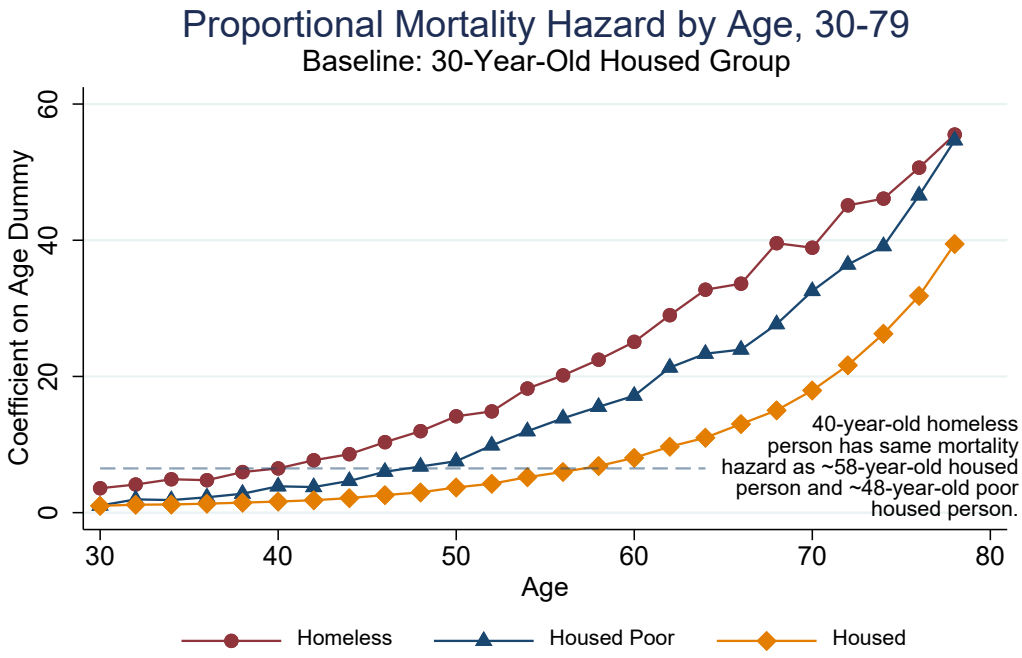
Note: Plot displays coefficient from hazard model including age controls.

Figure 10:



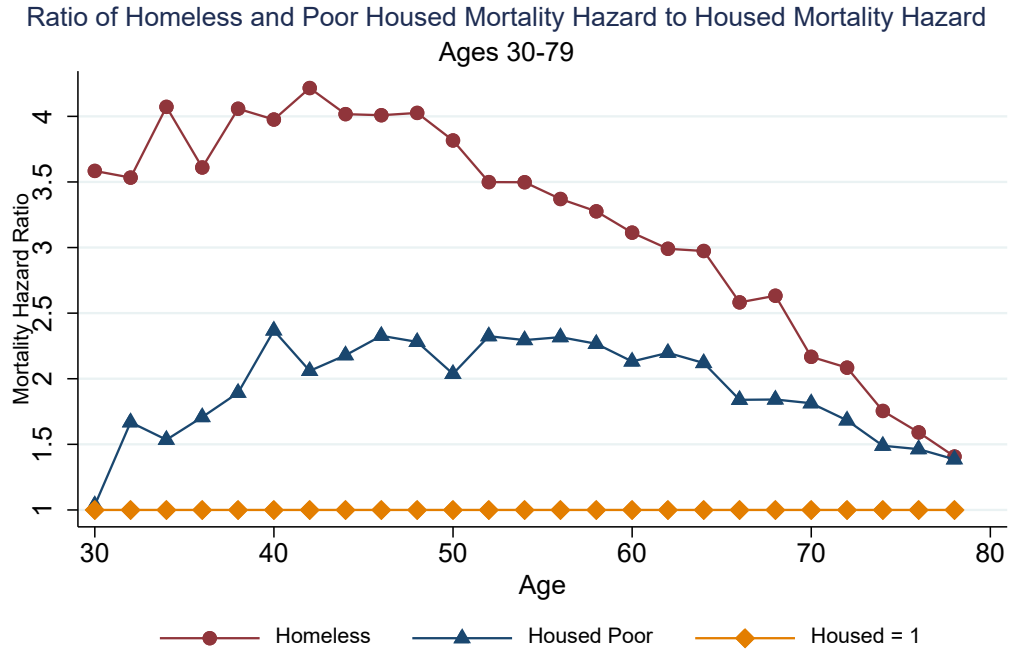
Figures

Figure 11:



Note: Figure displays coefficient on two-year age dummy with group interaction in model assuming common baseline hazard and controlling for gender. Samples includes poeple ages 30-79 in 2010-2022.

Figure 12:



Note: Figure dispalys ratio of coefficients on two-year age dummy with group interaction in model assuming common baseline hazard and controlling for gender. Sample includes poeple ages 30-79 in 2010-2022.

Figures

Figure 13:

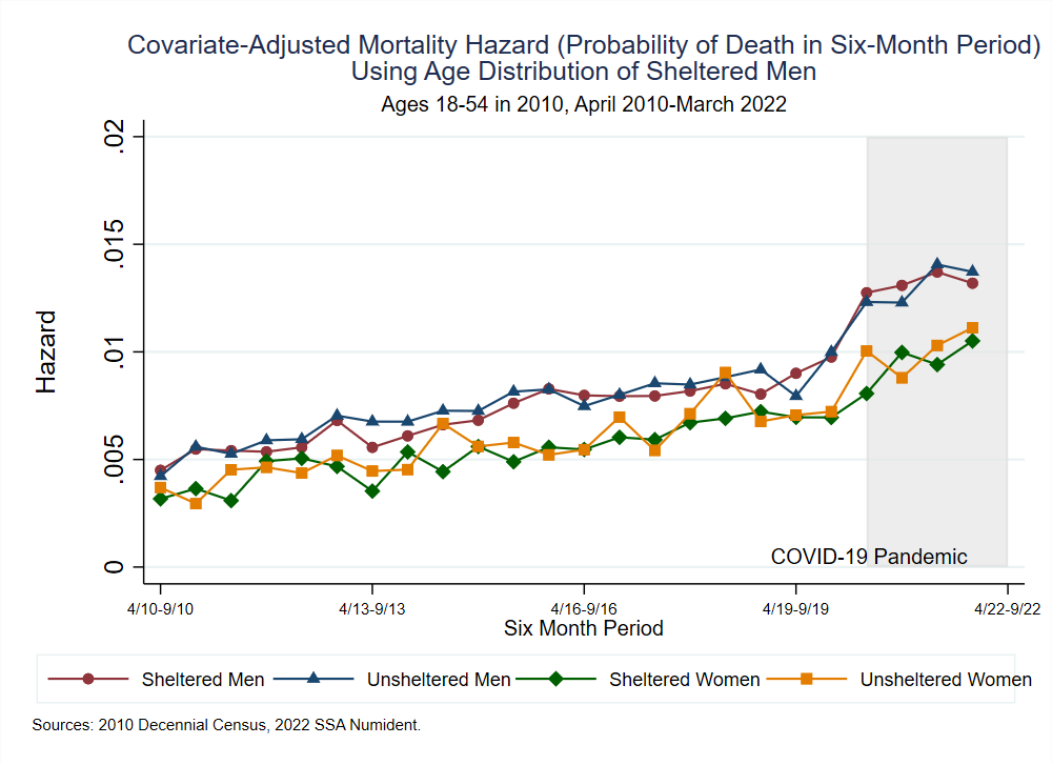
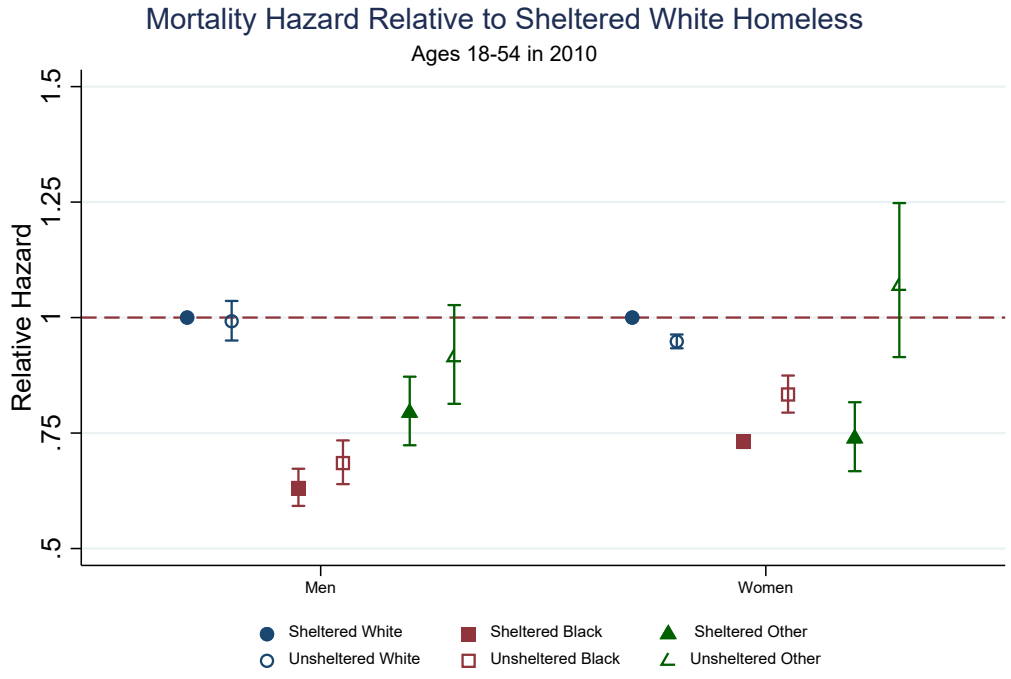


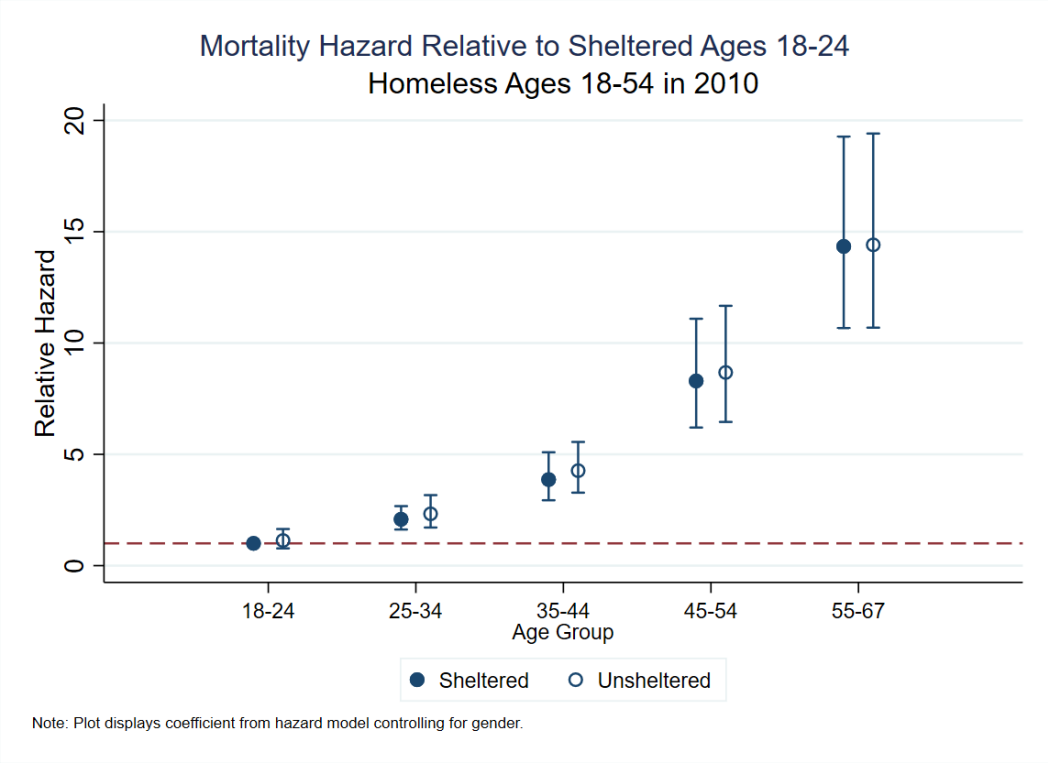
Figure 14:



Note: Plot displays coefficient from hazard model including age controls.

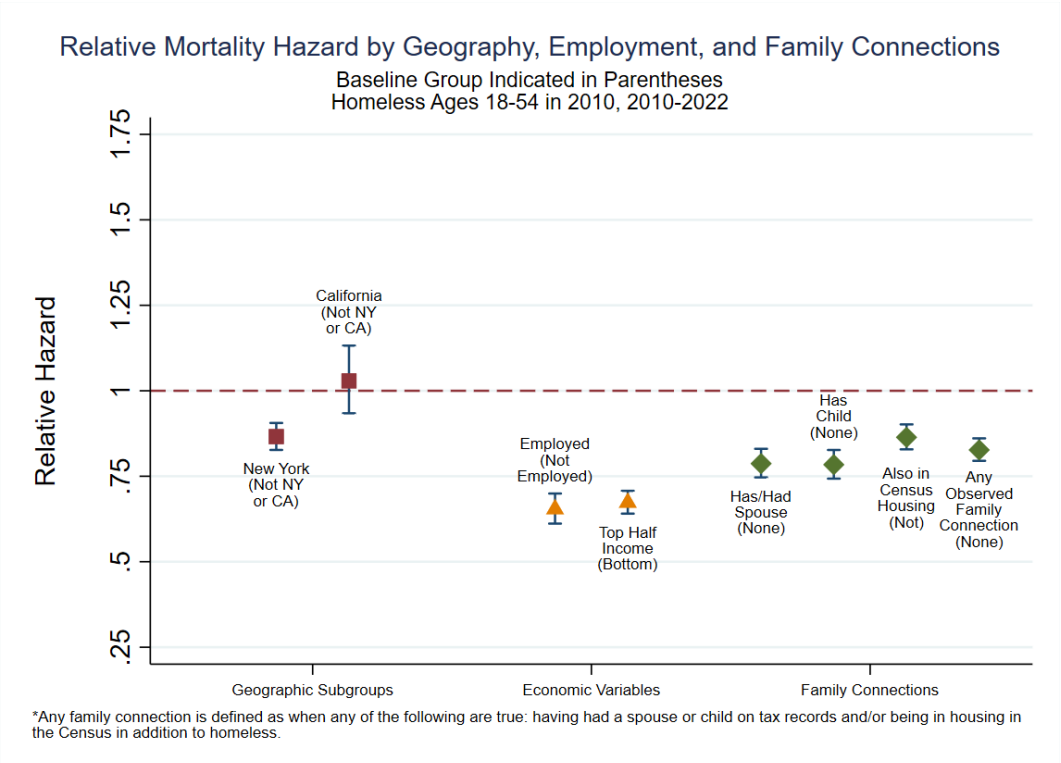
Figures

Figure 15:



Note: Plot displays coefficient from hazard model controlling for gender.

Figure 16:



*Any family connection is defined as when any of the following are true: having had a spouse or child on tax records and/or being in housing in the Census in addition to homeless.

Appendix Tables

Table A1:

Homeless Population Summary Statistics by Gender and Sheltered Status Demographic Characteristics and Region

	Sheltered Homeless		Unsheltered Homeless	
Age in 2010	Ages 18-54		Ages 18-54	
Gender	Males	Females	Males	Females
Mean Age	40.8	35.5	41.2	38.6
Ages 18-24	0.1090	0.2250	0.0982	0.1507
25-29	0.0881	0.1539	0.0856	0.1102
30-34	0.0953	0.1275	0.0921	0.1076
35-39	0.1081	0.1155	0.1086	0.1234
40-44	0.1580	0.1264	0.1658	0.1572
45-49	0.2135	0.1341	0.2206	0.1817
50-54	0.2280	0.1175	0.2291	0.1690
Race and Ethnicity				
White	0.5055	0.4459	0.5300	0.5572
Black	0.4020	0.4465	0.3691	0.3276
Other Race	0.0925	0.1076	0.1008	0.1152
Hispanic	0.1494	0.1753	0.1659	0.1527
Region				
Northeast	0.2524	0.3415	0.1769	0.1785
Midwest	0.1830	0.1691	0.1640	0.2013
South	0.3095	0.2622	0.2815	0.2462
West	0.2552	0.2272	0.3776	0.3739
Weighted Count	80,380	48,290	95,720	37,140
N	55,000	34,000	35,000	15,000

Notes: Weighted counts reflect inverse probability weighting to account for non-linkage. All reported ages reflect age in 2010.

Appendix Tables

Table A2:

Homeless Population Summary Statistics by Gender and Sheltered Status Disability, Economic Status, Family Connections, and State

	Sheltered Homeless		Unsheltered Homeless	
Age in 2010	Ages 18-54		Ages 18-54	
Gender	Males	Females	Males	Females
SSI receipt (2009)	0.1572	0.1516	0.2080	0.2564
DI receipt (2009)	0.0656	0.0474	0.1051	0.0944
SSI or DI	0.1726	0.1599	0.2309	0.2711
Employed in 2009	0.5186	0.5578	0.4412	0.4551
Top Half of Prior Income	0.5371	0.5105	0.4649	0.4324
Has Spouse or Former Spouse	0.1208	0.1630	0.1261	0.2076
Also Recorded in Housing	0.1702	0.2056	0.3505	0.4755
Has Child	0.2408	0.5140	0.2197	0.4056
Any Indicator of Family Connection	0.3791	0.6289	0.4840	0.6814
New York	0.1290	0.2209	0.0706	0.0726
California	0.1352	0.1257	0.2256	0.2263
Other State	0.7358	0.6534	0.7037	0.7011
Weighted Count	80,380	48,290	95,720	37,140
N	55,000	34,000	35,000	15,000

Notes: Weighted counts reflect inverse probability weighting to account for non-linkage. All reported ages reflect age in 2010.

Appendix Tables

Table A3:

Mortality Hazard of Homeless and Housed (Ages 18-54 in 2010)

Period	Empirical Hazard			Covariate-Adjusted Hazard		
	Homeless	Housed Poor	Housed	Homeless	Housed Poor	Housed
1	0.00382	0.00180	0.00087	0.00379	0.00296	0.00113
2	0.00459	0.00184	0.00093	0.00456	0.00304	0.00121
3	0.00456	0.00160	0.00109	0.00454	0.00266	0.00142
4	0.00503	0.00163	0.00104	0.00502	0.00271	0.00135
5	0.00510	0.00160	0.00111	0.00510	0.00269	0.00144
6	0.00593	0.00201	0.00124	0.00595	0.00337	0.00162
7	0.00521	0.00182	0.00122	0.00524	0.00307	0.00160
8	0.00562	0.00210	0.00125	0.00567	0.00354	0.00163
9	0.00611	0.00211	0.00129	0.00618	0.00357	0.00169
10	0.00620	0.00242	0.00140	0.00628	0.00408	0.00183
11	0.00669	0.00228	0.00140	0.00680	0.00386	0.00183
12	0.00695	0.00243	0.00154	0.00709	0.00412	0.00202
13	0.00659	0.00226	0.00152	0.00674	0.00385	0.00199
14	0.00703	0.00264	0.00166	0.00723	0.00451	0.00218
15	0.00702	0.00253	0.00158	0.00724	0.00433	0.00208
16	0.00740	0.00286	0.00172	0.00765	0.00491	0.00226
17	0.00790	0.00311	0.00171	0.00819	0.00535	0.00225
18	0.00764	0.00294	0.00184	0.00795	0.00509	0.00242
19	0.00748	0.00286	0.00188	0.00781	0.00495	0.00247
20	0.00847	0.00326	0.00218	0.00887	0.00565	0.00286
21	0.01074	0.00418	0.00235	0.01128	0.00725	0.00309
22	0.01093	0.00406	0.00259	0.01155	0.00708	0.00341
23	0.01187	0.00469	0.00290	0.01262	0.00824	0.00384
24	0.01185	0.00471	0.00296	0.01269	0.00833	0.00392

Notes: Covariate-adjusted hazard indicates simulated hazard using age and gender distribution of homeless sample.

Appendix Tables

Table A4:

Survivor Function of Homeless and Housed (Ages 18-54 in 2010)

Period	Empirical Hazard			Covariate-Adjusted Hazard		
	Homeless	Housed Poor	Housed	Homeless	Housed Poor	Housed
1	0.99618	0.99820	0.99913	0.99621	0.99704	0.99887
2	0.99161	0.99637	0.99820	0.99167	0.99402	0.99766
3	0.98709	0.99477	0.99711	0.98717	0.99137	0.99625
4	0.98212	0.99315	0.99608	0.98221	0.98868	0.99491
5	0.97712	0.99156	0.99498	0.97720	0.98603	0.99348
6	0.97132	0.98957	0.99374	0.97138	0.98270	0.99187
7	0.96626	0.98777	0.99252	0.96630	0.97969	0.99028
8	0.96083	0.98569	0.99128	0.96082	0.97622	0.98867
9	0.95496	0.98361	0.99000	0.95489	0.97274	0.98700
10	0.94904	0.98123	0.98862	0.94889	0.96877	0.98520
11	0.94269	0.97899	0.98723	0.94244	0.96504	0.98339
12	0.93614	0.97661	0.98572	0.93576	0.96106	0.98141
13	0.92997	0.97440	0.98422	0.92945	0.95736	0.97946
14	0.92343	0.97182	0.98258	0.92273	0.95304	0.97732
15	0.91695	0.96937	0.98103	0.91605	0.94892	0.97530
16	0.91017	0.96659	0.97935	0.90905	0.94426	0.97310
17	0.90298	0.96359	0.97767	0.90160	0.93920	0.97091
18	0.89608	0.96075	0.97587	0.89444	0.93442	0.96855
19	0.88937	0.95800	0.97403	0.88745	0.92980	0.96616
20	0.88184	0.95488	0.97191	0.87958	0.92455	0.96339
21	0.87237	0.95089	0.96962	0.86966	0.91785	0.96041
22	0.86283	0.94703	0.96712	0.85961	0.91135	0.95714
23	0.85259	0.94259	0.96431	0.84876	0.90384	0.95346
24	0.84249	0.93815	0.96146	0.83799	0.89631	0.94973

Notes: Covariate-adjusted survivor function derived from simulated hazard using age and gender distribution of homeless sample.

Appendix Tables

Table A5:

Mortality Hazard of Homeless by Gender and Sheltered Status (Ages 18-54 in 2010)

Period	Empirical Hazard				Covariate-Adjusted Hazard			
	Sheltered		Unsheltered		Sheltered		Unsheltered	
	Men	Women	Men	Women	Men	Women	Men	Women
1	0.00382	0.00180	0.00180	0.00087	0.00379	0.00296	0.00296	0.00113
2	0.00459	0.00184	0.00184	0.00093	0.00456	0.00304	0.00304	0.00121
3	0.00456	0.00160	0.00160	0.00109	0.00454	0.00266	0.00266	0.00142
4	0.00503	0.00163	0.00163	0.00104	0.00502	0.00271	0.00271	0.00135
5	0.00510	0.00160	0.00160	0.00111	0.00510	0.00269	0.00269	0.00144
6	0.00593	0.00201	0.00201	0.00124	0.00595	0.00337	0.00337	0.00162
7	0.00521	0.00182	0.00182	0.00122	0.00524	0.00307	0.00307	0.00160
8	0.00562	0.00210	0.00210	0.00125	0.00567	0.00354	0.00354	0.00163
9	0.00611	0.00211	0.00211	0.00129	0.00618	0.00357	0.00357	0.00169
10	0.00620	0.00242	0.00242	0.00140	0.00628	0.00408	0.00408	0.00183
11	0.00669	0.00228	0.00228	0.00140	0.00680	0.00386	0.00386	0.00183
12	0.00695	0.00243	0.00243	0.00154	0.00709	0.00412	0.00412	0.00202
13	0.00659	0.00226	0.00226	0.00152	0.00674	0.00385	0.00385	0.00199
14	0.00703	0.00264	0.00264	0.00166	0.00723	0.00451	0.00451	0.00218
15	0.00702	0.00253	0.00253	0.00158	0.00724	0.00433	0.00433	0.00208
16	0.00740	0.00286	0.00286	0.00172	0.00765	0.00491	0.00491	0.00226
17	0.00790	0.00311	0.00311	0.00171	0.00819	0.00535	0.00535	0.00225
18	0.00764	0.00294	0.00294	0.00184	0.00795	0.00509	0.00509	0.00242
19	0.00748	0.00286	0.00286	0.00188	0.00781	0.00495	0.00495	0.00247
20	0.00847	0.00326	0.00326	0.00218	0.00887	0.00565	0.00565	0.00286
21	0.01074	0.00418	0.00418	0.00235	0.01128	0.00725	0.00725	0.00309
22	0.01093	0.00406	0.00406	0.00259	0.01155	0.00708	0.00708	0.00341
23	0.01187	0.00469	0.00469	0.00290	0.01262	0.00824	0.00824	0.00384
24	0.01185	0.00471	0.00471	0.00296	0.01269	0.00833	0.00833	0.00392

Notes: Covariate-adjusted hazard indicates simulated hazard using age distribution of sheltered men.

Appendix Tables

Table A6:

Proportional Hazard Model (Ages 18-54 in 2010)

	No Controls	Age Controls	Age and Gender Controls	All Demographic Controls	Region Fixed Effects	State Fixed Effects
Group Indicators (Pooled Sheltered and Unsheltered):						
Homeless	4.368***	3.771***	3.439***	3.395***	3.486***	3.514***
	(0.228)	(0.160)	(0.143)	(0.115)	(0.119)	(0.144)
Housed Poor	1.625***	2.073***	2.124***	2.209***	2.195***	2.183***
	(0.0945)	(0.123)	(0.127)	(0.0880)	(0.0638)	(0.0513)
Group Indicators (Separate Sheltered and Unsheltered):						
Sheltered Homeless	4.072***	3.695***	3.402***	3.340***	3.412***	3.446***
	(0.287)	(0.173)	(0.151)	(0.119)	(0.116)	(0.137)
Unsheltered Homeless	4.658***	3.839***	3.471***	3.445***	3.552***	3.575***
	(0.198)	(0.156)	(0.141)	(0.117)	(0.128)	(0.157)
Housed Poor	1.625***	2.073***	2.124***	2.209***	2.195***	2.183***
	(0.0945)	(0.123)	(0.127)	(0.0880)	(0.0638)	(0.0513)
Covariates:						
Ages 18-24		0.0293***	0.0296***	0.0308***	0.0308***	0.0306***
		(0.00333)	(0.00338)	(0.00356)	(0.00353)	(0.00348)
25-29		0.0451***	0.0458***	0.0472***	0.0471***	0.0468***
		(0.00529)	(0.00540)	(0.00568)	(0.00567)	(0.00561)
30-34		0.0512***	0.0523***	0.0537***	0.0536***	0.0532***
		(0.00498)	(0.00511)	(0.00528)	(0.00522)	(0.00519)
35-39		0.0781***	0.0804***	0.0841***	0.0839***	0.0830***
		(0.00828)	(0.00852)	(0.00915)	(0.00907)	(0.00891)
40-44		0.124***	0.128***	0.135***	0.135***	0.133***
		(0.0100)	(0.0102)	(0.0113)	(0.0112)	(0.0109)
45-49		0.199***	0.203***	0.213***	0.212***	0.211***
		(0.0169)	(0.0172)	(0.0189)	(0.0187)	(0.0185)
50-54		0.300***	0.304***	0.315***	0.314***	0.312***
		(0.0263)	(0.0268)	(0.0287)	(0.0284)	(0.0283)
55-59		0.451***	0.455***	0.463***	0.462***	0.459***
		(0.0340)	(0.0345)	(0.0354)	(0.0353)	(0.0351)
60-64		0.633***	0.638***	0.641***	0.640***	0.637***
		(0.0593)	(0.0601)	(0.0597)	(0.0596)	(0.0596)
Female			0.655***	0.653***	0.652***	0.651***
			(0.0184)	(0.0190)	(0.0191)	(0.0189)
Black				1.033	1.002	1.011
				(0.0380)	(0.0334)	(0.0356)
Other Race				0.679***	0.702***	0.708***
				(0.0308)	(0.0293)	(0.0281)
Hispanic				0.633***	0.640***	0.664***
				(0.0504)	(0.0480)	(0.0516)
Northeast					1.035	0.531***
					(0.0630)	(0.0542)
Midwest					1.119**	0.888***
					(0.0616)	(0.0189)
South					1.229***	1.298***
					(0.0743)	(0.0288)
Obs (N x Periods)	36,770,000	36,770,000	36,770,000	36,770,000	36,770,000	36,770,000
Standard Error Cluster	State x Group	State x Group	State x Group	State x Group	State x Group	State x Group
Fixed Effects	Duration	Duration	Duration	Duration	Duration	Duration, State

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A7:

Proportional Mortality Hazard by Housing Status and Race

Group	No Age Controls	Age Controls
Homeless Black	3.754***	3.255***
	(0.209)	(0.120)
Homeless Other	3.601***	3.564***
	(0.278)	(0.238)
Homeless White	5.000***	4.469***
	(0.199)	(0.188)
Housed Black	1.292***	1.432***
	(0.0409)	(0.0440)
Housed Other	0.685***	0.799***
	(0.0318)	(0.0395)
Poor Black	1.891***	2.443***
	(0.0913)	(0.114)
Poor Other	0.94	1.262***
	(0.0646)	(0.0941)
Poor White	1.686***	2.225***
	(0.0855)	(0.118)
Baseline group	Housed Whites	Housed Whites
Covariates	None	Age
Standard Errors	State x Group	State x Group
Fixed Effects	Duration	Duration
Age Group	18-54	18-54

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A8:

Proportional Mortality Hazard by Housing Status and Gender

Group	No Age Controls	Age Controls
Homeless Female	2.463***	2.542***
	(0.172)	(0.125)
Homeless Male	4.124***	3.267***
	(0.174)	(0.122)
Housed Female	0.640***	0.633***
	(0.00919)	(0.00937)
Poor Female	1.069	1.369***
	(0.0689)	(0.0906)
Poor Male	1.679***	2.099***
	(0.0920)	(0.116)
Baseline group	Housed Males	Housed Males
Covariates	None	Age
Standard Errors	State x Group	State x Group
Fixed Effects	Duration	Duration
Age Group	18-54	18-54

*** p<0.01, ** p<0.05, * p<0.1

Table A9:

Proportional Mortality Hazard by Housing Status and Hispanic Ethnicity

Group	No Age Controls	Age Controls
Homeless Hispanic	3.018***	3.117***
	(0.185)	(0.149)
Homeless Non-Hispanic	4.435***	3.823***
	(0.203)	(0.156)
Housed Hispanic	0.755***	0.896**
	(0.0322)	(0.0389)
Poor Hispanic	0.937	1.252**
	(0.0828)	(0.118)
Poor Non-Hispanic	1.753***	2.273***
	(0.0795)	(0.108)
Baseline group	Housed Non-Hispanic	Housed Non-Hispanic
Covariates	None	Age
Standard Errors	State x Group	State x Group
Fixed Effects	Duration	Duration
Age Group	18-54	18-54

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A10:

Proportional Mortality Hazard by Housing and Disability Status

Group	**No Age Controls**	**Age Controls**
Homeless Disabled	8.479***	6.230***
	(0.361)	(0.244)
Homeless Non-Disabled	4.399***	3.976***
	(0.259)	(0.186)
Housed Disabled	6.236***	4.727***
	(0.131)	(0.100)
Poor Disabled	6.726***	5.170***
	(0.343)	(0.263)
Poor Non-Disabled	1.404***	1.855***
	(0.0760)	(0.110)
Baseline group	Housed Non-Disabled	Housed Non-Disabled
Covariates	None	Age
Standard Errors	State x Group	State x Group
Fixed Effects	Duration	Duration
Age Group	18-54	18-54

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A11:

Proportional Mortality Hazard by Housing Status and Age

Group	
Homeless 18-24	2.062***
	(0.324)
Homeless 25-34	4.561***
	(0.489)
Homeless 35-44	8.705***
	(0.765)
Homeless 45-54	18.69***
	(1.486)
Homeless 55-67	32.91***
	(2.689)
Housed 25-34	1.356***
	(0.072)
Housed 35-44	2.042***
	(0.130)
Housed 45-54	4.463***
	(0.227)
Housed 55-67	9.153***
	(0.541)
Poor 18-24	1.134
	(0.136)
Poor 25-34	1.830***
	(0.185)
Poor 35-44	3.835***
	(0.377)
Poor 45-54	9.732***
	(0.870)
Poor 55-67	20.13***
	(1.933)
Baseline group	Housed Ages 18-24
Covariates	None
Standard Errors	State x Group
Fixed Effects	Duration
Age Group	18-54

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A12:

Proportional Mortality Hazard by Housing Status and Age (Ages 30-79)

Age *(lower bound of 2-yr bin)*	**Age Only**			**Age x Duration Interactions**		
	Homeless	Housed Poor	Housed	Homeless	Housed Poor	Housed
30	3.584	1.036		3.583	1.049	
32	4.13	1.95	1.169	4.121	1.952	1.168
34	4.903	1.848	1.204	4.698	1.795	1.159
36	4.769	2.256	1.321	4.412	2.118	1.228
38	5.961	2.781	1.469	5.514	2.599	1.365
40	6.496	3.869	1.634	16.48	9.77	4.139
42	7.694	3.759	1.825	19.6	9.5	4.629
44	8.584	4.657	2.137	18.86	10.34	4.737
46	10.35	6.009	2.582	20.08	11.87	5.079
48	11.97	6.781	2.973	23.29	13.4	5.856
50	14.15	7.554	3.708	30.01	16.03	7.865
52	14.87	9.879	4.25	31.56	20.95	9.02
54	18.23	11.96	5.212	37.48	24.6	10.72
56	20.16	13.86	5.982	40.19	27.63	11.92
58	22.46	15.54	6.856	44.8	30.99	13.67
60	25.08	17.17	8.055	59.85	41.09	19.27
62	29	21.31	9.697	69.17	51.05	23.2
64	32.74	23.34	11.01	75.98	54.47	25.66
66	33.62	23.95	13.02	75.69	54.42	29.55
68	39.57	27.68	15.03	88.85	62.76	34.06
70	38.9	32.55	17.95	74.11	61.63	33.93
72	45.13	36.43	21.65	85.81	69.02	40.98
74	46.11	39.14	26.28	85.65	72.58	48.72
76	50.66	46.59	31.84	91.45	84.6	57.68
78	55.52	54.68	39.46	100.6	99.58	71.55
Baseline group	Housed Ages 30-31			Housed Ages 30-31		
Covariates	Gender, Age			Gender, Age, Duration		
Standard Errors	State x Group			State x Group		
Fixed Effects	Period			Period		
Age Group	30-79			30-79		

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A13:

Proportional Mortality Hazard by Housing Status and Race (Homeless Ages 18-54 in 2010)

Group	Coefficient	95% CI	
Sheltered Female Black	0.523	0.488	0.561
Sheltered Female Other	0.528	0.4538	0.6149
Sheltered Female White	0.715	0.6799	0.7529
Sheltered Male Black	0.631	0.5923	0.6727
Sheltered Male Other	0.794	0.7236	0.872
Unsheltered Female Black	0.596	0.54	0.6584
Unsheltered Female Other	0.764	0.6217	0.9395
Unsheltered Female White	0.678	0.6347	0.7253
Unsheltered Male Black	0.685	0.6394	0.7341
Unsheltered Male Other	0.914	0.8133	1.027
Unsheltered Male White	0.992	0.9503	1.036
Baseline group	Sheltered Male White		
Covariates	Age, Region, Hispanic		
Standard Errors	Robust		
Fixed Effects	Duration		
Age Group	18-54		

*** p<0.01, ** p<0.05, * p<0.1

Table A14:

Proportional Mortality Hazard by Housing Status and Age (Homeless Ages 18-54 in 2010)

Group	Coefficient	95% CI	
Sheltered 25-34	2.082	1.622	2.673
Sheltered 35-44	3.866	2.936	5.092
Sheltered 45-54	8.295	6.203	11.09
Sheltered 54-67	14.34	10.67	19.27
Unsheltered 18-24	1.128	0.7743	1.644
Unsheltered 25-34	2.328	1.712	3.167
Unsheltered 35-44	4.267	3.277	5.556
Unsheltered 45-54	8.678	6.454	11.67
Unsheltered 54-67	14.41	10.69	19.41
Baseline group	Sheltered 18-24		
Covariates	Age, Gender, Hispanic, Race, Region		
Standard Errors	Robust		
Fixed Effects	Duration		
Age Group	18-54		

*** p<0.01, ** p<0.05, * p<0.1

Appendix Tables

Table A15:

Proportional Mortality Hazard by Geography, Family Connections, and Employment and Income (Homeless Ages 18-54 in 2010)

	Coefficient	95% CI	
Geography			
New York	0.866	0.827	0.9058
California	1.029	0.9342	1.132
Baseline group	Other states		
Additional Covariates	Income		
Family Connections			
Has/Had Spouse	0.787	0.7466	0.8303
Baseline group	No Spouse		
Additional Covariates	Income		
Has Child	0.784	0.7431	0.8269
Baseline group	No Child		
Additional Covariates	Income		
Census Duplicate	0.864	0.8287	0.9017
Baseline group	No Census Duplicate		
Additional Covariates	Income		
Any Family Connection	0.827	0.7951	0.8608
Baseline group	No Observed Family Connection		
Additional Covariates	Income		
Employment and Income			
Employed	0.654	0.6115	0.6995
Baseline group	Not Employed		
Additional Covariates	None		
Top Half Income	0.673	0.6407	0.7073
Baseline group	Bottom Half Income		
Additional Covariates	None		
Covariates	Age, Gender, Hispanic, Race, Region, Sheltered		
Standard Errors	Robust		
Fixed Effects	Duration		
Age Group	18-54		

*** p<0.01, ** p<0.05, * p<0.1