# Health care service utilization of individuals in permanent supportive housing in Seattle, WA accessing care through Public Health - Seattle and King County's Health Care for the Homeless Network

Lorraine Twohey-Jacobs

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science

University of Washington

2020

Committee:

Anjum Hajat

Wendy Barrington

Program Authorized to Offer Degree:

Epidemiology

©Copyright 2020
Lorraine Twohey-Jacobs

University of Washington

## Abstract

Health care service utilization of individuals in permanent supportive housing in Seattle, WA accessing care through the Health Care for the Homeless Network

Lorraine Twohey-Jacobs

Chair of the Supervisory Committee:

Anjum Hajat

Department of Epidemiology

**Introduction:** Permanent supportive housing (PSH) programs combine non-time limited housing with optional supportive services, including case management and health care, and are designed for those facing barriers to housing stability. Prior studies suggest that PSH can reduce emergency room visits and health care expenditures for an individual while improving their housing stability and well-being. However, research also suggests that not all groups utilize the same services or at the same rate.

**Methods:** In a retrospective longitudinal study of PSH residents in Seattle, WA utilizing health care between 2015 and 2019, we examined health care service utilization across age, sex, race and ethnicity, education, and veteran status. We fit Generalized Estimating Equations (GEE) models specifying a Poisson distribution to compare annual service utilization rates. We also compared proportions of visits pertaining to respiratory diagnoses or symptoms, mental and behavioral health concerns, and injury.

**Results:** Older groups utilized health care services at a higher rate than younger groups. Relative to non-Hispanic white groups, non-Hispanic Black or African American and non-Hispanic Asian, Pacific Islander, or Native Hawaiian groups exhibited lower annual service utilization rates. Veterans exhibited significantly lower annual service utilization rates than non-veterans. We did not identify significant associations between sex or education and annual utilization frequency.

**Discussion:** This study provides insight to health care programs offering services to those in permanent supportive housing by identifying differential utilization of health care services by age, sex, race/ethnicity, education, and veteran status. Future studies should examine utilization across other sociodemographic characteristics and additional health care visit types.

## I. Introduction

Homelessness, Health, and Permanent Supportive Housing in the United States

Housing is well-established as a key social determinant of health by the U.S. Department of Health and Human Services, the World Health Organization, and the Robert Wood Johnson Foundation (Donovan & Shinseki, 2013; Housing and Health, 2018; Housing Instability, 2020; World Health Organization, 2018). Housing instability, loosely defined as lacking access to housing of reasonable quality, has negative consequences for physical and mental health (Frederick et al., 2014; Housing Instability, 2020). Poor housing quality is associated with increased morbidity and poorer well-being and in the United States, the mortality rate among those experiencing homelessness is estimated to be 3 to 4 times that of the general population (Fazel et al., 2014; Kreiger & Higgins, 2002; O'Connell, 2005; Housing and Health, 2018). Those experiencing homelessness are also more likely to suffer from infectious diseases, mental disorders, and substance use (Fazel et al., 2008, 2014). Moreover, previous literature identifies mutual causality between health and homelessness, or a cycle in which poor health continues to cause homelessness and homelessness persists due to poor health (Dai & Zhou, 2018).

There are a variety of models proposed and implemented in the United States to address homelessness, including emergency shelters, transitional housing, housing first models, and permanent supportive housing (National Academies of Sciences, Engineering, and Medicine (U.S.), 2018). Permanent supportive housing (PSH), broadly defined as non-time-limited housing with additional supportive services, has grown in popularity over the last few decades and is supported by organizations such as the U.S. Interagency Council on Homelessness, the National Alliance to End Homelessness, and the National Health Care for the Homeless Council as a cost-effective strategy to increase housing stability and improve health (Byrne et al., 2014; Permanent Supportive Housing, 2019; Permanent Supportive Housing, 2020; Rog et al., 2014; Supportive Housing, 2018).

Generally, PSH programs are designed for those who have experienced chronic homelessness or face multiple barriers in maintaining housing stability, such a long-term disability or low income (Housing Instability, 2020; National Academies of Sciences, Engineering, and Medicine (U.S.), 2018). Leases are in the tenants' name, are subsidized so that no more than 30% of a tenant's income goes towards rent, and operate similar to any other rental lease, where tenants have the opportunity to renew (Rog et al., 2014; SAMHSA, 2011). While a key component and philosophy of PSH is service provision designed to preserve tenancy and address needs, utilization of services is not required, and the types of services provided vary by county and by state (Henwood et al., 2018; Rog, 2014). One study aimed at defining PSH services across sites in Los Angeles found that most programs offered case management as well as primary and mental health care (Henwood et al., 2018). However, availability of services vary by site and does not necessarily imply that they are well coordinated or heavily utilized (Driscoll et al., 2018; Henwood et al., 2018; Rog et al., 2014; Srebnik et al., 2013).

Health Care Service Utilization among PSH Residents

Systematic reviews have found moderate support for PSH's impact on reduced homelessness, increased housing tenure, reduced emergency room (ER) visits, reduced hospitalizations, and increased satisfaction among individuals in PSH programs (Rog et al., 2014; Mackelprang et al., 2014). Studies of individuals who were chronically homeless and have a mental illness, a chemical dependency disorder, or both, also identified significant reductions in ER use (Culhane et al., 2002; Martinez et al., 2006; Mackelprang et al., 2014). Reductions in health care expenditures have also been identified in studies evaluating health care associated costs for

individuals in PSH-type programs in Oregon, Seattle, and Alaska (Srebnik et al., 2013; Driscoll et al., 2018; Wright et al., 2016).

It is estimated that 10-20% of individuals who are homeless account for 60% of public service costs, and that this high cost use is indicative of circumstances which PSH could remedy (Fazel et al., 2008; Flaming et al., 2011). However, prior research among homeless and PSH populations confirm that not all groups utilize the same services or at the same rate.

A recent study found differential patterns in PSH services among veterans dependent on age, incarceration histories, depression or PTSD criteria, and whether individuals had a case manager (Harris et al., 2018). A study of homeless youth in Seattle found differences between males and females in reasons for seeking health care visits, with female respondents seeking care more frequently for contraceptive and STI-related care and male respondents seeking care more frequently for respiratory and dermatologic concerns (Evans et al., 2014). While one study identified a reduction in reported experiences of everyday discrimination based on poverty and race among those who obtained housing in PSH, discrimination related to race, stigma, poverty, and mental health disorders are common among this population (Gattis & Larson, 2016; Phelan et al., 1997; Wenzel et al., 2019). Prior and current experiences of discrimination, coupled with health care provider sensitivity, may influence the frequency at which different racial groups seek health care (Fusaro et al., 2018).

Finally, older age is associated with increased need for and utilization of health care services across many populations (National Academies Press, 2008). The proportion of homeless individuals over 50 is increasing substantially, and this population faces distinct health problems, including respiratory health conditions and mobility problems like falls (Brown et al., 2015; Culhane et al., 2013; Henwood et al., 2015). Homeless adults develop health problems at rates typical of adults 15-20 years older than the general population; therefore, many consider homeless adults to be “elderly” at 50 (Brown et al., 2012; Gelberg et al., 1990). PSH may be especially beneficial for this population, with a variety of studies demonstrating positive health outcomes for individuals 50 or older, particularly related to mental health (Brown et al., 2015; Henwood et al., 2015; National Academies of Sciences, Engineering, and Medicine (U.S.), 2018).

Prior research has noted challenges in data integration, tracking health care utilization, and identifying the characteristics that affect service use (Driscoll et al., 2018; Harris et al., 2018; National Academies of Sciences, Engineering, and Medicine (U.S.), 2018; Rog et al., 2014). Understanding the rate of health care service utilization among different populations in PSH may benefit PSH program administrators and health care providers looking to best serve their patients.

Homelessness and PSH in Seattle and King County, Washington

All Home, King County’s committee to end homelessness, estimated that just over 11,000 individuals were experiencing homelessness in King County on January 25, 2019; 68% of these individuals resided in Seattle (Count Us In, 2019). King County’s Homeless Housing Program (HHP) oversees a variety of rapid re-housing programs for individuals experiencing homelessness, including PSH (Homeless Housing Program, 2020). Seattle’s PSH model, like many models in the United States, stipulates that individuals must have a condition or disability (such as substance use or a chronic condition) that creates multiple barriers to housing stability and requires a high level of service needs.

Public Health – Seattle King County's Health Care for the Homeless Network (HCHN) provides medical, dental, mental, and substance use health care services to people experiencing homelessness in King County, including those in PSH (Health Care for the Homeless Network, 2020). This network is comprised of Public Health Centers, Public Health Teen Clinics, mobile medical care, and other centers and clinics which offer low cost or free services. In addition to providing trauma-informed and patient-centered health care, HCHN coordinates with community and housing support and provides street outreach and engagement.

In conjunction with Public Health-Seattle and King County's HCHN, this study aims to provide a more rigorous analysis of the health care service utilization patterns of individuals in PSH in Seattle. First, we aim to describe the demographic characteristics (e.g. age, sex, race, ethnicity, education, and veteran status) of individuals in PSH in Seattle accessing health care through the HCHN from 2015 through 2019. To provide epidemiologic understanding of differential service use by individual characteristics, we aim to compare service utilization of HCHN health care programs across the following sociodemographic characteristics: age, sex, race/ethnicity, education, and veteran status. We aim to identify significant differences in annual health care visit frequency by sociodemographic characteristics. Additionally, we aim to compare the proportions of visits pertaining to 1) respiratory diagnoses or symptoms, 2) mental and behavioral health concerns, and 3) injury; these health care visit types were selected due to their relevance among populations experiencing homelessness and in PSH.

## II. Methods

Study Design, Setting, Subjects, and Data Collection

This study was an observational, retrospective longitudinal study, examining health care service utilization patterns among individuals in PSH sites in Seattle who accessed health care through HCHN from January 1, 2015 and December 31, 2019. A de-identified patient visit data set was obtained from Public Health – Seattle & King County's HCHN. Date of visit, sociodemographic information, and health care provider information were recorded each time an individual in PSH accessed health care through one of HCHN's clinics or programs. Information regarding when an individual entered or left PSH was not available. Patient visit data were reported once a month by affiliated contractors and subcontractors and were subsequently loaded into HCHN's database. Data are collected on an ongoing basis.

Outcomes

*Service Utilization*

We identified the number of visits each individual had in each study year (2015-2019) as a measure of service utilization. As data regarding when an individual entered PSH was not available, follow-up time for each individual was estimated as beginning the year of their first visit (from the beginning of data collection) and ending the year of their last visit (through the end of data collection).

*Health Care Visit Type*

Health care visit type was recorded by providers through International Classification of Diseases (ICD) codes. Due to a database error, ICD codes were not retained through 2018 and 2019. Analyses considering health care visit type are thus limited to visits between January 1, 2015 through December 31, 2017. HCHN visits from January 1, 2015 to September 30, 2015 were classified using the ICD-9-CM and visits from October 1, 2015 through December 31, 2017 were classified by the ICD-10-CM structure. We used ICD-9-CM and ICD-10-CM codes to create indicators for visits pertaining to the following categories: respiratory diagnoses and

symptoms, mental and behavioral health concerns, and injury. An extensive descriptive of steps taken to manipulate ICD codes into these categories is provided in Appendix 1.

Exposures/Covariates

All covariates were recorded at each visit. We identified age by subtracting a patient's birth date from health care visit date and rounding down to the nearest integer year. All participants selected either male or female sex.

We combined self-identified race and ethnicity data to create the following racial/ethnic categories: non-Hispanic Black or African American individuals, Hispanic individuals, non-Hispanic Asian/Pacific Islander (PI)/Native Hawaiian (NH) individuals, non-Hispanic American Indian/Alaska Native (AI/AN) individuals, non-Hispanic multiracial individuals, and non-Hispanic White individuals.

For the few individuals who reported changes in levels of education across visits, we replaced their highest level of education reported as their education for all visits. We aggregated education into three categories: less than high school, high school or General Educational Development (GED), and college or some college.

Individuals were categorized as veterans or non-veterans.

Descriptive Statistics

We calculated the mean and standard deviation for age, and proportions and n's of sex, race, ethnicity, education, and veteran status categories.

We calculated the average number of visits per person per year for the entire study population and for each category of sex, race/ethnicity, education, and veteran status. We also calculated the proportion of visits attributable to respiratory diagnoses and symptoms, behavioral and mental health, or injury, for the 2015 – 2017 study population and for each category of sex, race/ethnicity, education, and veteran status.

Statistical Analysis

In order to account for clustering by individuals (i.e., we had multiple visits per person), we selected a Generalized Estimating Equations (GEE) models, specifying a Poisson distribution. GEE was selected because parameter estimates can be interpreted as population averages. The correlation structure was specified as exchangeable, meaning the correlation between any two observations within the same cluster are the same. We also used a robust variance estimator, allowing valid inferences to be made even if this correlation structure was misspecified. The Poisson distribution is utilized to model count data by modeling the log of the outcome with a linear combination of predictors. While overdispersion (variance greater than the mean) is a concern with Poisson regression models, the semi-parametric nature of GEE model and utilization of robust standard errors mitigate that concern. We used the GEE model to compare 1) frequency of service utilization overall, 2) proportions of visits corresponding to respiratory diagnoses or symptoms, 3) proportions of visits corresponding to mental and behavioral health concerns, and 4) proportions of visits corresponding to injury, by sociodemographic characteristics (age, sex, race/ethnicity, education, and veteran status).

We fit unadjusted models to compare service utilization for each of the following: age (years), sex, race/ethnicity, education, and veteran status. We then fit the following adjusted models: age and sex mutually adjusted for one another, race/ethnicity adjusted age and sex, education adjusted for age and sex, and veteran status adjusted for age and sex. All models for service

utilization frequency were fit to estimate rate ratios and 95% confidence intervals (CIs); all models for visit type were fit to estimate relative risks and 95% CIs. All analyses were performed in R Studio Version 1.2.5033 (R Core Team, 2019).

Sensitivity analyses were performed to assess whether individuals with only one visit may be different from the majority of people in PSH. The same adjusted and unadjusted models as described above were fit, using a subset of data for individuals only with 2 or more visits across the relevant study period, and are presented in Appendices 3-6. Nearly all rate ratio and relative risk estimates did not differ by more than 5%. We also performed additional analyses comparing monthly rates of service utilization frequency, rather than annual rates, to explore whether approximating follow-up time more granularly would influence results; these results are presented in Appendix 7.

Our study was determined not to be human subjects research and was exempt from full review by the University of Washington.

## III. Results

Descriptive Statistics

*PSH Population Profile*

A total of 1,799 individuals in PSH accessed care through HCHN between 2015 and 2019, comprising 49,081 health care visits. The average age of clients (on January 1, 2015) was 52 and about two-thirds of clients were male. The largest racial/ethnic category of clients were non-Hispanic White individuals (43%), followed by 23% of clients identifying as non-Hispanic Black or African American, and 22% of clients identifying as Hispanic. Less than 10% of clients identified with each of non-Hispanic AI/AN, non-Hispanic Asian/NH/PI, and non-Hispanic multiracial. The majority of clients received at least a high school diploma or GED, with 18% reporting highest level of education achieved less than high school, and 24% reporting completing at least some college education. Just under a third of clients reported prior military service.

1,417 individuals in permanent supportive housing accessed care through HCHN between 2015 and 2017, comprising 24,662 health care visits where ICD codes were retained. This subset of clients appeared to have a similar demographic breakdown to those with visits over the entire study period; there appears to be less missingness for race/ethnicity, education, and veteran status. Table 1 displays demographic characteristics for individuals in PSH accessing health care services across the entire study period and between 2015-2017.

*Visit Frequency*

Across the entire PSH population, individuals had an average of approximately 8.5 visits per year between 2015 and 2019. Overall and demographic category-specific annual rates are presented in Table 3. Approximately one-third of clients had just one year of calculated follow-up time; 18% had two years of follow-up, 14% had three years of follow-up, 16% had four years of follow-up, and 19% had five years of follow-up. Monthly overall and demographic category-specific service utilization rates are presented in Appendix 7.

*Health Care Visit Types (2015 – 2017)*

Approximately 6% of visits were related to respiratory diagnoses or symptoms, 22% of visits were related to a mental or behavioral health concern, and 5% of visits were related to injury. These visit categories are not mutually exclusive. Table 2 displays the percentage of visits related to these three types of visits. Demographic category-specific proportions for visits

related to respiratory diagnoses and symptoms, mental and behavioral health concerns, and injury are presented in Tables 4, 5, 6, respectively. Appendix 2 displays all visit types by ICD-10-CM chapters, categories, and codes.

Service Utilization

*Visit Frequency*

Age was positively associated with number of health care visits in a year. Comparing groups 10 years apart in age, the older group utilized health care services at 1.36 (95% CI 1.29, 1.42) times the rate of the younger group, adjusting for sex. Those who were non-Hispanic Asian, Pacific Islander, or Native Hawaiian utilized health care services at approximately half the rate of the non-Hispanic white group (adjusted RR=0.49; 95% CI 0.37, 0.64). Those who were non-Hispanic black or African American also utilized health care services significantly less frequently (adjusted RR=0.85; 95% CI 0.74, 0.99).

Veteran status was negatively associated with number of visits in a year; those who were veterans used services at 0.77 times the rate of those who were not veterans, adjusted for age and sex (95% CI 0.68, 0.88). Sex and education were not significant predictors of service utilization. Unadjusted and adjusted rate ratios comparing annual service utilization by covariates are presented in Table 3. Unadjusted and adjusted rate ratios comparing monthly service utilization are provided in Appendix 7; significant findings did not vary when looking at monthly versus annual rates.

*Health Care Visit Type: Respiratory Symptoms and Diagnoses*

Older age was significantly associated with higher likelihood of visits for respiratory reasons; comparing groups 10 years apart and of the same sex, the risk of a visit for respiratory symptoms and diagnoses is 1.18 times higher among the older group (95% CI 1.07, 1.32). Most racial/ethnic groups did not differ significantly from non-Hispanic whites with respect to their likelihood of a visit for respiratory symptoms and/or diagnoses. Non-Hispanic Asian, Pacific Islander, and Native Hawaiian groups, had approximately half the proportion of visits for respiratory reasons than that of non-Hispanic white groups (adjusted RR=0.50; 95% CI 0.26, 0.93), holding age and sex constant.

Education, veteran status, and sex were not significant predictors of having a health care visit type related to respiratory symptoms and diagnoses. Unadjusted and adjusted relative risks comparing likelihood of visit for respiratory symptoms and diagnoses by covariates are presented in Table 4.

*Health Care Visit Type: Mental and Behavioral Health*

Health care service utilization for mental and behavioral health reasons appears differential across some racial groups. Non-Hispanic black or African American groups (adjusted RR=0.77; 95% CI 0.66, 0.91) and non-Hispanic Asian, Pacific Islander, and Native Hawaiian groups (adjusted RR=0.64; 95% CI 0.43, 0.95) exhibited significantly lower likelihood of visits for mental or behavioral health reasons relative to non-Hispanic white groups, holding age and sex constant. Utilization did not differ between those with some college education relative to those with a high school diploma or GED. However, those without a high school diploma or GED were significantly more likely to have a visit for mental or behavioral health services than those with (adjusted RR=1.21; 95% CI 1.02, 1.43).

Among this population, age, sex, and veteran status did not appear to be significant predictors of visits for mental or behavioral health reasons. Unadjusted and adjusted relative risks

comparing likelihood of visit for mental and behavioral health by covariates are presented in Table 5.

*Health Care Visit Type: Injury*
Older age was negatively associated with likelihood of visit related to an injury; comparing groups 10 years apart and of the same sex, the older group had 0.87 times the likelihood of a visit related to injury than the younger group (95% CI 0.78, 0.98). Compared with non-Hispanic white groups, the proportion of visits attributable to injury was significantly lower among non-Hispanic black or African American groups (adjusted RR=0.52; 95% CI 0.35, 0.77), Asian, Pacific Islander, and Native Hawaiian non-Hispanic groups (adjusted RR=0.37; 95% CI 0.17, 0.77), and Hispanic groups (adjusted RR=0.64; 95% CI 0.45, 0.92).

Sex, educational achievement, and veteran status were not significantly associated with likelihood of visit for injury. Unadjusted and adjusted relative risks comparing likelihood of visit injury by covariates are presented in Table 6.

## IV. Discussion

Age was a significant predictor for increased service utilization overall and for respiratory diagnoses or symptom visits. This is consistent with other literature on older groups generally (National Academies Press, 2008). Age was not significantly associated with mental/behavioral health visits. While other research has identified positive changes in mental health outcomes for older individuals in PSH, this does not necessarily mean that positive changes are related to mental health care visits (Brown et al., 2015). While falls and other mobility related injuries are common among older adults in this population (Henwood et al., 2015), the negative association observed between age and injury visits in our study may be a function of relatively high proportions of visits related to other chronic and acute health conditions not examined here.

We did not identify sex as a significant predictor in any of our analyses. This contrasts with findings in another study on sex differences in health care utilization and reasons for seeking care among youth experiencing homelessness in Seattle (Evans et al., 2014). There may be confounding factors unexamined here that may be related to sex differences, such as health care provider characteristics or other sociodemographic factors.

Non-Hispanic Asian, Pacific Islander, and Native Hawaiian individuals utilized services at about half the rate of Non-Hispanic white individuals and were also less likely to have visits pertaining to respiratory, mental and behavioral health, and injury. Non-Hispanic Black or African American individuals also utilized services less frequently than non-Hispanic white individuals and were less likely to have visits pertaining to mental and behavioral health and injury. This is consistent with prior research and may be explained by the impact that prior and current discrimination may have on willingness to seek care (Fusaro et al., 2018).

While service utilization frequency did not significantly differ across levels of education, those without a high school degree or GED had a larger share of visits related to mental and behavioral health than those with high school degree or GED. The association between educational attainment and mental health is well-established across populations, with debate surrounding the causal mechanisms (Yu & Williams, 1999). Recent research suggests these findings may be explained by genetic and environmental factors early in the life course influencing both education and mental health (Halpern-Manners et al., 2016). An alternative explanation may be the role that education plays in development of skills and problem-solving

abilities that may be helpful to avoid or better manage future mental health problems (Ross & Mirowsky, 2013).

Veterans had overall lower service utilization frequency than non-veterans. This could be related to veterans seeking care at alternate sources such as the Veterans Administration. There also may be important impacts of stigma and discrimination; while we did not find differences between veterans and non-veterans in the proportion of visits related to mental and behavioral health conditions, other literature points out that veterans with depression experiencing high self-stigma used mental health care less frequently (Campbell et al., 2016).

Strengths and Limitations

A major strength of this study is that it harnessed longitudinal visit information to provide insight on service utilization patterns over a relatively long period of time, which was identified as lacking in prior research (Driscoll et al., 2018; Harris et al., 2018; National Academies of Sciences, Engineering, and Medicine (U.S.), 2018; Rog et al., 2014). Moreover, the availability of ICD-9-CM and ICD-10-CM codes allowed for the examination of specific visit types, further disentangling differences in utilization by several sociodemographic groups.

To approximate the amount of time individuals spent in PSH, analyses comparing visit frequency were clustered within individuals by years, assuming that for the years of an individual's first and last visit, an individual was in PSH the entirety of both years. There is likely to be an underestimation of follow-up time for those who do not use health care at least once a year. However, examining service utilization rates on a monthly, versus annual, basis did find similar significant differences in utilization (Appendix 7). Overestimation of follow-up time may also be a concern, given that some individuals may utilize health care services immediately when they enter PSH.

ICD-9-CM and ICD-10-CM codes were missing from this study for 2018 and 2019. However, the characteristics of the subset with visits between 2015-2017 were similar to the characteristics of the entire study population. Additionally, ICD-9-CM codes do not perfectly map onto ICD-10-CM codes, so conversion of codes may not be perfect on an individual basis. However, because codes were used to create indicators across broader categories, concern about misalignment is minimal.

We performed complete case analyses of individuals for which covariate data was available. Data on age and sex were complete, with some missingness observed for race/ethnicity and high missingness observed for education and veteran status. This missingness likely violates the missing completely at random (MCAR) assumption required to for valid GEE methods. which stipulates that missing data do not depend on any measured or unmeasured covariates. However, missing covariate data are plausibly related to HCHN contractor data collection.

Finally, while this study aims to provide insight regarding the differential health care service utilization of those in PSH across demographic groups, results cannot necessarily be generalized to those in PSH across the United States. PSH requirements and service provisions differ across counties and states, as do the burden of health conditions and sociodemographic profiles and experiences of individuals in PSH. The reasons people seek health care are likely not just related to their own characteristics and demographics, but the characteristics and demographics of others at their PSH site and in their community and city; this is certainly different across cities in the U.S.

Implications and Future Study

This study complements other research done on PSH and similar programs in Seattle and in other cities. This study offers insight for program administrators and health care providers of Public Health-Seattle & King County's HCHN and other health care programs used by those in permanent supportive housing, by identifying differential utilization rates and proportion of visits related to select health conditions across demographic groups.

Future studies on health care service utilization among this population should aim to link PSH entry and exit data with health care service utilization to better compute follow-up time. Moreover, future research should examine differential utilization across additional health conditions and across sociodemographic characteristics such as income level, utilization of other social service and welfare programs, and employment status.

**Tables & Figures**

Table 1. Descriptive Table of PSH Client Dataset

| | **All Clients (visits 2015 - 2019)** N = 1799 | **Clients with visit type information (visits 2015 - 2017)** N = 1417 |
|---|---|---|
| **Age as of January 1, 2015 (mean (standard deviation (SD)))** | 51.89 (11.8) | 53.07 (11.3) |
| **Sex (n (%))** | | |
| Female | 599 (33.3) | 465 (32.8) |
| Male | 1200 (66.7) | 952 (67.2) |
| Missing | 0 (0) | 0 (0) |
| **Race/Ethnicity (n (%))** | | |
| Non-Hispanic Black/AA | 388 (23.2) | 328 (23.5) |
| Hispanic | 367 (22.0) | 318 (22.8) |
| Asian/NH/PI non-Hispanic | 45 (2.7) | 35 (2.5) |
| Non-Hispanic AI/AN | 128 (7.7) | 107 (7.6) |
| Non-Hispanic Multiracial | 31 (1.9) | 23 (1.6) |
| Non-Hispanic White | 712 (42.6) | 585 (41.9) |
| Missing | 128 (7.7) | 21 (1.5) |
| **Education (n (%))** | | |
| < High school degree | 241 (18.4) | 208 (18.4) |
| High school degree/GED | 753 (57.4) | 622 (55.2) |
| College/Some College | 318 (24.2) | 297 (26.4) |
| Missing | 487 (27.1) | 290 (20.5) |
| **Veteran (n (%))** | | |
| Yes | 452 (29.5) | 395 (31.4) |
| No | 1082 (70.5) | 864 (68.6) |
| Missing | 265 (14.7) | 158 (11.2) |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development

Table 2. Respiratory, Mental/Behavioral Health, and Injury Visit Type, for visits 2015 – 2017

| Visit Category of Interest | n (% of all visits)*<br>N = 24,662 visits |
|---|---|
| **Respiratory Diagnoses and Symptoms**[1] | 1470 (6.0) |
| **Mental and Behavioral Health**[2] | 5320 (21.6) |
| **Injury**[3] | 1150 (4.9) |
| **Visits not related to all categories above** | 17283 (70.1) |

*Visit categories are not mutually exclusive. An exhaustive list is in Appendix 2.

1 Respiratory Diagnoses and Symptoms correspond to ICD codes J00-J99 and R04-R09
2 Mental and Behavioral Health corresponds to ICD codes F01-F99 and R40-R46
3 Injury corresponds to ICD codes S00-S99, T07-T14, and T90-T94

Table 3. Annual Service Utilization Frequency Rate Ratios (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status

| | Mean visits per year per person (SD) | Unadjusted RR Estimate (95% CI) | Adjusted RR Estimate (95% CI) |
|---|---|---|---|
| **Entire Population** | 8.473 (10.639) | - | - |
| **Age (10 year difference)*** | | | |
| n† = 4826 | - | 1.357 (1.293, 1.424) | 1.357 (1.293, 1.438) |
| **Sex‡** | | | |
| n† = 4826 | | | |
| Female | 8.261 (9.917) | 0.968 (0.858, 1.093) | 1.042 (0.921, 1.180) |
| Male | 8.578 (10.984) | Reference | Reference |
| **Race/Ethnicity§** | | | |
| n† = 4740 | | | |
| Non-Hispanic Black/AA | 7.785 (9.582) | 0.854 (0.736, 0.992) | 0.853 (0.736, 0.990) |
| Hispanic | 8.236 (9.864) | 0.895 (0.770, 1.040) | 0.933 (0.805, 1.083) |
| Non-Hispanic Asian/PI/NH | 4.583 (3.817) | 0.493 (0.384, 0.632) | 0.488 (0.371, 0.643) |
| Non-Hispanic AI/AN | 9.300 (11.740) | 1.024 (0.812, 1.292) | 1.081 (0.851, 1.372) |
| Non-Hispanic Multiracial | 10.344 (18.787) | 1.121 (0.621, 2.025) | 1.211 (0.660, 2.221) |
| Non-Hispanic White | 9.172 (11.261) | Reference | Reference |
| **Education§** | | | |
| n† = 3873 | | | |
| < High school degree | 9.874 (10.890) | 1.056 (0.894, 1.246) | 1.042 (0.881, 1.232) |
| High school degree/GED | 9.275 (11.679) | Reference | Reference |
| College/Some College | 10.137 (11.645) | 1.076 (0.920, 1.257) | 0.927 (0.794, 1.082) |
| **Veteran§** | | | |
| n† = 4286 | | | |
| Yes | 8.030 (9.329) | 0.844 (0.742, 0.960) | 0.769 (0.675, 0.875) |
| No | 9.200 (11.472) | Reference | Reference |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (years)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Table 4. Respiratory Visit Relative Risks (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, 2015 – 2017

| | % of visits among group for respiratory | Unadjusted RR Estimate (95% CI) | Adjusted RR Estimate (95% CI) |
|---|---|---|---|
| **Entire Population (2015 - 2017)** | 5.960% | - | - |
| **Age (10 year difference)*** | | | |
| n† = 24662 | - | 1.184 (1.072, 1.318) | 1.184 (1.072, 1.318) |
| **Sex**‡ | | | |
| n† = 24662 | | | |
| Female | 5.957% | 0.977 (0.759, 1.256) | 1.019 (0.795, 1.308) |
| Male | 5.962% | Reference | Reference |
| **Race/Ethnicity**§ | | | |
| n† = 24519 | | | |
| Non-Hispanic Black/AA | 7.440% | 1.234 (0.905, 1.684) | 1.227 (0.900, 1.673) |
| Hispanic | 4.121% | 0.855 (0.598, 1.223) | 0.880 (0.616, 1.258) |
| Non-Hispanic Asian/PI/NH | 2.727% | 0.458 (0.244, 0.859) | 0.482 (0.256, 0.908) |
| Non-Hispanic AI/AN | 4.250% | 0.979 (0.662, 1.448) | 1.018 (0.691, 1.498) |
| Non-Hispanic Multiracial | 2.332% | 0.660 (0.204, 2.130) | 0.675 (0.207, 2.197) |
| Non-Hispanic White | 6.656% | Reference | Reference |
| **Education**§ | | | |
| n† = 22447 | | | |
| < High school degree | 4.707% | 0.775 (0.529, 1.134) | 0.745 (0.508, 1.093) |
| High school degree/GED | 7.174% | Reference | Reference |
| College/Some College | 4.774% | 0.891 (0.654, 1.216) | 0.818 (0.592, 1.129) |
| **Veteran**§ | | | |
| n† = 23306 | | | |
| Yes | 4.312% | 0.848 (0.637, 1.129) | 0.813 (0.603, 1.096) |
| No | 6.851% | Reference | Reference |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Table 5. Mental/Behavioral Health Visit Relative Risks (RRs) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, 2015 – 2017

| | % of visits among group for mental health | Unadjusted RR Estimate (95% CI) | Adjusted RR Estimate (95% CI) |
|---|---|---|---|
| **Entire Population (2015 - 2017)** | 21.572% | - | - |
| **Age (10 year difference)*** | | | |
| n† = 24662 | - | 0.961 (0.904, 1.020) | 0.961 (0.904, 1.020) |
| **Sex**‡ | | | |
| n† = 24662 | | | |
| Female | 21.295% | 1.056 (0.934, 1.194) | 1.045 (0.923, 1.183) |
| Male | 21.707% | Reference | Reference |
| **Race/Ethnicity**§ | | | |
| n† = 24519 | | | |
| Non-Hispanic Black/AA | 17.550% | 0.772 (0.656, 0.908) | 0.770 (0.655, 0.905) |
| Hispanic | 22.192% | 0.937 (0.795, 1.104) | 0.932 (0.790, 1.098) |
| Non-Hispanic Asian/PI/NH | 13.939% | 0.656 (0.442, 0.973) | 0.637 (0.428, 0.949) |
| Non-Hispanic AI/AN | 24.125% | 1.106 (0.914, 1.337) | 1.089 (0.901, 1.315) |
| Non-Hispanic Multiracial | 16.618% | 0.616 (0.357, 1.065) | 0.615 (0.357, 1.061) |
| Non-Hispanic White | 22.844% | Reference | Reference |
| **Education**§ | | | |
| n† = 22447 | | | |
| < High school degree | 24.024% | 1.200 (1.011, 1.423) | 1.207 (1.018, 1.431) |
| High school degree/GED | 20.627% | Reference | Reference |
| College/Some College | 21.030% | 0.978 (0.832, 1.149) | 0.998 (0.846, 1.178) |
| **Veteran**§ | | | |
| n† = 23306 | | | |
| Yes | 20.670% | 0.951 (0.829, 1.092) | 0.965 (0.839, 1.110) |
| No | 21.329% | Reference | Reference |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Table 6. Injury Visit Relative Risks (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, 2015 – 2017

| | % of visits among group for injury | Unadjusted RR Estimate (95% CI) | Adjusted RR Estimate (95% CI) |
|---|---|---|---|
| **Entire Population (2015 - 2017)** | 4.663% | - | - |
| **Age (10 year difference)*** | | | |
| n† = 24662 | - | 0.877 (0.784, 0.980) | 0.865 (0.776, 0.980) |
| **Sex**‡ | | | |
| n† = 24662 | | | |
| Female | 4.561% | 0.883 (0.661, 1.181) | 0.848 (0.632, 1.139) |
| Male | 4.713% | Reference | Reference |
| **Race/Ethnicity**§ | | | |
| n† = 24519 | | | |
| Non-Hispanic Black/AA | 2.869% | 0.512 (0.344, 0.760) | 0.519 (0.350, 0.771) |
| Hispanic | 3.791% | 0.663 (0.465, 0.947) | 0.642 (0.450, 0.917) |
| Non-Hispanic Asian/PI/NH | 2.727% | 0.380 (0.182, 0.792) | 0.365 (0.174, 0.765) |
| Non-Hispanic AI/AN | 6.125% | 1.058 (0.741, 1.510) | 1.040 (0.728, 1.485) |
| Non-Hispanic Multiracial | 3.499% | 0.614 (0.265, 1.422) | 0.580 (0.246, 1.368) |
| Non-Hispanic White | 5.642% | Reference | Reference |
| **Education**§ | | | |
| n† = 22447 | | | |
| < High school degree | 5.341% | 1.312 (0.908, 1.895) | 1.328 (0.919, 1.918) |
| High school degree/GED | 4.943% | Reference | Reference |
| College/Some College | 4.124% | 0.797 (0.550, 1.155) | 0.833 (0.572, 1.214) |
| **Veteran**§ | | | |
| n† = 23306 | | | |
| Yes | 5.002% | 0.998 (0.729, 1.366) | 1.000 (0.731, 1.368) |
| No | 4.636% | Reference | Reference |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

**References**


Brown, R. T., Kiely, D. K., Bharel, M., & Mitchell, S. L. (2012). Geriatric Syndromes in Older Homeless Adults. *Journal of General Internal Medicine*, *27*(1), 16–22. https://doi.org/10.1007/s11606-011-1848-9

Brown, R. T., Miao, Y., Mitchell, S. L., Bharel, M., Patel, M., Ard, K. L., Grande, L. J., Blazey-Martin, D., Floru, D., & Steinman, M. A. (2015). Health Outcomes of Obtaining Housing Among Older Homeless Adults. *American Journal of Public Health*, *105*(7), 1482–1488. https://doi.org/10.2105/AJPH.2014.302539

Byrne, T., Fargo, J. D., Montgomery, A. E., Munley, E., & Culhane, D. P. (2014). The Relationship between Community Investment in Permanent Supportive Housing and Chronic Homelessness. *Social Service Review*, *88*(2), 234–263. https://doi.org/10.1086/676142

Campbell, D. G., Bonner, L. M., Bolkan, C. R., Lanto, A. B., Zivin, K., Waltz, T. J., Klap, R., Rubenstein, L. V., & Chaney, E. F. (2016). Stigma Predicts Treatment Preferences and Care Engagement Among Veterans Affairs Primary Care Patients with Depression. *Annals of Behavioral Medicine*, *50*(4), 533–544. https://doi.org/10.1007/s12160-016-9780-1

Cooper, W (2020). icdcoder: ICD-9 and ICD-10 code utility functions and datasets. R package version 0.0.0.9000.

Count Us In. (2019). Retrieved May 13, 2020, from http://allhomekc.org/king-county-point-in-time-pit-count/)

Culhane, D. P., Metraux, S., Byrne, T., Stino, M., & Bainbridge, J. (2013). The Age Structure of Contemporary Homelessness: Evidence and Implications For Public Policy: Age Structure of Homelessness. *Analyses of Social Issues and Public Policy*, *13*(1), 228–244. https://doi.org/10.1111/asap.12004

Culhane, D. P., Metraux, S., & Hadley, T. (2002). Public service reductions associated with placement of homeless persons with severe mental illness in supportive housing. *Housing Policy Debate*, *13*(1), 107–163. https://doi.org/10.1080/10511482.2002.9521437

Dai, L., & Zhou, P. (2018). The health issues of the homeless and the homeless issues of the ill-health. *Socio-Economic Planning Sciences*, 100677. https://doi.org/10.1016/j.seps.2018.12.004

Donovan, S., & Shinseki, E. K. (2013). Homelessness Is a Public Health Issue. *American Journal of Public Health*, *103*(S2), S180–S180. https://doi.org/10.2105/AJPH.2013.301727

Driscoll, D. L., Johnston, J. M., Chapman, C., Hedwig, T., Shimer, S., Barker, R., Burke, N., Baldwin, M., & Brown, R. A. (2018). Changes in the health status of newly housed chronically homeless: The Alaska Housing First program evaluation. *Journal of Social Distress and the Homeless*, *27*(1), 34–43. https://doi.org/10.1080/10530789.2018.1441678

Evans, Y. N., Handschin, S. M., & Giesel, A. E. (2014). Health Care Utilization in Homeless Youth. *Journal of Community Health*, *39*(3), 521–523. https://doi.org/10.1007/s10900-013-9789-3

Fazel, S., Geddes, J. R., & Kushel, M. (2014). The health of homeless people in high-income countries: Descriptive epidemiology, health consequences, and clinical and policy recommendations. *The Lancet*, *384*(9953), 1529–1540. https://doi.org/10.1016/S0140-6736(14)61132-6

Fazel, S., Khosla, V., Doll, H., & Geddes, J. (2008). The Prevalence of Mental Disorders among the Homeless in Western Countries: Systematic Review and Meta-Regression Analysis. *PLoS Medicine*, *5*(12), e225. https://doi.org/10.1371/journal.pmed.0050225

Flaming, D., Burns, P., Sumner, G., Moreno, M. H., & Toros, H. (2011, August 1). CRISIS INDICATOR TRIAGE TOOL FOR IDENTIFYING HOMELESS ADULTS IN CRISIS. Retrieved May 13, 2020, from https://economicrt.org/publication/crisis-indicator/

Frederick, T. J., Chwalek, M., Hughes, J., Karabanow, J., & Kidd, S. (2014). HOW STABLE IS STABLE? DEFINING AND MEASURING HOUSING STABILITY: Defining and Measuring Housing Stability. *Journal of Community Psychology*, *42*(8), 964–979. https://doi.org/10.1002/jcop.21665

Fusaro, V. A., Levy, H. G., & Shaefer, H. L. (2018). Racial and Ethnic Disparities in the Lifetime Prevalence of Homelessness in the United States. *Demography*, *55*(6), 2119–2128. https://doi.org/10.1007/s13524-018-0717-0

Gattis, M. N., & Larson, A. (2016). Perceived racial, sexual identity, and homeless status-related discrimination among Black adolescents and young adults experiencing homelessness: Relations with depressive symptoms and suicidality. *American Journal of Orthopsychiatry*, *86*(1), 79–90. https://doi.org/10.1037/ort0000096

Gelberg, L., Linn, L. S., & Mayer-Oakes, S. A. (1990). Differences in health status between older and younger homeless adults. *Journal of the American Geriatrics Society*, *38*(11), 1220–1229. https://doi.org/10.1111/j.1532-5415.1990.tb01503.x

Halpern-Manners, A., Schnabel, L., Hernandez, E. M., Silberg, J. L., & Eaves, L. J. (2016). The Relationship between Education and Mental Health: New Evidence from a Discordant Twin Study. *Social Forces*, *95*(1), 107–131. https://doi.org/10.1093/sf/sow035

Harris, T., Winetrobe, H., Rhoades, H., Castro, C. A., & Wenzel, S. (2018). Moving Beyond Housing: Service Implications for Veterans Entering Permanent Supportive Housing. *Clinical Social Work Journal*, *46*(2), 130–144. https://doi.org/10.1007/s10615-018-0648-7

Healthcare for the Homeless Network (HCHN). (2020, April 7). Retrieved May 13, 2020, from https://www.kingcounty.gov/depts/health/locations/homeless-health/healthcare-for-the-homeless.aspx

Henwood, B. F., Harris, T., Woo, D., Winetrobe, H., Rhoades, H., & Wenzel, S. L. (2018). Availability of comprehensive services in permanent supportive housing in Los Angeles. *Health & Social Care in the Community*, *26*(2), 207–213. https://doi.org/10.1111/hsc.12510

Henwood, B. F., Katz, M. L., & Gilmer, T. P. (2015). Aging in place within permanent supportive housing: Aging in place within supportive housing. *International Journal of Geriatric Psychiatry*, *30*(1), 80–87. https://doi.org/10.1002/gps.4120

Henwood, B. F., Lahey, J., Harris, T., Rhoades, H., & Wenzel, S. L. (2018). Understanding Risk Environments in Permanent Supportive Housing for Formerly Homeless Adults. *Qualitative Health Research*, *28*(13), 2011–2019. https://doi.org/10.1177/1049732318785355

Henwood, B. F., Lahey, J., Rhoades, H., Winetrobe, H., & Wenzel, S. L. (2018). Examining the health status of homeless adults entering permanent supportive housing. *Journal of Public Health*, *40*(2), 415–418. https://doi.org/10.1093/pubmed/fdx069

Homeless Housing Program. (2020, January 24). Retrieved May 13, 2020, from https://www.kingcounty.gov/depts/community-human-services/housing/services/homeless-housing.aspx

Housing and Health: An Overview of the Literature. (2018, June 7). Retrieved from https://www.rwjf.org/en/library/research/2018/06/housing-and-health--an-overview-of-the-literature.html

Housing Instability. (2020). Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/housing-instability

ICD - Classification of Diseases, Functioning, and Disability. (2020, January 6). Retrieved May 13, 2020, from https://www.cdc.gov/nchs/icd/index.htm

Krieger, J., & Higgins, D. L. (2002). Housing and Health: Time Again for Public Health Action. *American Journal of Public Health*, *92*(5), 758–768. https://doi.org/10.2105/AJPH.92.5.758

Mackelprang, J. L., Collins, S. E., & Clifasefi, S. L. (2014). Housing First Is Associated with Reduced Use of Emergency Medical Services. *Prehospital Emergency Care*, *18*(4), 476–482. https://doi.org/10.3109/10903127.2014.916020

Martinez, T. E., & Burt, M. R. (2006). Impact of Permanent Supportive Housing on the Use of Acute Care Health Services by Homeless Adults. *Psychiatric Services*, *57*(7), 992–999. https://doi.org/10.1176/ps.2006.57.7.992

National Academies of Sciences, Engineering, and Medicine (U.S.) (Ed.). (2018). *Permanent supportive housing: Evaluating the evidence for improving health outcomes among people experiencing chronic homelessness*. The National Academies Press.

National Academies Press. (2008). *Retooling for an aging America: building the health care workforce*. Washington, D.C.

O'Connell, J.J. (2005). *Premature Mortality in Homeless Populations: A Review of the Literature.* National Health Care for the Homeless Council, Inc.

Permanent Supportive Housing. (2019). Retrieved May 13, 2020, from https://nhchc.org/clinical-practice/homeless-services/permanent-supportive-housing/

Permanent Supportive Housing. (2020, January 27). Retrieved from https://endhomelessness.org/ending-homelessness/solutions/permanent-supportive-housing/

Phelan, J., Link, B. G., Moore, R. E., & Stueve, A. (1997). The Stigma of Homelessness: The Impact of the Label "Homeless" on Attitudes Toward Poor Persons. *Social Psychology Quarterly*, *60*(4), 323. https://doi.org/10.2307/2787093

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rog, D. J., Marshall, T., Dougherty, R. H., George, P., Daniels, A. S., Ghose, S. S., & Delphin-Rittmon, M. E. (2014). Permanent Supportive Housing: Assessing the Evidence.

Ross, C. E., & Mirowsky, J. (2013). The Sense of Personal Control: Social Structural Causes and Emotional Consequences. In C. S. Aneshensel, J. C. Phelan, & A. Bierman (Eds.), *Handbook of the Sociology of Mental Health* (pp. 379–402). Springer Netherlands. https://doi.org/10.1007/978-94-007-4276-5_19

SAMHSA. (2011). Results from the 2010 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-41, HHS Publication No. (SMA) 11-4658. Rockville MD: SAMHSA. Retrieved April 10, 2020, from https://www.samhsa.gov/data/sites/default/files/NSDUHNationalFindingsResults2010-web/2k10ResultsRev/NSDUHresultsRev2010.pdf

Srebnik, Debra, Connor, T., & Sylla, L. (2013). A Pilot Study of the Impact of Housing First–Supported Housing for Intensive Users of Medical Hospitalization and Sobering Services. *American Journal of Public Health*, *103*(2), 316–321. https://doi.org/10.2105/AJPH.2012.300867

Supportive Housing. (2018, August 15). Retrieved from https://www.usich.gov/solutions/housing/supportive-housing

Wenzel, S. L., Rhoades, H., LaMotte-Kerr, W., & Duan, L. (2019). Everyday discrimination among formerly homeless persons in permanent supportive housing. *Journal of Social Distress and the Homeless*, *28*(2), 169–175. https://doi.org/10.1080/10530789.2019.1630959

World Health Organization. (1992). The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines. Geneva: World Health Organization.

World Health Organization. Division of Mental Health. (1994). The ICD-10 classification of mental and behavioural disorders: conversion tables between ICD-8, ICD-9 and ICD-10, Rev. 1. World Health Organization.

World Health Organization, United States, Department of Housing and Urban Development, France, Ministère des affaires sociales et de la santé, United States, & Environmental Protection Agency. (2018). *WHO housing and health guidelines.* http://www.ncbi.nlm.nih.gov/books/NBK535293/

Wright, B. J., Vartanian, K. B., Li, H.-F., Royal, N., & Matson, J. K. (2016). Formerly Homeless People Had Lower Overall Health Care Expenditures After Moving Into Supportive Housing. *Health Affairs*, *35*(1), 20–27. https://doi.org/10.1377/hlthaff.2015.0393

Yu, Y., & Williams, D. R. (1999). Socioeconomic Status and Mental Health. In C. S. Aneshensel & J. C. Phelan (Eds.), *Handbook of the Sociology of Mental Health* (pp. 151–166). Springer US. https://doi.org/10.1007/0-387-36223-1_8

## Appendix

Appendix 1. Manipulation of ICD codes into categories relevant for analyses

Health care visit type was recorded by providers through International Classification of Diseases (ICD) codes. ICD, Ninth Revision, Clinical Modification (ICD-9-CM) was the system utilized for diagnosis in the United States until 1999, when ICD, Tenth Revision, Clinical Modification (ICD-10-CM) began to be used (World Health Organization, 1992). HCHN visits from January 1, 2015 to September 30, 2015 were classified using the ICD-9-CM and visits from October 1, 2015 through December 31, 2017 were classified by the ICD-10-CM structure. Due to a database error, ICD codes were not retained through 2018 and 2019. Analyses considering health care visit type are thus limited to visits between January 1, 2015 through December 31, 2017.

ICD-9-CM codes were converted to ICD-10-CM codes and subsequently organized by ICD-10 chapter, the highest level of aggregation of diagnoses and conditions. As ICD-9-CM codes do not all exactly align to ICD-10-CM codes, conversion was first done through R package "icdcoder" (Cooper, 2020). If an exact match was not identified, ICD-9-CM codes were converted manually into the corresponding ICD-10 chapter (World Health Organization, 1994). Given that broad categories, rather than finer diagnostic differences, were of interest, concern regarding misalignment between ICD-9-CM and ICD-10-CM codes is minimal. Providers at HCHN could record multiple ICD codes for each visit, hence, health care visit type categories are not mutually exclusive. The proportion of visits corresponding to each ICD-10-CM chapter, as well as for certain subcategories of chapters relevant for this study, are provided in Appendix 2.

ICD-10-CM structure separates individuals receiving diagnoses for a certain condition from individuals seeking care for symptoms related to a certain condition. As this study aimed to compare reasons for individuals in PSH to seek health care, these categories were combined in our analyses. We created indicators for visits pertaining to the following categories: respiratory diagnoses and symptoms, mental and behavioral health concerns, and injury.

Respiratory diagnoses and symptoms include influenza and pneumonia, other acute and chronic upper respiratory infections, acute and chronic lower respiratory infections and conditions, lung diseases due to external agents such as organic and inorganic dusts, diseases of the interstitium and pleural cavity, and respiratory symptoms not classified by a diagnosis.

Mental and behavioral health concerns include organic and symptomatic mental disorders, disorders related to substance use, schizophrenia, mood (affective) disorders, neurotic, stress-related and somatoform disorders, eating disorders, sleep disorders, disorders of adult personality and behavior, intellectual disabilities, psychological developmental disorders, and other symptoms pertaining to cognition, perception, emotional state and behavior.

Injury includes fractures, open wounds, contusion, dislocation, sprain, strain, traumatic amputation, crushing injuries, injury of nerves, blood vessels, muscles, or tendons, other unspecified injuries, and sequelae of injuries.

Appendix 2. Visit type based on ICD-10 code, for visits 2015 – 2017

| ICD-10 Chapter | ICD-10 Chapter Title | ICD-10 | n (% of all visits) | % of visits in category |
|---|---|---|---|---|
| **I** | **Certain infectious and parasitic diseases** | A00-B99 | 875 (3.55) | - |
| **II** | **Neoplasms** | C00-D49 | 134 (0.54) | - |
| **III** | **Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism** | D50-D89 | 66 (0.27) | - |
| **IV** | **Endocrine, nutritional and metabolic diseases** | E00-E89 | 875 (3.55) | - |
| **V** | **Mental and behavioral disorders** | F01-F99 | 4952 (20.08) | - |
| **VI** | **Diseases of the nervous system** | G00-G99 | 504 (2.04) | - |
| **VII** | **Diseases of the eye and adnexa** | H00-H59 | 247 (1) | - |
| **VIII** | **Diseases of the ear and mastoid process** | H60-H95 | 211 (0.86) | - |
| **IX** | **Diseases of the circulatory system** | I00-I99 | 1669 (6.77) | - |
| **X** | **Diseases of the respiratory system** | J00-J99 | 869 (3.52) | - |
| **XI** | **Diseases of the digestive system** | K00-K95 | 572 (2.32) | - |
| **XII** | **Diseases of the skin and subcutaneous tissue** | L00-L99 | 2412 (9.78) | - |
| **XIII** | **Diseases of the musculoskeletal system and connective tissue** | M00-M99 | 1303 (5.28) | - |
| **XIV** | **Diseases of the genitourinary system** | N00-N99 | 317 (1.29) | - |
| **XV** | **Pregnancy, childbirth and the puerperium** | O00-O9A | 1 (0) | - |
| **XVI** | **Certain conditions originating in the perinatal period** | P00-P96 | 1 (0) | - |
| **XVII** | **Congenital malformations, deformations and chromosomal abnormalities** | Q00-Q99 | 24 (0.1) | - |
| **XVIII** | **Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified** | R00-R99 | 3652 (14.81) | - |
| | Circulatory and respiratory systems | R00-R09 | 841 (3.41) | 23.03 |
| | Digestive system and abdomen | R10-R19 | 502 (2.04) | 13.75 |
| | Skin and subcutaneous tissue | R20-R23 | 466 (1.89) | 12.76 |
| | Nervous and musculoskeletal systems | R25-R29 | 191 (0.77) | 5.23 |
| | Involving the genitourinary system, or on examination of urine, without diagnosis | R30-R39, R80-R82 | 278 (1.13) | 7.61 |

| | | | | |
|---|---|---|---|---|
| | Cognition, perception, emotional state and behavior | R40-R46 | 475 (1.93) | 13.01 |
| | General symptoms and signs | R50-R69 | 1188 (4.82) | 32.53 |
| | On examination of blood, without diagnosis | R70-R79 | 130 (0.53) | 3.56 |
| | On examination of other bodily fluids, substances and tissues, without diagnosis | R84-R89 | 11 (0.04) | 0.3 |
| | On diagnostic imaging and in function studies, without diagnosis | R90-R94 | 50 (0.2) | 1.37 |
| | Ill-defined and unknown causes of mortality | R99 | 2 (0.01) | 0.05 |
| **XIX** | **Injury, poisoning and certain other consequences of external causes** | S00-T98 | 1330 (5.39) | - |
| | Injury | S00-S99, T00-T14, T90-T94 | 1150 (4.66) | 86.47 |
| | Poisoning and certain other consequences of external causes | T15-T65 | 82 (0.33) | 6.17 |
| | Other and unspecified effects of external causes | T66-T88, T95-T98 | 111 (0.45) | 8.35 |
| **XX** | **External causes of morbidity and mortality** | V00-Y99 | 133 (0.54) | - |
| **XXI** | **Factors influencing health status and contact with health services** | Z00-Z99 | 14570 (59.08) | - |

Appendix 3. Annual Service Utilization Frequency Rate Ratios (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, limited to individuals with 2 or more health care visits between January 1, 2015 and December 31, 2019

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | **RR Estimate (95% CI)** | **% change from Table 3** | **RR Estimate (95% CI)** | **% change from Table 3** |
| **Age (10 year difference)*** | | | | |
| n† = 4577 | 1.293 (1.243, 1.370) | 4.7% | 1.305 (1.243, 1.384) | 3.8% |
| **Sex**‡ | | | | |
| n† = 4577 | | | | |
| Female | 0.955 (0.848, 1.077) | 1.4% | 1.028 (0.910, 1.162) | 1.4% |
| Male | Reference | | Reference | |
| **Race/Ethnicity**§ | | | | |
| n† = 4506 | | | | |
| Non-Hispanic Black/AA | 0.861 (0.743, 0.998) | 0.8% | 0.863 (0.745, 0.998) | 1.2% |
| Hispanic | 0.898 (0.774, 1.041) | 0.3% | 0.927 (0.801, 1.073) | 0.7% |
| Non-Hispanic Asian/PI/NH | 0.485 (0.380, 0.619) | 1.6% | 0.488 (0.374, 0.639) | 0.0% |
| Non-Hispanic AI/AN | 1.005 (0.798, 1.264) | 1.9% | 1.058 (0.837, 1.338) | 3.0% |
| Non-Hispanic Multiracial | 1.082 (0.601, 1.948) | 3.5% | 1.152 (0.630, 2.107) | 4.9% |
| Non-Hispanic White | Reference | | Reference | |
| **Education**§ | | | | |
| n† = 3730 | | | | |
| < High school degree | 1.010 (0.857, 1.191) | 4.4% | 1.000 (0.847, 1.181) | 4.0% |
| High school degree/GED | Reference | | Reference | |
| College/Some College | 1.047 (0.898, 1.222) | 2.7% | 0.918 (0.788, 1.070) | 1.0% |
| **Veteran**§ | | | | |
| n† = 4100 | | | | |
| Yes | 0.820 (0.722, 0.932) | 2.8% | 0.756 (0.665, 0.860) | 1.7% |
| No | Reference | | Reference | |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (years)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Appendix 4. Respiratory Visit Relative Risks (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, limited to individuals with 2 or more health care visits between January 1, 2015 and December 31, 2017

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | **RR Estimate (95% CI)** | **% change from Table 4** | **RR Estimate (95% CI)** | **% change from Table 4** |
| **Age (10 year difference)*** | | | | |
| n† = 24445 | 1.160 (1.040, 1.293) | 2.0% | 1.160 (1.040, 1.293) | 2.0% |
| **Sex**‡ | | | | |
| n† = 24445 | | | | |
| Female | 0.994 (0.769, 1.283) | 1.7% | 1.033 (0.802, 1.331) | 1.5% |
| Male | Reference | | Reference | |
| **Race/Ethnicity**§ | | | | |
| n† = 24308 | | | | |
| Non-Hispanic Black/AA | 1.218 (0.886, 1.675) | 1.3% | 1.211 (0.880, 1.664) | 1.3% |
| Hispanic | 0.836 (0.579, 1.209) | 2.2% | 0.856 (0.593, 1.237) | 2.8% |
| Non-Hispanic Asian/PI/NH | 0.473 (0.252, 0.887) | 3.1% | 0.495 (0.264, 0.931) | 2.5% |
| Non-Hispanic AI/AN | 0.999 (0.674, 1.480) | 2.0% | 1.033 (0.701, 1.522) | 1.5% |
| Non-Hispanic Multiracial | 0.698 (0.216, 2.252) | 5.1% | 0.707 (0.217, 2.305) | 4.3% |
| Non-Hispanic White | Reference | | Reference | |
| **Education**§ | | | | |
| n† = 22314 | | | | |
| < High school degree | 0.765 (0.519, 1.126) | 1.3% | 0.737 (0.499, 1.089) | 1.1% |
| High school degree/GED | Reference | | Reference | |
| College/Some College | 0.898 (0.656, 1.229) | 0.8% | 0.831 (0.599, 1.152) | 1.6% |
| **Veteran**§ | | | | |
| n† = 23130 | | | | |
| Yes | 0.834 (0.622, 1.117) | 1.7% | 0.807 (0.593, 1.096) | 0.7% |
| No | Reference | | Reference | |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Appendix 5. Mental/Behavioral Health Visit Relative Risks (RRs) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, limited to individuals with 2 or more health care visits between January 1, 2015 and December 31, 2017

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | **RR Estimate (95% CI)** | **% change from Table 5** | **RR Estimate (95% CI)** | **% change from Table 5** |
| **Age (10 year difference)*** | | | | |
| n† = 24445 | 0.980 (0.923, 1.040) | 2.1% | 0.990 (0.923, 1.051) | 3.1% |
| **Sex**‡ | | | | |
| n† = 24445 | | | | |
| Female | 1.068 (0.941, 1.212) | 1.1% | 1.064 (0.936, 1.210) | 1.8% |
| Male | Reference | | Reference | |
| **Race/Ethnicity**§ | | | | |
| n† = 24308 | | | | |
| Non-Hispanic Black/AA | 0.775 (0.656, 0.917) | 0.4% | 0.772 (0.653, 0.912) | 0.3% |
| Hispanic | 0.917 (0.772, 1.089) | 2.1% | 0.915 (0.770, 1.087) | 1.7% |
| Non-Hispanic Asian/PI/NH | 0.640 (0.427, 0.958) | 2.4% | 0.624 (0.416, 0.937) | 2.0% |
| Non-Hispanic AI/AN | 1.103 (0.909, 1.338) | 0.3% | 1.089 (0.897, 1.321) | 0.0% |
| Non-Hispanic Multiracial | 0.588 (0.331, 1.045) | 4.5% | 0.591 (0.333, 1.051) | 3.9% |
| Non-Hispanic White | Reference | | Reference | |
| **Education**§ | | | | |
| n† = 22314 | | | | |
| < High school degree | 1.193 (1.000, 1.422) | 0.6% | 1.195 (1.003, 1.424) | 1.0% |
| High school degree/GED | Reference | | Reference | |
| College/Some College | 0.983 (0.834, 1.159) | 0.5% | 0.988 (0.834, 1.171) | 1.0% |
| **Veteran**§ | | | | |
| n† = 23130 | | | | |
| Yes | 0.970 (0.842, 1.117) | 2.0% | 0.985 (0.853, 1.137) | 2.1% |
| No | Reference | | Reference | |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Appendix 6. Injury Visit Relative Risks (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status, limited to individuals with 2 or more health care visits between January 1, 2015 and December 31, 2017

| | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | **RR Estimate (95% CI)** | **% change from Table 6** | **RR Estimate (95% CI)** | **% change from Table 6** |
| **Age (10 year difference)*** | | | | |
| n† = 24445 | 0.860 (0.761, 0.970) | 1.9% | 0.851 (0.753, 0.961) | 2.0% |
| **Sex**‡ | | | | |
| n† = 24445 | | | | |
| Female | 0.866 (0.645, 1.161) | 1.9% | 0.826 (0.613, 1.113) | 2.6% |
| Male | Reference | | Reference | |
| **Race/Ethnicity**§ | | | | |
| n† = 24308 | | | | |
| Non-Hispanic Black/AA | 0.511 (0.342, 0.763) | 0.2% | 0.520 (0.348, 0.776) | 0.2% |
| Hispanic | 0.665 (0.465, 0.953) | 0.3% | 0.644 (0.450, 0.922) | 0.3% |
| Non-Hispanic Asian/PI/NH | 0.383 (0.184, 0.798) | 0.8% | 0.364 (0.173, 0.764) | 0.3% |
| Non-Hispanic AI/AN | 1.024 (0.715, 1.466) | 3.2% | 1.004 (0.700, 1.439) | 3.5% |
| Non-Hispanic Multiracial | 0.682 (0.272, 1.450) | 11.1% | 0.591 (0.200, 1.398) | 1.9% |
| Non-Hispanic White | Reference | | Reference | |
| **Education**§ | | | | |
| n† = 22314 | | | | |
| < High school degree | 1.309 (0.906, 1.892) | 0.2% | 1.329 (0.919, 1.920) | 0.1% |
| High school degree/GED | Reference | | Reference | |
| College/Some College | 0.798 (0.551, 1.156) | 0.1% | 0.840 (0.576, 1.224) | 0.8% |
| **Veteran**§ | | | | |
| n† = 23130 | | | | |
| Yes | 1.006 (0.734, 1.377) | 0.8% | 1.003 (0.733, 1.371) | 0.3% |
| No | Reference | | Reference | |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (health care visits)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex

Appendix 7. Monthly Service Utilization Frequency Rate Ratios (RR) by Age, Sex, Race/Ethnicity, Education, and Veteran Status

| | Mean visits per person per month (SD) | Unadjusted RR Estimate (95% CI) | Adjusted RR Estimate (95% CI) |
|---|---|---|---|
| **Entire Population** | 1.260 (1.174) | - | - |
| **Age (10 year difference)*** | | | |
| n† = 43271 | - | 1.386 (1.305, 1.480) | 1.397 (1.305, 1.480) |
| **Sex**‡ | | | |
| n† = 43271 | | | |
| Female | 1.284 (1.236) | 0.989 (0.897, 1.089) | 1.082 (0.973, 1.202) |
| Male | 1.248 (1.142) | Reference | Reference |
| **Race/Ethnicity**§ | | | |
| n† = 42714 | | | |
| Non-Hispanic Black/AA | 1.200 (1.184) | 0.879 (0.781, 0.989) | 0.884 (0.780, 1.001) |
| Hispanic | 1.215 (1.075) | 0.909 (0.805, 1.026) | 0.931 (0.821, 1.056) |
| Non-Hispanic Asian/PI/NH | 1.092 (1.033) | 0.691 (0.551, 0.868) | 0.645 (0.491, 0.847) |
| Non-Hispanic AI/AN | 1.280 (1.258) | 0.987 (0.818, 1.191) | 1.058 (0.867, 1.292) |
| Non-Hispanic Multiracial | 1.373 (1.663) | 1.076 (0.674, 1.716) | 1.182 (0.725, 1.928) |
| Non-Hispanic White | 1.317 (1.206) | Reference | Reference |
| **Education**§ | | | |
| n† = 36278 | | | |
| < High school degree | 1.344 (1.238) | 1.054 (0.920, 1.208) | 1.055 (0.910, 1.223) |
| High school degree/GED | 1.231 (1.147) | Reference | Reference |
| College/Some College | 1.338 (1.330) | 1.067 (0.935, 1.217) | 0.925 (0.805, 1.063) |
| **Veteran**§ | | | |
| n† = 39244 | | | |
| Yes | 1.135 (1.024) | 0.846 (0.760, 0.941) | 0.763 (0.681, 0.855) |
| No | 1.329 (1.257) | Reference | Reference |

AA: African American; NH: Native Hawaiian; PI: Pacific Islander; AI/AN: American Indian/Alaska Native; GED: General Educational Development
*Adjusted model is adjusted for sex
† Number of observations (months)
‡ Adjusted model is adjusted for age
§ Adjusted model is adjusted for age and sex