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Housing Status and Cancer Diagnosis, Care Coordination, and Outcomes in a Public Hospital

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Running Head: Housing Status and Cancer in a Public Hospital

Abstract (277 words)

Objectives: Cancer is a leading cause of death in unhoused adults. We sought to examine the association between housing status, stage at diagnosis, and all-cause survival following cancer diagnosis at a public hospital.

Design: Retrospective cohort study examining new cancer diagnoses between July 1, 2011 and June 30, 2021

Setting: A public hospital in San Francisco

Exposure: Housing status (housed, formerly unhoused, unhoused) was ascertained via a county-wide integrated dataset that tracks both observed and reported homelessness.

Methods: We reported univariate analyses to investigate differences in demographic and clinical characteristics by housing group. We then constructed Kaplan-Meier curves stratified by housing group to examine unadjusted all-cause mortality. Finally, we used multivariable Cox Proportional Hazards models to compare the hazard rate of mortality for each housing status group, adjusting for demographic and clinical factors.

Results: Our cohort included 5,123 patients with new cancer diagnoses, with 4,062 (79%) in housed patients, 623 (12%) in formerly unhoused patients, and 9% (438) in unhoused patients. Unhoused and formerly unhoused patients were more commonly diagnosed with Stage 4 disease (28% and 27% of the time, respectively, versus 22% of housed patients). After adjusting for demographic and clinical characteristics, unhoused patients with Stage 0-3 disease had a 50% increased hazard of death (adjusted hazard ratio [aHR] 1.5, 95% CI 1.1-1.9; p<0.004) as did formerly unhoused patients (aHR 1.5, 95%CI 1.2-1.9; p=0.001) compared to housed individuals three months after diagnosis.

Conclusions: Unhoused and formerly unhoused patients diagnosed with non-metastatic cancer had substantially increased hazards of death compared to housed patients cared for in a public hospital setting. Current or former lack of housing could contribute to poor outcomes following cancer diagnoses via multiple mechanisms.

Strengths and Limitations of this Study

- Strengths:
  - Unhoused patients are commonly undercounted because of poor documentation of housing status. A unique strength of this study is the use of a county-wide integrated dataset that tracks both observed and reported homelessness to determine housing status. This reduces misclassification of the exposure.
  - This dataset also allows classification of housing status with more granularity, including formerly unhoused patients.
- Limitations:
  - This is a single center study, which limits generalizability to other settings.
  - Our outcome measure is limited to all-cause mortality, not disease-specific mortality. As unhoused individuals have increased rates of mortality from other causes, it is possible that not all of the deaths we captured were related to cancer.

Introduction

Housing is essential for health, with unhoused people having worse health status when compared to the general population.[1] The drivers of these disparities are multifactorial, and include poor access to primary and preventive care,[2,3] higher incidence of injuries,[4] higher rates of comorbid mental health and substance use disorders,[5] experiences of bias, stigma, and structural racism within the healthcare system,[6] and financial and logistical barriers to care.[7]

Cancer is a leading cause of death in older unhoused adults.[8] Understanding the best way to provide unhoused patients with the full spectrum of high-quality cancer care -- prevention, screening, disease-directed therapy, and surveillance/survivorship – is critical as this population continues to age.[5,9,10] Research on cancer in unhoused patients has focused on screening with limited work examining cancer outcomes.[11] Two studies in the United States examined cancer survival in the unhoused population: a 2015 study in Boston, which compared mortality rates of 316 homeless individuals with cancer to standardized mortality estimates[12] and a 2023 national study of over 5,000 unhoused patients examining all-cause survival in breast, lung, and colorectal cancers in veterans cared for in the Veteran Health Affairs (VA) setting.[13] While both studies found poorer survival outcomes for unhoused patients with cancer, the disparity was attenuated in the VA, possibly because of reduced financial and insurance barriers and increased support for unhoused patients.[14]

Cancer care for patients experiencing homelessness in public hospitals, which provide care for high proportions of patients experiencing homelessness, has not been explicitly evaluated.[15] Further, while 40% of single adults experience homelessness in unsheltered settings,[16] there have not been studies in populations where a large proportion experience unsheltered homelessness. We sought to examine the association between housing status, stage at diagnosis, and all-cause survival following cancer diagnosis at a public hospital.

Methods

Overall Design

We conducted a retrospective cohort study examining all new cancer diagnoses at Zuckerberg San Francisco General Hospital (ZSFG), a public hospital in San Francisco City and County that serves a diverse and under-resourced population; less than five percent of patients served have commercial insurance with the remainder being publicly insured or uninsured.[17,18] The UCSF Institutional Review Board reviewed and approved the study with a waiver of informed consent due to minimal risk to participants. We used STROBE guidelines to report our findings.[19]

Study Population

We identified all patients with a new cancer diagnosis from July 1, 2011-June 30, 2021 (fiscal year 2011-2012 through fiscal year 2020-2021) using the ZSFG Cancer Registry. We merged this cohort with the Coordinated Care Management System (CCMS). CCMS is an integrated data system implemented by the San Francisco Department of Public Health (DPH) that links physical, behavioral, and social health records.[20] A record is created in CCMS for any patient who a health care or social service worker determines to be unhoused; or who used county behavioral health, housing, or jail health services; or who used urgent or emergent medical services across physical, behavioral, and substance use domains. Based on these criteria, we

were able to link 75% of individuals in the cancer registry to individuals with CCMS records. More information on CCMS is available in the **Supplement**.

Exposure

Our exposure was housing status at time of diagnosis (housed, formerly unhoused, or unhoused). We defined patients as unhoused if they were identified in CCMS as unhoused in the same fiscal year as their cancer was diagnosed. Housing status identifiers came from any DPH or county system and included both observed (e.g. shelter use, housing navigation services, case management services, medical respite stays) and reported homelessness (e.g. during a physical or behavioral health clinical encounter). We characterized patients as formerly unhoused if they had a homeless identifier in CCMS during any fiscal year prior to cancer diagnosis, but not in the same year of diagnosis. We classified all other patients (including those who could not be linked to CCMS) as housed.

Outcome

Our primary outcome was all-cause mortality, which we obtained from the Cancer Registry which is required to search and match individual patient data with the state vital records files.[21] Our secondary outcomes were stage at diagnosis, inpatient admission for definitive treatment or diagnosis,[22] presentation at a multi-disciplinary tumor board, and evidence of care fragmentation. We classified patients who were diagnosed and received all treatment at ZSFG as having no care fragmentation. All others had evidence of care fragmentation either via diagnosis or partial treatment at other hospitals. We obtained these data from the ZSFG Cancer Registry. We additionally assessed what proportion of patients would have been classified as unhoused had we relied on Cancer Registry documentation alone.

Covariates

We extracted age at diagnosis, sex, race, ethnicity, marital status, smoking status, alcohol use, cancer site, stage at diagnosis, year of diagnosis, and date of death or last contact from the ZSFG Cancer Registry. We included information on race and ethnicity as a proxy for differential experiences of the healthcare system.[23] We calculated the Elixhauser score using comorbidity information from CCMS.[24]

Statistical Approach

We first performed univariate analyses to investigate differences in demographic and clinical characteristics by housing group. We then constructed Kaplan-Meier curves stratified by housing group to show unadjusted all-cause mortality, defining survival time as the interval between diagnosis date and death. We censored patients at the last contact date. Finally, we constructed multivariable Cox Proportional Hazards models to compare the hazard rate of mortality for each housing status group. We stratified the model into stage 0-3 and stage 4 disease because of evidence of non-proportionality in the survival curves due to this variable. We also stratified the model into two time periods: the first 100 days after diagnosis and beyond 100 days after diagnosis, given evidence of non-proportionality in the survival curves prior to 100 days and a hypothesis that outcomes in different housing groups would become more evident beyond the initial diagnosis and treatment interval. We then adjusted the models for age at diagnosis, sex, cancer site, race, ethnicity, marital status, smoking, alcohol use, Elixhauser score (which includes mental health comorbidities such as depression, psychosis, and substance use disorders), and

year of diagnosis. We used the Elixhauser score as a marker of total comorbidity burden rather than adjusting for each individual component. We additionally adjusted the Stage 0-3 model for individual stage. We conducted data analysis in Stata (Versions 16 and 18) from June 2023-March 2024.

Patient and Public Involvement

Patients and the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

Results

Population Characteristics

We identified 5,123 total new cancer diagnoses, with 4,062 (79%) in housed patients, 623 (12%) in formerly unhoused patients, and 9% (438) in unhoused patients. Follow up time after diagnosis ranged from 0-11.3 years with a mean of 3.6 years. The cohort was 54% male (n=2,086), 49% white (n=2,511), 32% Asian or Pacific Islander (n=1,615), and 18% Black (n=921). The most common cancer sites were lung (13%, n=675), breast (11%, n=576), colorectal (9%, n=453) and liver/biliary tract (9%, n=439). Thirty percent (N=130) of our unhoused cohort was classified as unhoused by the Cancer Registry alone, with the remainder identified only through CCMS documentation.

Univariate Analysis

Compared to housed, unhoused and formerly unhoused patients were more commonly male, Black, and single (**Table 1**). Unhoused and formerly unhoused patients had higher rates of current or prior smoking and alcohol use compared to housed.

Lung cancer was the most common cancer site in all housing status groups, though made up a higher proportion of diagnoses in unhoused and formerly unhoused patients when compared to housed counterparts (17% and 17%, compared to 12%). Liver and biliary tract cancers as well as cancers of the kidneys, ureters, and bladder also comprised a greater share in unhoused and formerly unhoused patients.

Stage at Diagnosis

Unhoused and formerly unhoused patients were more commonly diagnosed with Stage 4 disease (28% and 27% of the time, respectively, versus 22% of housed patients). Common cancer sites with the largest difference in proportion of Stage 4 disease between the unhoused and housed groups were in colorectal cancer (64% of unhoused patients [N=19] versus 26% of housed [N=100]) and breast cancer (34% [N=9] of unhoused patients versus 7% of housed [N=36]).

Care Pathways

The proportion of patients who were admitted to the hospital for definitive cancer treatment or diagnosis were similar between housing status groups (56% of unhoused patients, 54% of formerly unhoused patients, 54% of housed patients) (**Table 2**). A minority of patients were discussed at multidisciplinary tumor boards in all housing status groups (24% of unhoused, 30% of formerly unhoused and 22% of housed). Formerly unhoused patients less commonly had fragmented care than the other groups (30% versus 35% of unhoused and 36% of housed).

Kaplan-Meier Curves
Housed patients had significantly better all-cause survival when compared to unhoused and formerly unhoused patients (**Figure 1**). This relationship persisted when stratifying the curves into Stage 0-3 and Stage 4 disease.

Cox Proportional Hazard Model
After adjustment, unhoused patients with Stage 0-3 disease had a 50% increased hazard of death (adjusted hazard ratio [aHR] 1.5, 95% CI 1.1-1.9; p<0.004) as did formerly unhoused patients (aHR 1.5, 95%CI 1.2-1.9; p=0.001) compared to housed individuals three months after diagnosis (**Table 3**). Unhoused patients with Stage 4 disease had 50% increased hazard of death (aHR 1.5, 95% CI 1.1-2.1; p=0.014) compared to housed patients. Formerly unhoused patients with Stage 4 disease did not have a statistically significantly different hazard of death when compared to housed patients.

Discussion

In this study of over 5,000 patients with new cancer diagnoses at a San Francisco public hospital, unhoused and formerly unhoused patients diagnosed with non-metastatic cancer had substantially increased hazards of death three months after diagnosis compared to housed patients cared for in the same setting. ZSFG cares for a diverse and under-resourced group of patients, with 84% of patients identifying as non-White, less than 5% of patients having any private insurance, and many having limited English proficiency.[17] However, even in this setting, in which healthcare teams commonly provide care to underserved patients, unhoused and formerly unhoused patients had substantially worse all-cause survival after cancer diagnosis.

Lack of housing could contribute to worse outcomes following cancer diagnoses via multiple potential mechanisms. Prior research has highlighted that unhoused patients face multiple challenges to accessing scheduled outpatient care,[25] including inconsistent access to phones and other forms of communication,[26] vulnerability to external forces,[27] transportation challenges, experiences of bias and stigma in healthcare[28] and more. All of these factors may play a role in cancer care, which is complex, multidisciplinary, and longitudinal.[29] Clinicians and unhoused patients may also be hesitant to pursue complex treatment regimens due to competing health priorities;[30] prior research has reported lower rates of high-intensity care for acute cardiovascular conditions in unhoused adults.[31] These factors may contribute to reduced initiation and completion of guideline-concordant care which may lead to disparate outcomes. In the present study, we were unable to examine treatment courses for each combination of cancer site and stage given our sample size. While there were no large differences in the proportion of patients admitted for definitive cancer treatment, discussed at multidisciplinary tumor boards, or who had evidence of care fragmentation based on housing status, the question of cancer care delivery in unhoused patients warrants future study.[11]

Of note, our findings here are more pronounced than what was observed in lung, colorectal, and breast cancer outcomes in unhoused patients at the VA,[13] which has universal coverage for its beneficiaries and has a multi-pronged, coordinated approach to preventing and reducing homelessness among veterans.[32] The VA is a unique, integrated system of care with dedicated investment for addressing health needs of homeless veterans and ending homelessness. Prior study has highlighted that 20% of unhoused veterans diagnosed with cancer gained housing in

the year after diagnosis and that gaining housing was associated with improved cancer outcomes.[33] Without this type of structure and resources, it may be difficult for public hospital systems to conduct the intensive outreach and longitudinal care coordination needed to improve cancer outcomes in unhoused patients. However, there may be strategies from the VA that can be adopted to reduce inequities in cancer outcomes.

Formerly unhoused and unhoused patients were more commonly diagnosed with metastatic disease than housed. This finding was pronounced in cancers that can be screened for, such as colorectal and breast cancer. Prior research has demonstrated lower rates of cancer screening in unhoused patients than in their housed counterparts.[34–37] Screening for colon cancer specifically may pose challenges in unhoused patients, who have poorer access to water, sanitation, and hygiene facilities, including private bathrooms for colon preparation or stool-based tests.[38] Presentation at later stages may also be related to poorer access to primary or preventive care for symptom evaluation.[3] Other work has highlighted that unhoused patients more commonly underwent emergent operations for cancer than housed, which suggests that patients may have delayed evaluation of cancer-related symptoms.[39] Even in unhoused patients that do access primary care, clinicians may opt to focus on other real or perceived higher-priority needs.[30]

In our study, both unhoused and formerly unhoused patients had worse cancer-related outcomes when compared to housed counterparts. This may be related to poorly addressed risk factors for cancer during the period of homelessness, persisting experiences of bias and stigma in healthcare systems, among other factors. We could not assess the quality of housing with our data, which may be variable among the formerly unhoused group. Given the increased interest in health-related social needs screening in health systems – including new requirements from Centers from Medicaid Services that hospitals screen patients for health-related social needs beginning in 2024[40] – it is important to note that both ongoing homelessness and a history of homelessness were associated with worse outcomes. Homelessness screening tools should consider assessing a history of homelessness as well, which may be associated with ongoing vulnerabilities that impact health and access to care.

There are several policies that may be beneficial for unhoused patients with new cancer diagnoses. First, research has highlighted that veterans who gained housing after cancer diagnosis had improved outcomes compared to those who experienced continued homelessness.[33] Housing may improve cancer outcomes by reducing competing priorities and improving the ability to receive outpatient cancer care, health maintenance, and surveillance. As insurers and health systems have increased interest in addressing upstream health-related social needs, including direct investments in housing, more research is essential to understand where resource allocation may be most impactful in improving health.[41] Second, states may modify their Medicaid programs via Section 1115 waivers, which have been used to expand Medicaid coverage, enhance care coordination, and address upstream social determinants of health.[42] In California's program (California Advancing and Innovating Medi-Cal [CalAIM]) unhoused individuals with at least one complex medical problem, such as cancer, are eligible for enhanced case management, which includes a lead care manager to coordinate doctors, specialists, pharmacists, case managers, social services providers and others.[43] This program was initiated in July 2023 and may help unhoused patients with cancer given the complexity of care coordination after a new cancer diagnosis. Additionally, as part of Cal-AIM there are community supports

related to housing navigation and post-hospitalization housing services. Several states have included medical respite in these Medicaid waivers,[42] which provides a place for unhoused patients to recuperate after hospital care and provide shelter, medical care, and social services.[44] Medical respite use has been associated with fewer readmissions and shorter hospital lengths of stay in unhoused patients with complex medical problems, including cancer.[45] Further work should explore barriers to medical respite utilization, which may include lack of inpatient provider knowledge of medical respite as an option, bed availability constraints, or patient-level barriers, among others. Evaluation of these waivers is essential to assess if this type of support improves outcomes in unhoused patients with cancer.

This study has certain limitations. First, there is the risk of misclassification of our exposure (housing status), which would bias our results towards the null. We attempted to capture the unhoused and formerly unhoused populations more robustly by using a novel, city-wide data source that tracks both observed and reported homelessness. When compared to the Cancer Registry documentation alone, we were able to identify over three times the number of unhoused individuals. Our outcome measure is all-cause mortality, not cancer-specific mortality. As unhoused individuals have increased rates of mortality from other causes (including poorly managed chronic health conditions, injury, and substance use disorders),[47] it is possible that not all of the deaths we captured were related to cancer. Finally, this is a single center with a small sample size for each individual cancer, so results may not be generalizable to other settings.

Conclusion

Unhoused and formerly unhoused patients with cancer are more commonly diagnosed with metastatic disease and have up to 50% poorer survival after cancer diagnosis even when compared to other patients cared for in a public hospital setting. There are multiple mechanisms by which lack of housing could contribute to poorer outcomes in this group. There are policies that may be beneficial for unhoused patients with new cancer diagnoses that ought to be further explored.

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Hannah Decker: Conception and design of the work, analysis and interpretation of data, drafting the work.

Sara Colom-Brana: Acquisition, analysis and interpretation of data, critical review of work for important intellectual content

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All authors gave final approval of the manuscript and agree to be accountable for all aspects of the work.

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Table 1: Demographic and Clinical Characteristics, Stratified by Housing Status

	Housed	Formerly Unhoused	Unhoused	p-value
	N=4,062	N=623	N=438	
Age at Diagnosis (Median, IQR)	61 (52,68)	60 (55,66)	58 (51,64)	<0.001
Sex				<0.001
Male	49.8 (2,024)	71.6 (446)	76.7 (336)	
Female	49.9 (2,026)	27.1 (169)	22.4 (98)	
Race				<0.001
White	49.0 (1,992)	47.5 (296)	50.9 (223)	
Black	11.2 (453)	45.6 (284)	42.0 (184)	
Asian or Pacific Islander	38.3 (1,555)	5.5 (34)	5.9 (26)	
Other	1.5 (62)	1.4 (9)	1.1 (5)	
Marital Status				<0.001
Married or Domestic Partner	34.7 (1,408)	7.5 (47)	5.5 (24)	
Single, Separated, Divorced, Widowed	56.6 (2,301)	82.5 (514)	81.5 (357)	
Elixhauser Score (Median, IQR)	9 (0,19)	15 (4,24)	9 (0,21)	<0.001
Smoking Status				<0.001
None	68.5 (2,783)	40.1 (250)	43.2 (189)	
Current Use	15.7 (639)	45.3 (282)	46.3 (203)	
Previous Use	14.1 (573)	13.6 (85)	8.7 (38)	
Alcohol Use				<0.001
None	76.6 (3,112)	59.9 (373)	64.6 (283)	
Current Use	12.0 (488)	23.3 (145)	20.5 (90)	
Previous Use	5.4 (220)	10.6 (66)	8.9 (39)	
Site				<0.001
Lung	12.1 (493)	17.2 (107)	17.1 (75)	
Breast	12.8 (520)	4.8 (30)	5.9 (26)	
Colorectal	9.3 (379)	7.4 (46)	6.4 (28)	

Liver and Biliary Tract	7.2 (292)	14.4 (90)	13.0 (57)	
Kidneys, Ureter, Bladder, and other Urinary Tract	6.9 (279)	8.5 (53)	9.6 (42)	
Female Reproductive Tract	7.7 (311)	3.7 (23)	3.0 (13)	
Prostate	5.4 (219)	7.1 (44)	8.2 (36)	
Head and Neck	4.9 (198)	10.3 (64)	6.4 (28)	
Nervous System, Including Brain	5.0 (205)	3.4 (21)	3.2 (14)	
Blood or Bone Marrow	4.2 (171)	3.5 (22)	4.6 (20)	
Lymph Nodes	3.2 (129)	3.0 (19)	3.7 (16)	
Skin	3.1 (125)	1.9 (12)	4.3 (19)	
Thyroid	3.2 (130)	0.3 (2)	2.5 (11)	
Stomach	3.0 (120)	1.9 (12)	2.1 (9)	
Pancreas	2.4 (98)	3.0 (19)	0.5 (2)	
Other	9.7 (393)	9.5 (59)	9.6 (42)	
Stage at Diagnosis				<0.001
Stage 0-3	78.0 (3,168)	73.4 (457)	71.7 (314)	
Stage 4	22.0 (894)	26.6 (166)	28.3 (124)	

a – Numbers may not sum due to 100% due to missing data.

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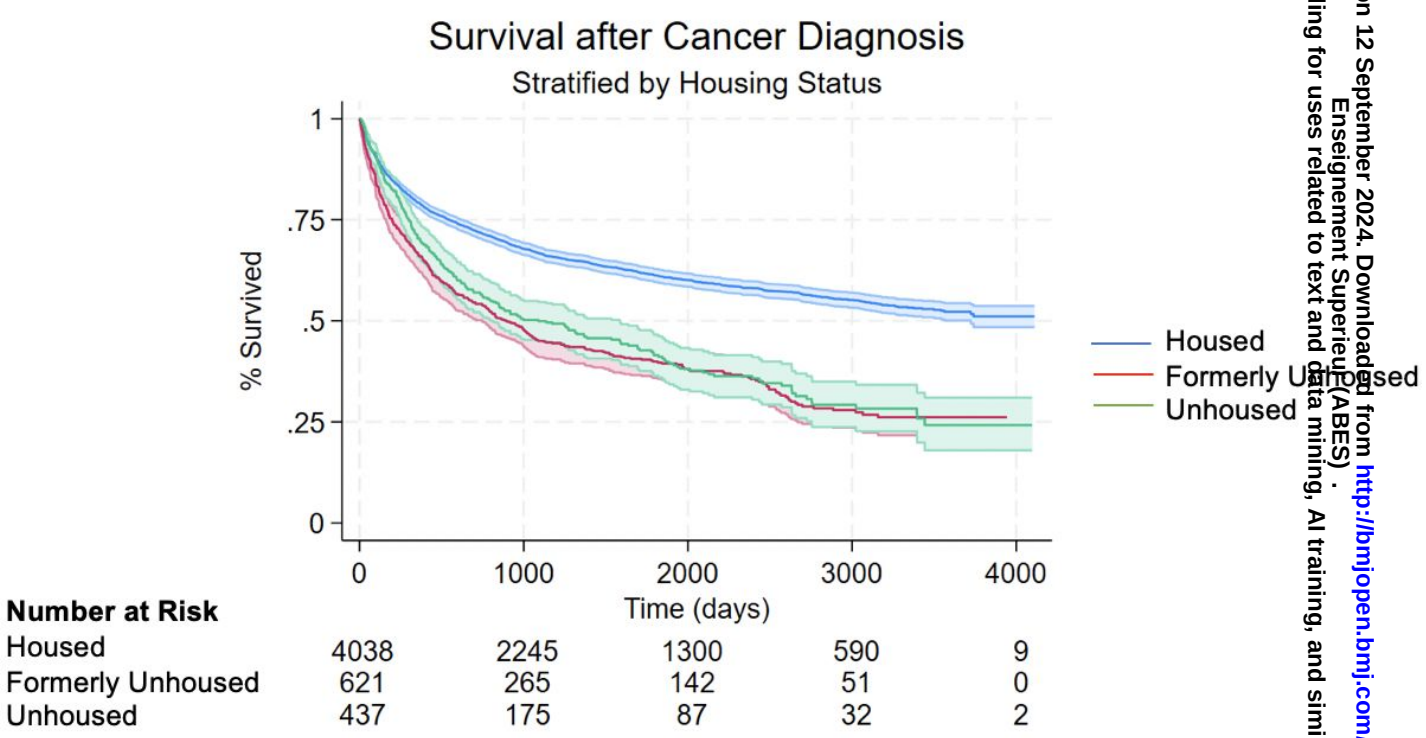
Table 2: Cancer Care Coordination, Stratified by Housing Status

	Housed	Formerly Unhoused	Unhoused	p-value
	N=4,062	N=623	N=438	
Admitted for Cancer Treatment				0.81
No	45.7 (1,858)	46.5 (290)	44.5 (194)	
Yes	54.2 (2,200)	53.5 (333)	55.5 (244)	
Presented at Multidisciplinary Tumor Board				<0.001
No	78.5 (3,187)	70.0 (436)	76.1 (335)	
Yes	21.5 (875)	30.0 (187)	23.9 (103)	
Evidence of Care Fragmentation	52 (26,84)	52.5 (20.5,87.5)	49 (11,81)	0.25
No	63.6 (2,583)	69.6 (434)	64.6 (283)	0.015
Yes	36.4 (1,478)	30.4 (190)	35.4 (155)	

Figure 1: Kaplan Meier Survival Estimates, Stratified by Housing Group



Number at Risk					
Housed	4038	2245	1300	590	9
Formerly Unhoused	621	265	142	51	0
Unhoused	437	175	87	32	2

Table 3: Cox Proportional Hazard Model for All-Cause Mortality 3 Months After Cancer Diagnosis, Stratified by Stage and Housing Status

	Stage 0-3				Stage 4			
Housing Category	**>3 months**				**>3 months**			
	Unadjusted (95% CI)	P value	Adjusted* (95% CI)	P value	Unadjusted (95% CI)	P value	Adjusted* (95% CI)	P value
Housed	Reference	--	--	--	Reference	--	--	--
Formerly Unhoused	2.3 (1.9-2.6)	**<0.001**	1.5 (1.2-1.9)	**0.001**	1.4 (1.1-1.7)	**0.003**	1.2 (0.9-1.6)	0.266
Unhoused	2.3 (1.9-2.7)	**<0.001**	1.5 (1.1-1.9)	**0.004**	1.6 (1.2-2.0)	**<0.001**	1.5 (1.1-2.1)	**0.014**

**Adjusted for age at diagnosis, stage of cancer, site of cancer, race, ethnicity, marital status, smoking, alcohol, Elixhauser score, sex, and year of diagnosis*

Supplemental Methods

Description of Coordinated Care Management System (CCMS)

CCMS is an integrated data system hosted by the San Francisco Department of Public Health (DPH) that links information about service use across mental health, physical health, substance use, and social health domains in a vulnerable, complex, and high-risk population.

The following services are included in the dataset:

- Medical Urgent/Emergent Services
  - Medical hospital stays
  - Emergency department visits
  - Medical urgent care visits
- Psychiatric/Mental Health
  - Mental health hospital stays
  - Psychiatric emergency service visits
  - Mental health urgent care visits
- Substance use urgent/emergent services
  - Sobering center visits
  - Substance use disorder medical detoxification stays
  - Substance use disorder social detoxification stays
- Social services
  - Jail health days
  - Medical respite days

Description of CCMS Record Creation

A CCMS record is created for any patient observed or reported to be homeless in a DPH or county housing system; engaged with county behavioral health, housing, or jail services; or engaged with urgent/emergent services across physical health, mental health, substance use, or social health domains.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, explain how loss to follow-up was addressed	6
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	16-17
		(c) Summarise follow-up time (eg, average and total amount)	19
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	7-8
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Association of Housing Status and Cancer Diagnosis, Care Coordination, and Outcomes in a Public Hospital: A Retrospective Cohort Study

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Running Head: Housing Status and Cancer in a Public Hospital

Abstract (277 words)

Objectives: Cancer is a leading cause of death in unhoused adults. We sought to examine the association between housing status, stage at diagnosis, and all-cause survival following cancer diagnosis at a public hospital.

Design: Retrospective cohort study examining new cancer diagnoses between July 1, 2011 and June 30, 2021

Setting: A public hospital in San Francisco

Exposure: Housing status (housed, formerly unhoused, unhoused) was ascertained via a county-wide integrated dataset that tracks both observed and reported homelessness.

Methods: We reported univariate analyses to investigate differences in demographic and clinical characteristics by housing group. We then constructed Kaplan-Meier curves stratified by housing group to examine unadjusted all-cause mortality. Finally, we used multivariable Cox Proportional Hazards models to compare the hazard rate of mortality for each housing status group, adjusting for demographic and clinical factors.

Results: Our cohort included 5,123 patients with new cancer diagnoses, with 4,062 (79%) in housed patients, 623 (12%) in formerly unhoused patients, and 9% (438) in unhoused patients. Unhoused and formerly unhoused patients were more commonly diagnosed with Stage 4 disease (28% and 27% of the time, respectively, versus 22% of housed patients). After adjusting for demographic and clinical characteristics, unhoused patients with Stage 0-3 disease had a 50% increased hazard of death (adjusted hazard ratio [aHR] 1.5, 95% CI 1.1-1.9; p<0.004) as did formerly unhoused patients (aHR 1.5, 95%CI 1.2-1.9; p=0.001) compared to housed individuals three months after diagnosis.

Conclusions: Unhoused and formerly unhoused patients diagnosed with non-metastatic cancer had substantially increased hazards of death compared to housed patients cared for in a public hospital setting. Current or former lack of housing could contribute to poor outcomes following cancer diagnoses via multiple mechanisms.

Strengths and Limitations of this Study

Strengths:

- This study uses a county-wide integrated dataset to determine housing status, which reduces misclassification of the exposure.
- This dataset allows identification of formerly unhoused patients.

Limitations:

- This is a single center study which limits generalizability to other settings.
- Our outcome measure is all-cause mortality, not disease-specific mortality.
- Given the observational nature of the study, there may be unmeasured confounding factors.

Introduction

Housing is essential for health, with unhoused people having worse health status when compared to the general population.[1] The drivers of these disparities are multifactorial, and include poor access to primary and preventive care,[2,3] higher incidence of injuries,[4] higher rates of comorbid mental health and substance use disorders,[5] experiences of bias, stigma, and structural racism within the healthcare system,[6] and financial and logistical barriers to care.[7]

Cancer is a leading cause of death in older unhoused adults.[8] Understanding the best way to provide unhoused patients with the full spectrum of high-quality cancer care -- prevention, screening, disease-directed therapy, and surveillance/survivorship – is critical as this population continues to age.[5,9,10] Research on cancer in unhoused patients has focused on screening with limited work examining cancer outcomes.[11] Two studies in the United States examined cancer survival in the unhoused population: a 2015 study in Boston, which compared mortality rates of 316 homeless individuals with cancer to standardized mortality estimates[12] and a 2023 national study of over 5,000 unhoused patients examining all-cause survival in breast, lung, and colorectal cancers in veterans cared for in the Veteran Health Affairs (VA) setting.[13] While both studies found poorer survival outcomes for unhoused patients with cancer, the disparity was attenuated in the VA, possibly because of reduced financial and insurance barriers and increased support for unhoused patients.[14]

Cancer care for patients experiencing homelessness in public hospitals, which provide care for high proportions of patients experiencing homelessness, has not been explicitly evaluated.[15] Public hospitals may have more developed programs and policies in place to care for socially marginalized patients as well as different financial and material constraints when compared to other settings. Further, while 40% of single adults experience homelessness in unsheltered settings,[16] there have not been studies in populations where a large proportion experience unsheltered homelessness. We sought to examine the association between housing status, stage at diagnosis, and all-cause survival following cancer diagnosis at a public hospital. We hypothesized that unhoused patients would be diagnosed with later states of cancer and have poorer all-cause survival.

Methods

Overall Design

We conducted a retrospective cohort study examining all new cancer diagnoses at Zuckerberg San Francisco General Hospital (ZSFG), a public hospital in San Francisco City and County that serves a diverse and under-resourced population; less than five percent of patients served have commercial insurance with the remainder being publicly insured or uninsured.[17,18] This study used identifiable data for data linkage. The UCSF Institutional Review Board reviewed and approved the study with a waiver of informed consent due to minimal risk to participants. We used STROBE guidelines to report our findings.[19]

Study Population

We identified all patients with a new cancer diagnosis from July 1, 2011-June 30, 2021 (fiscal year 2011-2012 through fiscal year 2020-2021) using the ZSFG Cancer Registry. We merged this cohort with the Coordinated Care Management System (CCMS). More information on the data systems and linkages available in the **Supplement**. CCMS is an integrated data system

implemented by the San Francisco Department of Public Health (DPH) that links physical, behavioral, and social health records.[20] A record is created in CCMS for any patient who a health care or social service worker determines to be unhoused; or who used county behavioral health, housing, or jail health services; or who used urgent or emergent medical services across physical, behavioral, and substance use domains. Based on these criteria, we were able to link 75% of individuals in the cancer registry to individuals with CCMS records.

Exposure

Our exposure was housing status at time of diagnosis, which we categorized as housed, formerly unhoused, or unhoused. We defined patients as unhoused if they were identified in CCMS as unhoused in the same fiscal year as their cancer was diagnosed. Housing status identifiers came from any DPH or county system and included both observed (e.g. shelter use, housing navigation services, case management services, medical respite stays) and reported homelessness (e.g. during a physical or behavioral health clinical encounter). We characterized patients as formerly unhoused if they had a homeless identifier in CCMS during any fiscal year prior to cancer diagnosis, but not in the same year of diagnosis. We classified all other patients (including those who could not be linked to CCMS) as housed.

Outcome

Our primary outcome was all-cause mortality, which we obtained from the Cancer Registry which is required to search and match individual patient data with the state vital records files.[21] Our secondary outcomes were stage at diagnosis, inpatient admission for definitive treatment or diagnosis,[22] presentation at a multi-disciplinary tumor board, and evidence of care fragmentation. We classified patients who were diagnosed and received all treatment at ZSFG as having no care fragmentation. All others had evidence of care fragmentation either via diagnosis or partial treatment at other hospitals. We obtained these data from the ZSFG Cancer Registry. We additionally assessed what proportion of patients would have been classified as unhoused had we relied on Cancer Registry documentation alone.

Covariates

We extracted age at diagnosis, sex, race, ethnicity, marital status, smoking status, alcohol use, cancer site, stage at diagnosis, year of diagnosis, and date of death or last contact from the ZSFG Cancer Registry. We included information on race and ethnicity as a proxy for differential experiences of the healthcare system.[23] We calculated the Elixhauser score using comorbidity information from CCMS.[24]

Statistical Approach

We first performed univariate analyses to investigate differences in demographic and clinical characteristics by housing group. We then constructed Kaplan-Meier curves stratified by housing group to show unadjusted all-cause mortality, defining survival time as the interval between diagnosis date and death. We censored patients at the last contact date. Finally, we constructed multivariable Cox Proportional Hazards models to compare the hazard rate of mortality for each housing status group. We stratified the model into stage 0-3 and stage 4 disease because of evidence of non-proportionality in the survival curves due to this variable. We also stratified the model into two time periods: the first 100 days after diagnosis and beyond 100 days after diagnosis, given evidence of non-proportionality in the survival curves prior to 100 days and a

hypothesis that outcomes in different housing groups would become more evident beyond the initial diagnosis and treatment interval. We then adjusted the models for age at diagnosis, sex, cancer site, race, ethnicity, marital status, smoking, alcohol use, Elixhauser score (which includes mental health comorbidities such as depression, psychosis, and substance use disorders), and year of diagnosis. We used the Elixhauser score as a marker of total comorbidity burden rather than adjusting for each individual component. We additionally adjusted the Stage 0-3 model for individual stage. We conducted data analysis in Stata (Versions 16 and 18) from June 2023-March 2024.

Patient and Public Involvement

Patients and the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Results

Population Characteristics

We identified 5,123 total new cancer diagnoses, with 4,062 (79%) in housed patients, 623 (12%) in formerly unhoused patients, and 9% (438) in unhoused patients. Follow up time after diagnosis ranged from 0-11.3 years with a mean of 3.6 years. The cohort was 54% male (n=2,086), 49% white (n=2,511), 32% Asian or Pacific Islander (n=1,615), and 18% Black (n=921). The most common cancer sites were lung (13%, n=675), breast (11%, n=576), colorectal (9%, n=453) and liver/biliary tract (9%, n=439). Thirty percent (N=130) of our unhoused cohort was classified as unhoused by the Cancer Registry alone, with the remainder identified only through CCMS documentation.

Univariate Analysis

Compared to housed, unhoused and formerly unhoused patients were more commonly male, Black, and single (**Table 1**). Unhoused and formerly unhoused patients had higher rates of current or prior smoking and alcohol use compared to housed.

Lung cancer was the most common cancer site in all housing status groups, though made up a higher proportion of diagnoses in unhoused and formerly unhoused patients when compared to housed counterparts (17% and 17%, compared to 12%). Liver and biliary tract cancers as well as cancers of the kidneys, ureters, and bladder also comprised a greater share in unhoused and formerly unhoused patients.

Stage at Diagnosis

Unhoused and formerly unhoused patients were more commonly diagnosed with Stage 4 disease (28% and 27% of the time, respectively, versus 22% of housed patients). Common cancer sites with the largest difference in proportion of Stage 4 disease between the unhoused and housed groups were in colorectal cancer (64% of unhoused patients [N=19] versus 26% of housed [N=100]) and breast cancer (34% [N=9] of unhoused patients versus 7% of housed [N=36]).

Care Pathways

The proportion of patients who were admitted to the hospital for definitive cancer treatment or diagnosis were similar between housing status groups (56% of unhoused patients, 54% of formerly unhoused patients, 54% of housed patients) (**Table 2**). A minority of patients were

discussed at multidisciplinary tumor boards in all housing status groups (24% of unhoused, 30% of formerly unhoused and 22% of housed). Formerly unhoused patients less commonly had fragmented care than the other groups (30% versus 35% of unhoused and 36% of housed).

Kaplan-Meier Curves

Housed patients had significantly better all-cause survival when compared to unhoused and formerly unhoused patients (**Figure 1**). This relationship persisted when stratifying the curves into Stage 0-3 and Stage 4 disease.

Cox Proportional Hazard Model

After adjustment, unhoused patients with Stage 0-3 disease had a 50% increased hazard of death (adjusted hazard ratio [aHR] 1.5, 95% CI 1.1-1.9; p<0.004) as did formerly unhoused patients (aHR 1.5, 95%CI 1.2-1.9; p=0.001) compared to housed individuals three months after diagnosis (**Table 3**). Unhoused patients with Stage 4 disease had 50% increased hazard of death (aHR 1.5, 95% CI 1.1-2.1; p=0.014) compared to housed patients. Formerly unhoused patients with Stage 4 disease did not have a statistically significantly different hazard of death when compared to housed patients.

Discussion

In this study of over 5,000 patients with new cancer diagnoses at a San Francisco public hospital, unhoused and formerly unhoused patients diagnosed with non-metastatic cancer had substantially increased hazards of death three months after diagnosis compared to housed patients cared for in the same setting. ZSFG cares for a diverse and under-resourced group of patients, with 84% of patients identifying as non-White, less than 5% of patients having any private insurance, and many having limited English proficiency.[17] However, even in this setting, in which healthcare teams commonly provide care to underserved patients, unhoused and formerly unhoused patients had substantially worse all-cause survival after cancer diagnosis.

Lack of housing could contribute to worse outcomes following cancer diagnoses via multiple potential mechanisms. Prior research has highlighted that unhoused patients face multiple challenges to accessing scheduled outpatient care,[25] including inconsistent access to phones and other forms of communication,[26] vulnerability to external forces,[27] transportation challenges, experiences of bias and stigma in healthcare[28] and more. All of these factors may play a role in cancer care, which is complex, multidisciplinary, and longitudinal.[29] Clinicians and unhoused patients may also be hesitant to pursue complex treatment regimens due to competing health priorities;[30] prior research has reported lower rates of high-intensity care for acute cardiovascular conditions in unhoused adults.[31] These factors may contribute to reduced initiation and completion of guideline-concordant care which may lead to disparate outcomes. In the present study, we were unable to examine treatment courses for each combination of cancer site and stage given our sample size. While there were no large differences in the proportion of patients admitted for definitive cancer treatment, discussed at multidisciplinary tumor boards, or who had evidence of care fragmentation based on housing status, the question of cancer care delivery in unhoused patients warrants future study.[11]

Of note, our findings here are more pronounced than what was observed in lung, colorectal, and breast cancer outcomes in unhoused patients at the VA,[13] which has universal coverage for its

beneficiaries and has a multi-pronged, coordinated approach to preventing and reducing homelessness among veterans.[32] The VA is a unique, integrated system of care with dedicated investment for addressing health needs of homeless veterans and ending homelessness. Prior study has highlighted that 20% of unhoused veterans diagnosed with cancer gained housing in the year after diagnosis and that gaining housing was associated with improved cancer outcomes.[33] Without this type of structure and resources, it may be difficult for public hospital systems to conduct the intensive outreach and longitudinal care coordination needed to improve cancer outcomes in unhoused patients. However, there may be strategies from the VA that can be adopted to reduce inequities in cancer outcomes.

Formerly unhoused and unhoused patients were more commonly diagnosed with metastatic disease than housed. This finding was pronounced in cancers that can be screened for, such as colorectal and breast cancer. Prior research has demonstrated lower rates of cancer screening in unhoused patients than in their housed counterparts.[34–37] Screening for colon cancer specifically may pose challenges in unhoused patients, who have poorer access to water, sanitation, and hygiene facilities, including private bathrooms for colon preparation or stool-based tests.[38] Presentation at later stages may also be related to poorer access to primary or preventive care for symptom evaluation.[3] Other work has highlighted that unhoused patients more commonly underwent emergent operations for cancer than housed, which suggests that patients may have delayed evaluation of cancer-related symptoms.[39] Even in unhoused patients that do access primary care, clinicians may opt to focus on other real or perceived higher-priority needs.[30]

In our study, both unhoused and formerly unhoused patients had worse cancer-related outcomes when compared to housed counterparts. This may be related to poorly addressed risk factors for cancer during the period of homelessness, persisting experiences of bias and stigma in healthcare systems, among other factors. We could not assess the quality of housing with our data, which may be variable among the formerly unhoused group. Given the increased interest in health-related social needs screening in health systems – including new requirements from Centers from Medicaid Services that hospitals screen patients for health-related social needs beginning in 2024[40] – it is important to note that both ongoing homelessness and a history of homelessness were associated with worse outcomes. Homelessness screening tools should consider assessing a history of homelessness as well, which may be associated with ongoing vulnerabilities that impact health and access to care. Poverty is also significantly associated with later stages of cancer diagnosis and poorer survival.[41] As poverty and homelessness are inextricably linked in settings with high housing prices, unhoused and formerly unhoused individuals experience the stressors of poverty that are likely compounded by lack of safe and secure housing as well as bias and stigma against people experiencing homelessness.

There are several policies that may be beneficial for unhoused patients with new cancer diagnoses. First, research has highlighted that veterans who gained housing after cancer diagnosis had improved outcomes compared to those who experienced continued homelessness.[33] Housing may improve cancer outcomes by reducing competing priorities and improving the ability to receive outpatient cancer care, health maintenance, and surveillance. As insurers and health systems have increased interest in addressing upstream health-related social needs, including direct investments in housing, more research is essential to understand where resource allocation may be most impactful in improving health.[42] Second, states may modify

their Medicaid programs via Section 1115 waivers, which have been used to expand Medicaid coverage, enhance care coordination, and address upstream social determinants of health.[43] In California's program (California Advancing and Innovating Medi-Cal [CalAIM]) unhoused individuals with at least one complex medical problem, such as cancer, are eligible for enhanced case management, which includes a lead care manager to coordinate doctors, specialists, pharmacists, case managers, social services providers and others.[44] This program was initiated in July 2023 and may help unhoused patients with cancer given the complexity of care coordination after a new cancer diagnosis. Additionally, as part of Cal-AIM there are community supports related to housing navigation and post-hospitalization housing services. Several states have included medical respite in these Medicaid waivers,[43] which provides a place for unhoused patients to recuperate after hospital care and provide shelter, medical care, and social services.[45] Medical respite use has been associated with fewer readmissions and shorter hospital lengths of stay in unhoused patients with complex medical problems, including cancer.[46] Further work should explore barriers to medical respite utilization, which may include lack of inpatient provider knowledge of medical respite as an option, bed availability constraints, or patient-level barriers, among others. Evaluation of these waivers is essential to assess if this type of support improves outcomes in unhoused patients with cancer.

This study has certain limitations. First, there is the risk of misclassification of our exposure (housing status), which would bias our results towards the null. We attempted to capture the unhoused and formerly unhoused populations more robustly by using a novel, city-wide data source that tracks both observed and reported homelessness. When compared to the Cancer Registry documentation alone, we were able to identify over three times the number of unhoused individuals. Our outcome measure is all-cause mortality, not cancer-specific mortality. As unhoused individuals have increased rates of mortality from other causes (including poorly managed chronic health conditions, injury, and substance use disorders),[47] it is possible that not all of the deaths we captured were related to cancer. Finally, this is a single center with a small sample size for each individual cancer, so results may not be generalizable to other settings.

Conclusion

Unhoused and formerly unhoused patients with cancer are more commonly diagnosed with metastatic disease and have up to 50% poorer survival after cancer diagnosis even when compared to other patients cared for in a public hospital setting. There are multiple mechanisms by which lack of housing could contribute to poorer outcomes in this group. There are policies that may be beneficial for unhoused patients with new cancer diagnoses that ought to be further explored.

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Competing Interests

Outside of the published work, Dr. Decker is a National Clinician Scholar with salary support from the VA and receives person fees from Moon Surgical. Dr. Kanzaria's salary is supported by a grant from the Benioff Homelessness and Housing Initiative, University of California, San Francisco, CA and he works as an advisor for Amae Health. Dr. Kushel is on the Board of Housing California, National Homelessness Law Center and Steinberg Institute (K24 2K24AG046372 and BHHI).

Author Contributions:

Hannah Decker: Conception and design of the work, analysis and interpretation of data, drafting the work.

Sara Colom-Brana: Acquisition, analysis and interpretation of data, critical review of work for important intellectual content

Jennifer Evans: Interpretation of data, critical review of work for important intellectual content

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Margot Kushel: Conception and design of the work, interpretation of data, critical review of work for important intellectual content

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Maria Raven: Conception and design of the work, interpretation of data, critical review of work for important intellectual content

Hemal Kanzaria: Conception and design of the work, acquisition and interpretation of data, critical review of work for important intellectual content, oversight and leadership

All authors gave final approval of the manuscript and agree to be accountable for all aspects of the work. HD acts as the guarantor.

Data sharing statement

This dataset contains sensitive information including housing status, interaction with the criminal justice system, behavioral health system, and more and cannot be publicly shared.

Ethics approval

This study involved human subjects and was approved by the UCSF Institutional Review Board (22-36473) with a waiver of informed consent due to minimal risk to participants.

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Table 1: Demographic and Clinical Characteristics, Stratified by Housing Status

	Housed	Formerly Unhoused	Unhoused	p-value
	N=4,062	N=623	N=438	
Age at Diagnosis (Median, IQR)	61 (52,68)	60 (55,66)	58 (51,64)	<0.001
Sex				<0.001
Male	49.8 (2,024)	71.6 (446)	76.7 (336)	
Female	49.9 (2,026)	27.1 (169)	22.4 (98)	
Race				<0.001
White	49.0 (1,992)	47.5 (296)	50.9 (223)	
Black	11.2 (453)	45.6 (284)	42.0 (184)	
Asian or Pacific Islander	38.3 (1,555)	5.5 (34)	5.9 (26)	
Other	1.5 (62)	1.4 (9)	1.1 (5)	
Marital Status				<0.001
Married or Domestic Partner	34.7 (1,408)	7.5 (47)	5.5 (24)	
Single, Separated, Divorced, Widowed	56.6 (2,301)	82.5 (514)	81.5 (357)	
Elixhauser Score (Median, IQR)	9 (0,19)	15 (4,24)	9 (0,21)	<0.001
Smoking Status				<0.001
None	68.5 (2,783)	40.1 (250)	43.2 (189)	
Current Use	15.7 (639)	45.3 (282)	46.3 (203)	
Previous Use	14.1 (573)	13.6 (85)	8.7 (38)	
Alcohol Use				<0.001
None	76.6 (3,112)	59.9 (373)	64.6 (283)	
Current Use	12.0 (488)	23.3 (145)	20.5 (90)	
Previous Use	5.4 (220)	10.6 (66)	8.9 (39)	
Site				<0.001
Lung	12.1 (493)	17.2 (107)	17.1 (75)	
Breast	12.8 (520)	4.8 (30)	5.9 (26)	
Colorectal	9.3 (379)	7.4 (46)	6.4 (28)	

Liver and Biliary Tract	7.2 (292)	14.4 (90)	13.0 (57)	
Kidneys, Ureter, Bladder, and other Urinary Tract	6.9 (279)	8.5 (53)	9.6 (42)	
Female Reproductive Tract	7.7 (311)	3.7 (23)	3.0 (13)	
Prostate	5.4 (219)	7.1 (44)	8.2 (36)	
Head and Neck	4.9 (198)	10.3 (64)	6.4 (28)	
Nervous System, Including Brain	5.0 (205)	3.4 (21)	3.2 (14)	
Blood or Bone Marrow	4.2 (171)	3.5 (22)	4.6 (20)	
Lymph Nodes	3.2 (129)	3.0 (19)	3.7 (16)	
Skin	3.1 (125)	1.9 (12)	4.3 (19)	
Thyroid	3.2 (130)	0.3 (2)	2.5 (11)	
Stomach	3.0 (120)	1.9 (12)	2.1 (9)	
Pancreas	2.4 (98)	3.0 (19)	0.5 (2)	
Other	9.7 (393)	9.5 (59)	9.6 (42)	
Stage at Diagnosis				<0.001
Stage 0-3	78.0 (3,168)	73.4 (457)	71.7 (314)	
Stage 4	22.0 (894)	26.6 (166)	28.3 (124)	

a – Numbers may not sum due to 100% due to missing data.

Table 2: Cancer Care Coordination, Stratified by Housing Status

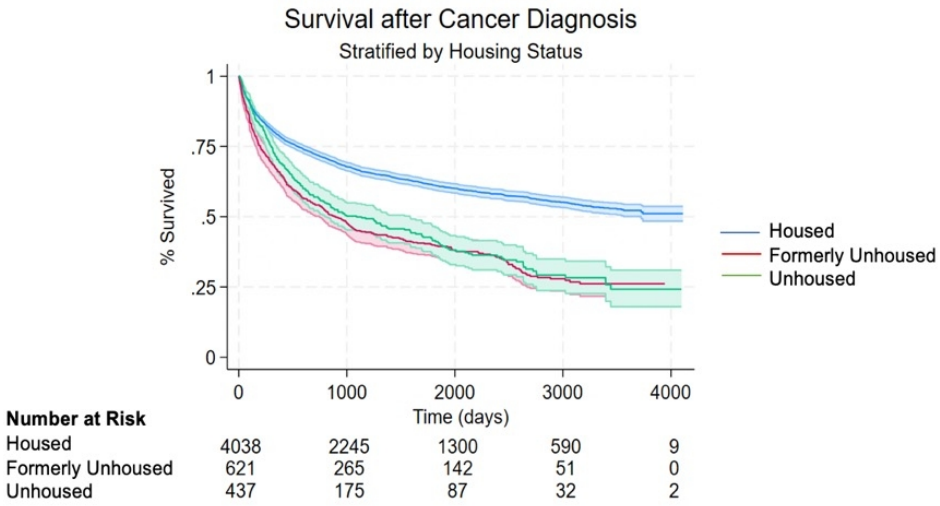
	Housed	Formerly Unhoused	Unhoused	p-value
	N=4,062	N=623	N=438	
Admitted for Cancer Treatment				0.81
No	45.7 (1,858)	46.5 (290)	44.5 (194)	
Yes	54.2 (2,200)	53.5 (333)	55.5 (244)	
Presented at Multidisciplinary Tumor Board				<0.001
No	78.5 (3,187)	70.0 (436)	76.7 (335)	
Yes	21.5 (875)	30.0 (187)	23.3 (103)	
Evidence of Care Fragmentation	52 (26,84)	52.5 (20.5,87.5)	49 (11,81)	0.25
No	63.6 (2,583)	69.6 (434)	64.8 (283)	0.015
Yes	36.4 (1,478)	30.4 (190)	35.2 (155)	

Figure 1: Kaplan Meier Survival Estimates, Stratified by Housing Group

Table 3: Cox Proportional Hazard Model for All-Cause Mortality 3 Months After Cancer Diagnosis, Stratified by Stage and Housing Status

	Stage 0-3				Stage 4			
Housing Category	**>3 months**				**>3 months**			
	Unadjusted (95% CI)	P value	Adjusted* (95% CI)	P value	Unadjusted (95% CI)	P value	Adjusted* (95% CI)	P value
Housed	Reference	--	--	--	Reference	--	--	--
Formerly Unhoused	2.3 (1.9-2.6)	**<0.001**	1.5 (1.2-1.9)	**0.001**	1.4 (1.1-1.7)	**0.003**	1.2 (0.9-1.6)	0.266
Unhoused	2.3 (1.9-2.7)	**<0.001**	1.5 (1.1-1.9)	**0.004**	1.6 (1.2-2.0)	**<0.001**	1.5 (1.1-2.1)	**0.014**

**Adjusted for age at diagnosis, stage of cancer, site of cancer, race, ethnicity, marital status, smoking, alcohol, Elixhauser score, sex, and year of diagnosis*



Kaplan Meier Survival Estimates, Stratified by Housing Group

323x183mm (72 x 72 DPI)

Supplemental Methods

Description of Coordinated Care Management System (CCMS)

CCMS is an integrated data system hosted by the San Francisco Department of Public Health (DPH) that links information about service use across mental health, physical health, substance use, and social health domains in a vulnerable, complex, and high-risk population.

The construction and maintenance of this dataset has been described comprehensively elsewhere (Kanzaria et al). In brief, San Francisco DPH matches and integrates data at the patient level within the CCMS based on last name, first name, date of birth, and social security number using computer probability algorithms followed by manual confirmation.

The following services are included in the dataset:

- Medical Urgent/Emergent Services
  - Medical hospital stays
  - Emergency department visits
  - Medical urgent care visits
- Psychiatric/Mental Health
  - Mental health hospital stays
  - Psychiatric emergency service visits
  - Mental health urgent care visits
- Substance use urgent/emergent services
  - Sobering center visits
  - Substance use disorder medical detoxification stays
  - Substance use disorder social detoxification stays
- Social services
  - Jail health days
  - Medical respite days

Description of CCMS Record Creation

A CCMS record is created for any patient observed or reported to be homeless in a DPH or county housing system; engaged with county behavioral health, housing, or jail services; or engaged with urgent/emergent services across physical health, mental health, substance use, or social health domains.

Description of the Cancer Registry

ZSFG is an American College of Surgeons Commission on Cancer (CoC) accredited cancer program. The CoC requires that accredited programs abstract tumors diagnosed and/or initially treated at the abstracting facility. More information about the fields included in a cancer registry is detailed here: https://www.facs.org/quality-programs/cancer-programs/national-cancer-database/ncdb-call-for-data/registry-manuals/.

Dataset Linkage

We linked patients in the ZSFG Cancer Registry and CCMS using social security numbers as a unique patient identifier in accordance with UCSF minimum security standards. Once matched, we limited the data to include records only where the cancer diagnosis overlapped with the fiscal year the CCMS data was pulled from.

We conducted all data linkages on UCSF's Research Analysis Environment (RAE), which is a secure data hosting and compute service for UCSF researchers and collaborators. RAE provides compute, storage, and analysis tools in a secure, HIPAA-compliant platform for sensitive data. Researchers trained and approved to work with Protected Health Information analyzed the data.

Additional References

- Kanzaria HK, Niedzwiecki M, Cawley CL, et al. Frequent Emergency Department Users: Focusing Solely On Medical Utilization Misses The Whole Person. Health Aff (Millwood). 2019;38(11):1866-1875. doi:10.1377/HLTHAFF.2019.00082

- Molina M, Evans J, Montoy JC, et al. Analysis of Emergency Department Encounters Among High Users of Health Care and Social Service Systems Before and During the COVID-19 Pandemic. *JAMA Netw Open.* 2022;5(10):e2239076. doi:10.1001/jamanetworkopen.2022.39076

- Cawley C, Henderson J, Kanzaria HK, Lacoe J, Paolillo S, Perez K, Raven M, Skog A. Signals of High Utilization of Criminal Legal and Urgent and Emergent Health Services in San Francisco. California Policy Lab (2022). https://www.capolicylab.org/signals-of-distress-high-utilization-of-criminal-legal-and-urgent-and-emergent-health-services-in-san-francisco/. Accessed December 27, 2023.

- Hewlett MM, Raven MC, Graham-Squire D, Evans JL, Cawley C, Kushel M, Kanzaria HK. Cluster Analysis of the Highest Users of Medical, Behavioral Health, and Social Services in San Francisco. J Gen Intern Med. 2023 Apr;38(5):1143-1151. doi: 10.1007/s11606-022-07873-y. Epub 2022 Nov 29. PMID: 36447066; PMCID: PMC9708142.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	5-6
		(*d*) If applicable, explain how loss to follow-up was addressed	6
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	16-17
		(c) Summarise follow-up time (eg, average and total amount)	19
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	7-8
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.