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Housing and Cancer Care and Outcomes: A Systematic Review

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Abstract

Background: Access to stable and affordable housing is an important social determinant of health in the United States. However, research addressing housing and cancer care, diagnosis, and outcomes has not been synthesized. **Methods:** We conducted a systematic review of studies examining associations of housing and cancer care and outcomes using PubMed, Embase, Scopus, and CINAHL. Included studies were conducted in the United States and published in English between 1980 and 2021. Study characteristics and key findings were abstracted and qualitatively synthesized. **Results:** A total of 31 studies were identified. Housing-related measures were reported at the individual level in 20 studies (65%) and area level in 11 studies (35%). Study populations and housing measures were heterogeneous. The most common housing measures were area-level housing discrimination (8 studies, 26%), individual-level housing status (8 studies, 26%), and individual-level housing concerns (7 studies, 23%). The most common cancer outcomes were screening (12 studies, 39%) and mortality (9 studies, 29%). Few studies assessed multiple dimensions of housing. Most studies found that exposure to housing insecurity was statistically significantly associated with worse cancer care (11 studies) or outcomes (10 studies). **Conclusions:** Housing insecurity is adversely associated with cancer care and outcomes, underscoring the importance of screening for housing needs and supporting systemic changes to advance equitable access to care. Additional research is needed to develop and test provider- and policy-level housing interventions that can effectively address the needs of individuals throughout the cancer care continuum.

Stable and affordable housing is an important social determinant of health in the United States and other countries (1-3). Millions of people in the United States experience housing insecurity each year, including, but not limited to, homelessness (4). In 2019, nearly 37 million households were housing cost burdened, spending more than 30% of their income on housing (5). In 2015, approximately 22.3 million households reported housing needs but only 4.7 million received federal subsidies in 2016, reflecting a large gap in housing assistance (6). The COVID-19 pandemic has exacerbated housing insecurity, put an increasing number of people at risk for eviction, and highlighted racialized and ethnic inequities in housing insecurity (7).

Housing is thought to affect cancer care and outcomes through a range of pathways (8). First, lack of housing stability, including homelessness and frequent moves, may affect people's ability to establish medical care and receive consistent, uninterrupted care. This may delay screening and diagnosis

and may be especially important in the setting of cancer treatment, which often requires extended, multimodality care. Second, poor housing conditions may increase the risk of cancer, as exemplified by the connection between environmental exposures such as radon and lung cancer (9). Due to the health consequences of cancer diagnosis and treatment, individuals diagnosed with cancer might be more sensitive to the health hazards associated with substandard housing conditions, including the presence of mold, excess dampness, unsafe water (10), and poor indoor air quality (11). Third, unaffordable housing can limit financial resources available for other needs, including healthy food, transportation, health insurance coverage, and medical care (10,12,13). Conversely, spending on cancer treatment together with employment changes during and after treatment for patients and their caregivers could strain available financial resources for housing (14). Fourth, housing is based in its neighborhood context, which influences exposures

and health behaviors, including ability to be physically active, access to healthy dietary choices, smoking prevalence, and alcohol consumption; these factors can, in turn, affect cancer risk and outcomes (15-18). Across these, housing insecurity can cause stress and anxiety and lead to disruptions in employment, social networks, and the receipt of social and health services (12,19,20). Moreover, the impact of housing insecurity on health involves both direct and indirect pathways (21) and is bidirectional, where poor health also impacts one's access to stable, affordable, and high-quality housing (22).

To date, no review, to our knowledge, has been conducted of research evaluating the associations of housing insecurity and cancer care, diagnosis, and outcomes. To fill this gap, we conducted a systematic review of the published literature to synthesize findings and inform future research, intervention development, and policy.

Methods

Literature Search

We used the PubMed, Embase, Scopus, and CINAHL databases to identify English language articles evaluating housing-related measures and cancer care and outcomes published between January 1, 1980, and December 31, 2021. In the PubMed database, our search strategy combined Medical Subject Heading, title, and abstract terms for neoplasms, and keywords such as housing assistance, housing discrimination, housing insecurity, housing instability, homeless, foreclosure, and eviction. We replicated the search strategy in the Embase, Scopus, and CINAHL databases. Supplementary Table 1 (available online) describes the search terms and search queries used in the literature review for each database.

We included studies that quantitatively examined the association between housing-related measures and cancer care or outcomes and were conducted in the United States. Editorials, commentaries, and literature reviews were excluded. Articles were required to separately report housing-related measures from other socioeconomic measures (eg, articles were excluded if housing was only included as part of a composite measure of socioeconomic status). Articles were excluded if the study populations were recruited from heterogenous sources containing housing programs (study eligibility criteria based on the exposure of interest). The search identified 1291 unique articles, and 55 full articles were further evaluated following abstract review. After the full-text review, 26 articles met the inclusion criteria. Reference lists were also reviewed, and 5 additional articles were identified for inclusion. A total of 31 articles were included in the literature review. Supplementary Figure 1 (available online) illustrates the process of identifying articles included in this review.

Data Abstraction

Data were abstracted on study characteristics, study population characteristics, housing-related measures, and cancer outcomes. Study characteristics included year of publication, data source, geographic setting, inclusion criteria, cancer site, exposure ascertainment method, and study design. Study population characteristics included sample size, age range or age distribution, sex, race, and participant recruitment method (eg, registry or self-report). Exposure measures were classified as housing characteristics at the individual or area levels (eg,

individual's housing status, census tract foreclosure risk, and historically redlined areas). Outcome measures were recorded as component(s) of the cancer control continuum (eg, screening, incidence, stage at diagnosis, treatment, survivorship, survival and/or mortality, and end-of-life care). Worse cancer care and outcomes were defined as overdue screening, missed treatment appointment, inappropriate treatment, and worse survival or mortality. One author (Q.F.) abstracted data from the underlying studies, and 2 authors (Q.F. and L.M.N.) reviewed these data, resolved any differences, and made decisions about data presentation.

Results

Study Characteristics

Of 31 included studies, 21 studies (67.7%) were published after 2015, 9 studies (29.0%) were published after 2019, 6 studies (19.4%) were conducted using national data, 12 studies (38.7%) used data from multiple states, and the remainder were single state, city, or institution (Table 1). Nineteen studies (61.3%) were cross-sectional, and 30 studies (96.8%) were conducted in samples of more than 100 patients. A total 21 studies (67.7%) included both males and females, 10 studies (32.3%) focused only on females, and 2 studies (6.5%) included transgender people. All studies included Black individuals, and most included White individuals (24 studies, 77.4%) and individuals of other races (20 studies, 64.5%). The most commonly evaluated cancer sites were breast (13 studies, 41.9%), colorectal (10 studies, 32.3%), cervical (6 studies, 19.4%), and lung cancer (4 studies, 12.9%), with 9 studies (29.0%) including all cancer sites.

Housing measures were heterogeneous at the individual or geographic area level. Individual-level housing measures included housing status, defined as exposure to homelessness; housing concerns, defined as self-reported concerns about housing affordability, overcrowding, risk of homelessness; self-reported experiences of housing discrimination, defined as unfair treatment because of race; and receipt of housing assistance, defined as participation in housing assistance programs, including federal public housing and housing support programs for veterans. Geographic area–level measures were defined at the county, census tract, and neighborhood level and included the census tract foreclosure rate, defined as percentage of foreclosure during the study period, county housing instability, defined as lower rates of community-members staying within the same house in the past year, higher rates of moving within the county, and moving to the United States from outside the country in the past year; and housing discrimination, defined as current residence in historically redlined areas, neighborhood mortgage denial rate, and/or racial bias in mortgage lending. Historically redlined neighborhoods representing discrimination in mortgage lending were identified using recently digitalized data from the Home Owners' Loan Corporation (HOLC), established by the federal government in 1933. Neighborhoods appraised by the HOLC were shaded in 1 of 4 colors denoting risk of lending: green (best or least financial risk), blue (still desirable), yellow (declining), and red (hazardous or most financial risk) (23). Neighborhood mortgage denial rate, also called "contemporary redlining index," was estimated as the rate of mortgage denial in a neighborhood compared with other areas included in the study using data from the Home Mortgage Disclosure Act (HMDA). Racial bias in mortgage lending was also based on the HMDA data and was estimated as the odds ratio

Table 1. Study characteristics (N = 31)

Study characteristics	No. of studies (%)
Publication year	
2005–2009	3 (9.7)
2010–2014	7 (22.6)
2015–2019	12 (38.7)
After 2019	9 (29.0)
Geographic setting	
National	6 (19.4)
Multiple cities or states	12 (38.7)
Single city or single institute	10 (32.3)
Single state	3 (9.7)
Data source	
Cancer Registry	9 (29.0)
BRFSS	2 (6.5)
The Boston REACH Coalition	2 (6.5)
Black Women Health Study	2 (6.5)
Other	16 (51.6)
Study design	
Cross-sectional	19 (61.3)
Cohort	12 (38.7)
Patient characteristics	
No. of patients	
<100	1 (3.2)
100–999	8 (25.8)
1000–9999	13 (41.9)
10000+	9 (29.0)
Age group[a], y	
<18	4 (12.9)
18–39	19 (61.3)
40–64	25 (80.6)
65+	26 (83.9)
Mean age <50	2 (6.5)
Mean age ≥50	3 (9.7)
Sex[a]	
Male only	0 (0.0)
Female only	10 (32.3)
Male and female	21 (67.7)
Transgender	2 (6.5)
Race[a]	
White	24 (77.4)
Black	31 (100.0)
Other	20 (64.5)
Cancer site[a]	
Breast	13 (41.9)
Cervical	6 (19.4)
Colorectal	10 (32.3)
Lung	4 (12.9)
Prostate	2 (6.5)
Acute myeloid leukemia	1 (3.2)
All cancer sites	9 (29.0)
Component of cancer continuum[a]	
Screening	12 (38.7)
Incidence or diagnosis	8 (25.8)
Treatment	2 (6.5)
Survival or mortality	9 (29.0)
Survivorship	3 (9.7)
End-of-life care	0 (0.0)
Cancer care or outcomes identification[a]	
Medical record review	10 (32.3)
Self-reported	7 (22.6)
Registry	9 (29.0)
National Death Index	2 (6.5)
	(continued)

Table 1. (continued)

Study characteristics	No. of studies (%)
Other	6 (19.4)
Housing concerns or status identification	
Self-reported	9 (29.0)
Medical record review	6 (19.4)
HUD	3 (9.7)
Housing programs	2 (6.5)
HOLC and HMDA	8 (25.8)
Other	3 (9.7)
Housing-related measures	
Individual level	20 (64.5)
County level	1 (3.2)
Tract level	7 (22.6)
Neighborhood-level	3 (9.7)
Individual-level housing measures	
Housing status: homelessness	8 (25.8)
Housing concerns: unmet housing needs and concerns	7 (22.6)
Self-reported housing discrimination	2 (6.5)
Receipt of housing assistance	3 (9.7)
Area-level housing measures	
Housing insecurity: foreclosure and instability	3 (9.7)
Housing discrimination: historical redlining and mortgage discrimination	8 (25.8)
Comparison group	
Calculated discrimination index (HOLC and HMDA) or foreclosure risk	11 (35.5)
Domiciled or stable housing status	9 (29.0)
No housing related needs or concerns	5 (16.1)
Did not participate in housing assistance programs	3 (9.7)
No cancer	1 (3.2)
Other racial or SES groups	1 (3.2)
No comparison group	1 (3.2)

[a]Categories are not mutually exclusive, and studies were included in multiple categories. BRFSS = Behavioral Risk Factor Surveillance System; HMDA = Home Mortgage Disclosure Act; HOLC = Home Owners' Loan Corporation; HUD = Department of Housing and Urban Development; REACH = Racial and Ethnic Approaches to Community Health; SES = socioeconomic status.

for denial of a mortgage application from a Black applicant compared with denial of a White applicant.

Data sources used to ascertain exposure measures varied widely. Sources of individual-level housing measures included self-reports, medical records, and Department of Housing and Urban Development (HUD) administrative data, and sources of area-level housing measures included data from HOLC and HMDA.

Most studies included a comparison group, with great heterogeneity in how comparison groups were defined. Some studies used calculated continuous or categorical housing discrimination indices and foreclosure risks, whereas other studies used binary measures, such as domiciled or stable housing status vs homeless, with vs without housing needs or concerns, no receipt of housing assistance, compared individuals with and without cancer or compared individuals in different racial and socioeconomic groups.

There was also heterogeneity in outcome measures throughout the cancer care continuum. Studies evaluated associations between housing and screening, incidence or diagnosis, treatment, survival or mortality, and survivorship care. However, none evaluated the association between housing and cancer prevention interventions or end-of-life care among individuals diagnosed with cancer. Data sources used to identify cancer

outcomes included medical records, self-reports, cancer registries, National Death Index, and other sources.

Heterogeneity of study populations, housing measures, cancer sites, and cancer outcomes precluded quantitative synthesis of study results (Supplementary Figure 2, available online). However, we identified 3 main categories of housing measures—housing insecurity, housing discrimination, and housing assistance—for further synthesis of study findings.

Housing Insecurity and Cancer Care and Outcomes

Housing insecurity encompasses a continuum of housing-related issues people may experience, such as individuals' concerns about high housing cost, lack of access to stable housing, frequent moves, and homelessness. Studies that evaluated housing insecurity and cancer care and outcomes were conducted at both individual and area levels (Tables 2-4). Supplementary Figure 3 (available online) summarizes the relative measures of effect for the most common outcomes from the included articles.

Individual-Level Housing Insecurity: Housing Needs, Concerns, and Instability

Individual-level measures of housing insecurity included self-reported unmet housing needs (24,25), housing concerns (26-28), and prevalence of housing insecurity (29,30). Findings were mixed for different study populations, housing insecurity measures, and cancer outcomes.

Two studies evaluated the association between self-reported housing needs and cancer outcomes (Table 2). One study focused on primary care patients in Boston and defined housing needs as their responding "yes" to the question "I would like help finding housing assistance or emergency shelter," and found it was not statistically significantly associated with receipt of colorectal, breast, and cervical cancer screening before the interview (24). Another study, evaluating access to cancer care among Black and Latinx patients in New York City, defined housing needs as responding "yes" to the question "Do you feel you need assistance with housing?" (25) and found that those reporting housing needs were statistically significantly more likely to miss a cancer-related medical appointment without control for any covariates.

Three studies investigated the association between housing concerns and cancer outcomes (Table 2). Two studies found self-reported housing concerns (measured as rent unaffordability, overcrowding, or homelessness) were statistically significantly associated with worse access to breast cancer screening but not cervical cancer screening before the interview (Supplementary Figure 3A, available online) (26,27). In a cohort of African American cancer survivors residing in Detroit, Michigan, 11.4% reported housing instability, measured as concern for not having housing in the next 2 months, which was associated with worse health-related quality of life (28).

One study used the Behavioral Risk Factor Surveillance System data in 11 states to estimate the prevalence of housing insecurity, defined as responding "yes" to the question "Are you worried about having enough money to pay your rent or mortgage?" among adults with and without a history of chronic diseases, including cancer, stroke, cardiovascular disease, and chronic lung disease (29), and found adults with a history of cancer had the lowest prevalence of reported housing insecurity compared with other chronic diseases and no association with higher likelihood of housing insecurity (Table 2). Another study

used Behavioral Risk Factor Surveillance System data in 16 states to estimate the prevalence of housing insecurity among cancer survivors (Table 2) (30). Housing instability was defined as an intensity measure from the combined responses to the questions "During the last 12 months, was there a time when you were not able to pay your mortgage, rent, or utility bills?" and the question "In the last 12 months, how many times have you moved from one home to another?" The study reported that 16.6% of cancer survivors reported some level of housing insecurity, with greater severity among individuals who were Black and had lower household income or lower educational attainment.

Individual-Level Housing Insecurity: Housing Status

Eight studies evaluated measures of individual-level housing status evaluating experiences of being unhoused or marginally housed; findings on the association with cancer care and outcomes were mixed (31-38).

Two studies using medical record data from shelter-based clinics in New York City found that exposure to homelessness (defined when the medical record indicated the patient lived in a shelter or on the street) was associated with being overdue for colorectal cancer screening compared with domiciled individuals visiting the same clinic (Table 3) (31). The association between housing status and breast cancer screening was not statistically significant (32), possibly due to limited power with small sample size (<100 individuals).

Two studies examined the association between housing status and cancer screening among veterans. McGuire et al. (33) found that among veterans with chronic medical conditions in active medical treatment, those who experienced homelessness (identified through linkage with the VA's Healthcare for Homeless Veterans Program) were more likely to be overdue for prostate, breast, and colorectal cancer screening. These associations were not statistically significant after adjusting for patient's age, sex, and race. Similarly, May et al. (34) reported a statistically significant association between frequency of exposure to homelessness and being overdue for colorectal cancer screening (Supplementary Figure 3B, available online).

A study in metropolitan Detroit evaluated the association between homelessness and cancer burden (Table 3). Homelessness was defined in a supplemental address variable in the cancer registry record indicating "homeless," "shelter," or "lives in car" or the address of diagnosis was listed as a hospital or a homeless shelter. Cancer burden was defined as proportional incidence ratios and survival. The study found homelessness was associated with higher proportions of preventable cancers (ie, respiratory system cancer diagnosis among men and female genital system cancer diagnosis among women) compared with the general population in metropolitan Detroit (35). Moreover, after propensity score matching patients on relevant characteristics, homelessness was associated with poorer overall and cancer-specific survival.

One study assessed the association between housing statuses, defined as marginally housed or experiencing homelessness, and psychological distress among individuals diagnosed with cancer evaluated during the first medical oncology clinic visit at a San Francisco public hospital (Table 3). The study found that individuals reporting problems with housing were twice as likely and individuals experiencing homelessness were 5 times as likely to report clinically relevant distress scores than individuals with stable housing (36).

Table 2. Individual-level housing insecurity: housing needs, concerns, and instability and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Berkowitz et al. 2016 (24)	Boston, MA Two academic hospital-based primary care practices, Oct 1, 2013–April 30, 2014, 3166 adults aged 21–75 y	Self-reported need for assistance with affordable housing and emergency shelter (87 out of 416 patients reporting any need)	Colorectal cancer screening (men and women aged 52–75 y), breast cancer screening (women aged 42–74 y), and cervical cancer screening (women aged 21–64 y)	Patients who reported housing needs were as likely to be overdue for colorectal, breast, and cervical cancer screenings as those who did not report housing needs, after adjusting for age, gender, race or ethnicity, insurance, educational attainment, primary language, and Charlson score (aOR = 1.09, 95% CI = 0.51 to 2.34; aOR = 2.28, 95% CI = 0.90 to 5.78; aOR = 1.01, 95% CI = 0.41 to 2.52). Authors did not report unadjusted estimates.
Costas-Muniz et al. 2016 (25)	New York City, NY Cancer clinics in New York City through the Cancer Portal Project, March 2011–June 2013, 1098 Latinx and Black adults with mean age >50 y	Self-reported needs for assistance including housing (80 out of 581 Latinx and 90 out of 517 Black patients)	Missing cancer treatment appointment	Latinx patients who reported needing assistance with housing were more likely to report missing cancer treatment appointments compared with Latinx patients who did not report needing assistance with housing (OR = 3.10, 95% CI = 1.53 to 6.26) in the unadjusted model. After adjusting for age, gender, marital status, educational level, monthly income, insurance status, and time since diagnosis, this association was not statistically significant (OR = 1.49, 95% CI = 0.53 to 4.15). Black cancer patients who reported needing assistance with housing were more likely to report missed cancer treatment appointments compared with Black patients who did not report needing assistance with housing in both unadjusted (OR = 3.31, 95% CI = 1.93 to 5.65) and adjusted model (aOR = 3.25, 95% CI = 1.64 to 6.46, including age, gender, marital status, educational level, monthly income, insurance status, and time since diagnosis).
Clark et al. 2009 (26)	Boston, MA Boston REACH Coalition, 2002–2007, 437 women aged 50–75 y	Self-reported social concerns, including concerns on affordable rent, overcrowding, eviction, and homelessness	Breast cancer screening (self-report of mammogram within 2 y before study, at least 1 occurrence of mammography use during study period from 2002–2007)	Among women with housing concerns, 64% obtained mammograms within 2 y of study enrollment, compared with 79% without housing concerns (P < .01), adjusting for baseline access to care (insurance coverage, having a regular provider), SES (age, country of birth, primary language, racial and ethnic identity, household income, employment status, and level of education), social determinants of health, and site of enrollment. Women who reported housing concerns were less likely to have mammography use at baseline (aOR = 0.55, 95% CI = 0.33 to 0.93) and mammography uptake (aOR = 0.40, 95% CI = 0.21 to 0.77) than women who did not report housing concerns. Authors did not report unadjusted estimates.

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Table 2. (continued)

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Clark et al. 2011 (27)	Boston, MA Boston REACH Coalition, 2002–2007, 732 women aged 18–75 y	Self-reported housing concerns about affordable rent, overcrowding, eviction, and homelessness	Cervical cancer screening (self-report of a Pap smear ≤2 y before study)	Women who reported housing concerns were less likely to have a recent Pap smear than women who did not report housing concerns, adjusting for insurance status, regular clinical provider, concerns communicating with provider, self-rated health, educational attainment, social support for childcare (aOR = 0.64, 95% CI = 0.40 to 1.03). Authors did not report unadjusted estimates.
Hastert et al. 2021 (28)	Detroit, MI Detroit Research on Cancer Survivors, 2013–2020, 1754 African American adults aged ≥18 y diagnosed with primary, invasive breast, colorectal, lung, or prostate cancer	Self-reported concerns about not having housing in next 2 mo	Health-related quality of life	Patients who reported housing instability were more likely to have lower health-related quality of life measured by the differences in FACT-G scores (in points) of −11.3 (95% CI = −14.2 to −8.4) compared with patients who did not report housing instability, adjusting for age, sex, education, household income, employment status, marital status, and census-tract poverty.
Charkhchi et al. 2018 (29)	Multiple states BRFSS, 2015, 84353 adults aged ≥18 y	Self-reported housing concerns about rent or mortgage affordability within past 12 mo	Cancer diagnosis before interview (self-reported)	Individuals diagnosed with cancer were as likely to report housing insecurity as individuals not diagnosed with cancer, adjusting for age, race or ethnicity, sex, educational attainment, marital status, employment and insurance status, and household income as a percentage of federal poverty line (aOR = 1.11, 95% CI = 0.81 to 2.36).
Coughlin et al. 2021 (30)	Multiple states BRFSS, 2017, 10936 adults aged ≥18 y	Self-reported housing inability to pay rent or mortgage or utility bills and times of move within past 12 months	Cancer diagnosis before interview (self-reported)	About 16.6% of cancer survivors had moderate to increased level of housing insecurity. Among these cancer survivors, Black individuals, individuals with low household income (<$15 000), and individuals with low educational attainment (high school or less) were more likely to report housing insecurity than White individuals, individuals with highest household income (≥$50000), and individuals with highest educational attainment (college graduate), after adjusting for age, sex, marital status, employment, and health coverage (aOR = 1.64, 95% CI = 1.11 to 2.50; aOR = 3.02, 95% CI = 2.05 to 4.43; aOR = 1.32, 95% CI = 1.01 to 1.73).

aOR = adjusted odds ratio; BRFSS = Behavioral Risk Factor Surveillance Survey; CI = confidence interval; OR = odds ratio; REACH = Racial and Ethnic Approaches to Community Health; SES = socioeconomic status; FACT-G = Functional Assessment of Cancer Therapy—General.

Table 3. Individual-level housing insecurity: housing status and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Asgary et al. 2014a (31)	New York City, NY Lutheran Family Health Centers, 2010–2012, 443 adults aged 50–85 y	Self-reported housing status (homelessness defined as living in shelter or on the street)	Colorectal cancer screening (FOBT ≤1 y, flexible sigmoidoscopy ≤5 y plus FOBT ≤3 y, or colonoscopy ≤10 y of the most recent visit)	Individuals experiencing homelessness less likely to be up-to-date with colorectal cancer screening than domiciled individuals (19.7% vs 41.3%, P < .001). Housing status not associated with receipt of provider counseling, and among those who received counseling (248 patients), individuals experiencing homelessness were less likely to be up-to-date with screening than domiciled individuals (P < .001). After adjusting for age, gender, insurance, history of mental health, substance abuse, provider counseling, and history of chronic disease, domiciled patients more likely to be up-to-date with colorectal cancer screening than homeless patients (aOR = 1.77, 95% CI = 1.05 to 3.00). Authors did not report unadjusted estimates.
Asgary et al. 2014b (32)	New York City, NY Lutheran Family Health Centers, 2010–2012, 100 women aged 50–74 y	Self-reported housing status (homelessness defined as living in shelter or on the street)	Breast cancer screening (mammogram ≤2 y of most recent visit, breast MRI ≤2 y of most recent visit)	Individuals experiencing homelessness were as likely to be up-to-date with breast cancer screening as domiciled individuals (57.1% vs 59.0%, P = .84). After adjusting for age, race, provider counseling, and health insurance, domiciled patients were as likely to be up-to-date with colorectal cancer screening as homeless patients (OR = 2.41, 95% CI = 0.80 to 7.56). Authors did not report unadjusted estimates.
McGuire et al. 2005 (33)	94 932 veterans aged ≥50 y in active medical treatment for chronic health conditions whose medical charts were selected for the National Veterans Health Administration EPRP, 1998–1999	Housing status (chart reviewed by EPRP merged with VA's HCHV Program)	Colorectal cancer (FOBT ≤1 y or sigmoidoscopy or colonoscopy ≤5 y, among persons ≥ aged 50y), breast cancer (mammography ≤2 y among females aged 50–69 y), cervical cancer (Pap smear ≤3 y among women ≤ aged 65 y), and prostate cancer (discussion ≤1 y of risks for and benefits of PSA testing for men aged ≥50 y) screening	Among veterans in active medical treatment for chronic health conditions, patients experiencing homelessness were no less likely to receive cancer screening or discussion of screening than domiciled patients (colorectal cancer: beta = −0.17, 95% CI = −0.8 to 0.47; breast cancer: beta = −1.20, 95% CI = −2.62 to 0.22; cervical cancer: beta = −0.81, 95% CI = −0.98 to 2.60; prostate cancer: beta = −0.03, 95% CI = −0.43 to 0.37) adjusting for age, sex, race, VHA service connection, distance from nearest VHA facility, mental illness, and 3 facility-level characteristics: percentage of hospital funds spent on teaching and research, hospital size, and percentage of hospital funds spent on mental health care.
May et al. 2014 (34)	Multiple cities in Southern CA Greater Los Angeles Veterans Affairs Healthcare System, 1996–2012, 178 African Americans aged >45 y and 179	Medical records documented homeless status	Uptake of any colorectal cancer screening procedure (age >50 y for African Americans and non-African Americans before 2009 and age >45 y for African Americans after 2009)	Among veteran patients, individuals experiencing homelessness were more likely to be overdue for colorectal cancer screening in both unadjusted (OR = 0.37, 95% CI = 0.22 to 0.62) and adjusted model (aOR = 0.43, 95% CI = 0.25 to 0.77) compared with domiciled individuals, adjusting for gender, race or

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Table 3. (continued)

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
	non-African Americans aged >50y			ethnicity, zip code-level median income, level of service connectedness to the VA, history of combat experience, marital status, employment, and age of screening eligibility for physiological and psychological comorbidities, number of primary care physician visits, history of alcohol abuse, history of drug abuse.
Holowatyj et al. 2019 (35)	Metropolitan Detroit, Metropolitan Detroit Cancer Surveillance System (MDCSS), 1973–2014, 655 060 adults aged ≥20y diagnosed with invasive cancer, 1508 for propensity score matched cohort	Homelessness identified based on supplemental address field reporting "homeless," "shelter," or "lives in car," or address of diagnosis listed as hospital or homeless shelter (388 individuals)	Patients diagnosed with invasive cancer including following primary tumor sites: oral cavity and pharynx; digestive system; respiratory system; bones and joints; soft tissue; skin; breast; female genital system; male genital system; urinary system; eye and orbit; brain and other nervous system; endocrine system; hematopoietic system; mesothelioma; Kaposi's sarcoma; and ill-defined sites	After adjusting for age, homeless men and women were more likely to be diagnosed with respiratory system cancer (PIR = 1.51, 95% CI = 1.28 to 1.79) and female genital system cancer (PIR = 1.83, 95% CI = 1.31 to 2.55) compared with domiciled men and women, and domiciled women, respectively.
Cimino et al. 2020 (36)	San Francisco, CA Medical oncology clinic in urban public hospital in San Francisco, 2014–2016, 200 adults aged ≥18y	Homeless status obtained from social service assessments or primary care notes	Self-reported psychosocial distress among cancer patients	Patients experiencing problems with housing (OR = 2.39, 95% CI = 1.04 to 5.93) and homelessness (OR = 4.96, 95% CI = 1.23 to 33.51) were more likely to have increased distress scores than patients without housing problems and domiciled patients after adjusting for patient characteristics and total number of problems reported in each domain (practical, social, emotional, and physical).
Simonsen et al. 2014 (37)	University of Utah Infectious Diseases Clinic, Jan 1, 2009, to Dec 31, 2009, 192 women living with HIV aged ≥18y	Medical records documenting housing status (stable housing vs homeless or transient or subsidized housing)	Medical records documented receipt of cervical, breast, and cancer screening for age eligible women in 2009	Among women living with HIV, individuals with unstable housing status were as likely to receive breast (47.6% vs 29.4%, P = .2) and cervical (60.9% vs 56.7%, P = .6) cancer screening as individuals with stable housing status.
Hessol et al. 2019 (38)	San Francisco, CA San Francisco Department of Public Health HIV surveillance registry, 4158 individuals aged ≥13y	Medical records documenting homeless status	Non-AIDS cancer listed as cause of death in death certificate obtained through linkage with NDI	Patients with a history of homelessness were 37% less likely to have non-AIDS cancers listed as cause of death in both unadjusted model (OR = 0.43, 95% CI = 0.31 to 0.59, P < .05) and adjusted model (aPR = 0.63, 95% CI = 0.44 to 0.89, P < .05, compared with patients with stable housing status, adjusting for gender, race, age, concurrent HIV and AIDS diagnosis, HIV transmission risk, income status at diagnosis, year of death, prescription of ART, and San Francisco residence at time of death).

aAIDS = acquired immunodeficiency syndrome; aOR = adjusted odds ratio; aPR = adjusted prevalence ratio; ART = antiretroviral therapy; CI = confidence interval; EPRP = External Peer Review Program; FOBT = fecal occult blood test; HCHV = Healthcare for Homeless Veterans; HIV = human immunodeficiency virus; NDI = National Death Index; OR = odds ratio; PIR = proportional incidence ratios; VA = Veterans Affairs; VHA = Veterans Health Administration.

Area-Level Housing Insecurity: Housing Instability and Foreclosure Risk

Three studies found statistically significant associations between area-level housing insecurity, including 1 study using census tract–level foreclosure rate, another using census tract–level foreclosure abandonment risk score, and a third using county-level housing instability, and cancer outcomes (Table 4) (39-41).

Calo et al. (39) found that residing in census tracts with higher foreclosure rates in Houston was associated with over-due colorectal cancer screening among adults aged 50-75 years. This association was not statistically significant after adjustment for patients' area-level socioeconomic status characteristics, including poverty, unemployment, education, and income inequality. Another study found that women diagnosed with breast cancer who resided in census tracts with high foreclosure risk in Missouri were more likely to report being in fair to poor health than women diagnosed with breast cancer who lived in low-foreclosure risk areas (defined using the HUD's foreclosure abandonment risk scores) (40). Knoble et al. (41) found children diagnosed with acute myeloid leukemia who resided in counties with increased levels of housing instability (defined as lower rates of community members staying within the same house in the past year, higher rates of moving within the county, and moving to the United States from outside the country in the past year) had statistically significantly worse mortality (Supplementary Figure 3B, available online).

Housing Discrimination and Cancer Outcomes

Racially discriminatory policies and practices have systematically shaped access to resources and exposure to health hazards and deliberately maintained racial residential segregation in the United States (42). In the 1930s, HOLC appraised loan risk and characterized neighborhoods with high proportions of non-White and/or immigrant residents in red, thereby denying them access to capital (23). By making mortgages less accessible to Black home buyers, it created a platform for systemic disinvestment in "redlined" neighborhoods and validated other racist practices, such as interpersonal racism through mob violence against Black individuals who moved to predominantly White neighborhoods and institutional racism though discriminatory mortgage-lending practices that persist to this day (43). After the federal Fair Housing Act banned racial discrimination in lending (44), contemporary mortgage discrimination persisted and was estimated as the rate of mortgage denial in a neighborhood compared with other areas included in the study using data from the HMDA. Therefore, understanding the intersection of exposure to interpersonal, institutional, and systemic racism is crucial for interpreting the results of studies evaluating the association between individual- and area-level measures of housing discrimination and cancer outcomes.

Individual-Level Housing Discrimination: Self-Reported Discrimination

Two studies used data from the Black Women's Health Study (43,44) to evaluate the association between self-reported experiences of individual-level housing discrimination and cancer outcomes (Table 5). The results were mixed: Taylor et al. (46) found that among women younger than 50 years, reporting experiences of major discrimination in the job, housing, and police (all 3) were associated with higher risk of being diagnosed with breast cancer than women who reported no major discriminatory experiences. However, discrimination in housing alone was not associated with breast cancer risk. Albert et al. (45) found self-reported experiences of unfair treatment in housing activities (including discrimination in renting, buying, and mortgage) were not associated with cancer being listed as a cause of death on death certificates (Supplementary Figure 4A, available online).

Area-Level Housing Discrimination

Three studies used residence in historically redlined areas to measure the association between exposure to area-level housing discrimination and stage of diagnosis for multiple cancer sites (Table 6) (47-49). Krieger et al. (47) used patients' addresses from the Massachusetts Cancer Registry to evaluate the association between residing in historically redlined areas and cancer diagnosis in 28 municipalities in Massachusetts. It found individuals residing in historically redlined areas were more likely to be diagnosed with preventable cancers, such as cervical cancer, and more likely to present with late-stage diagnosis of female breast and lung cancer (in men and women). Increased risk of late-stage diagnoses in residents of historically redlined areas was also observed for colorectal cancer (men only) but was not statistically significant (Supplementary Figure 4B, available online). Nardone et al. (48) used census tract age-standardized prevalence estimates from the Centers for Disease Control and Prevention 500 cities dataset and reported a negative association between HOLC risk grade and self-reported cancer diagnosis in 9 US cities, including Atlanta, Chicago, Cleveland, Los Angeles, Miami, New York, Oakland, San Francisco, and St. Louis. Poulson et al. (49) used addresses of patients from a single health-care institution in Boston, MA, and found that Black patients residing in historically redlined areas were less likely to receive lung cancer screening than White patients.

Four studies used contemporary neighborhood mortgage denial rated to measure the association between area-level housing discrimination and cancer outcomes (Supplementary Figure 4C, available online, Table 6) (50-53). The disproportionate denial of mortgage loans for Black applicants compared with similarly qualified White applicants contributes to the persistent home ownership gap and racial residential segregation between Black and White individuals in the United States (54). Therefore, this measure is also called "contemporary redlining index," where higher values of the index correspond to predominantly Black neighborhoods that have been targeted for marginalization and present-day denial of mortgage applications. All 4 studies examined the association between residing in high vs low contemporary redlining index neighborhoods and mortality (all cause and cancer-specific) among individuals diagnosed with cancer. Two studies found that residing in neighborhoods with a higher contemporary redlining index was associated with worse cancer outcomes, including higher breast cancer mortality and worse survival, compared with residents residing in areas with lower rates of contemporary redlining (Supplementary Figure 4B, available online) (50,51). Collin et al. (50) found that in the Atlanta metropolitan area, women residing in areas with a higher (≥ 1) mortgage denial rate had a higher risk of breast cancer mortality compared with women who lived in areas with lower (<1) mortgage denial rate. Similarly, Beyer et al. (51) found that among older female Medicare beneficiaries (aged 66-90 years) diagnosed with breast cancer, residing in areas with the highest (≥ 3) mortgage denial rate was associated with worse survival compared with residing in areas with the

Table 4. Area-level housing insecurity: housing instability, foreclosure risk and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Calo et al. 2015 (39)	City of Houston and Harris County, TX Health of Houston Survey, 2010, 1720 adults aged 50–75 y	Census tract-level foreclosure risk (% of foreclosures started in past 18 mo) from HUD	Self-reported adherence to colorectal cancer screening guidelines	Residing in census tracts with high foreclosure risk was more likely to have worse adherence to colorectal cancer screening guidelines (OR = 0.57, 95% CI = 0.43 to 0.76, P < .01) than residing in census tracts with low foreclosure risk. After adjusting for individual's sociodemographic characteristics including gender, age, race or ethnicity, foreign born, marital status, employment status, educational attainment, poverty level, and health insurance coverage, residing in census tracts with high foreclosure risk was no more likely to have worse adherence to colorectal cancer screening guidelines compared with residing in census tracts with low foreclosure risk (aOR = 0.78, 95% CI = 0.55 to 1.10).
Schootman et al. 2012 (40)	Missouri State, Missouri Cancer Registry, June 2006-June 2008, 1047 women aged ≥25 y	Census tract–level foreclosure abandonment risk score from HUD (score range from 0 to 10, predicts risk for foreclosed and abandoned homes in census tracts)	Self-rated health among breast cancer survivors	Breast cancer survivors who resided in foreclosure abandonment risk (7-10) areas were 2.39 times (95% CI = 1.83 to 3.13) more likely to report being in fair-poor health than women who lived in low foreclosure risk areas (0–3). The magnitude of the association was reduced after adjusting for perceived neighborhood conditions, including neighborhood social disorder, physical disorder or decay, collective efficacy, and neighborhood fear (aOR = 1.76, 95% CI = 1.02 to 3.05).
Knoble et al. 2016 (41)	SEER states and regions, 1973–2012, 3651 individuals aged ≤19 y	County-level housing instability from ACS (defined as lower rates of community members staying within same house, higher rates of moving within county, and higher rates of moving to US from outside country in past year)	Childhood AML mortality	Residing in counties with high housing instability was more likely to have an increased risk in childhood AML mortality than residing in counties with low housing instability, adjusting for age at diagnosis, race or ethnicity, sex, US region and AML subtypes (aHR = 1.05, 95% CI = 1.00 to 1.10).

[a]ACS = American Community Survey; AML = acute myeloid leukemia; aOR = adjusted odds ratio; CI = confidence interval; HR = hazard ratio; HIV = human immunodeficiency virus; HUD = Department of Housing and Urban Development; OR = odds ratio; SEER = Surveillance, Epidemiology, and End Results Program.

lowest (<0.5) contemporary redlining index value in the Surveillance Epidemiology and End Results (SEER) cancer registry states. Due to racial residential segregation, adjusting the contemporary redlining index by race of the applicant does not change the neighborhood scores (53). Additionally, racial residential segregation is critical for interpreting results from studies evaluating the association between residing in high vs low contemporary redlining index neighborhoods and cancer outcomes by race. Two studies evaluated the association between contemporary redlining index and cancer mortality by race among Milwaukee residents (52,53). Zhou et al. (52) found that, when stratified by race, residence in areas with a higher contemporary redlining index was not associated with colorectal cancer mortality among Black or White individuals. Another study found that among Black women, residing in areas with a higher contemporary redlining index was associated with a lower hazard ratio for all-cause mortality and breast cancer-specific mortality (53).

Four studies used racial bias in mortgage lending to evaluate the association between area-level housing discrimination and cancer outcomes (Supplementary Figure 4D, available online; Table 6) (50,52,53,55). Unlike the "contemporary redlining index," the "racial bias in mortgage lending" measure uses HMDA data to calculate the odds of mortgage denial among Black applicants compared with similar White applicants in the same neighborhood. Therefore, this measure identifies predominantly White neighborhoods, where both Black and White potential residents are submitting mortgage applications but racial residential segregation is being perpetuated through disproportional denial of applications from Black individuals. Two studies evaluating the association between racial bias in mortgage lending and cancer outcomes by race reported higher hazard of all-cause mortality among Black Milwaukee residents living in predominantly White neighborhoods with higher racial bias in mortgage lending (52,53). Beyer et al. (55) found that racial disparities in cancer mortality rates were larger in areas

Table 5. Individual-level housing discrimination and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Taylor et al. 2007 (46)	National, Black Women's Health Study, 1997–2003, 45 043 women aged 21–69 y	Self-reported experience of major housing discrimination	Breast cancer incidence	Women who reported experiencing discrimination in housing were as likely to develop breast cancer as those who did not report, after adjusting for age, body mass index, family history of breast cancer, menopausal status, age at menarche, parity, vigorous exercise, age at first birth, and oral contraceptive use (adjusted IRR = 1.00, 95% CI = 0.84 to 1.18). Women aged <50 y who reported experiencing major discrimination in housing, job, and police (all 3) were more likely to develop breast cancer compared with those who reported none (adjusted IRR = 1.48, 95% CI = 1.01 to 2.16).
Albert et al. 2010 (45)	National, Black Women's Health Study, 1997–2005, 48 924 women mean age = 40.5 y	Self-reported experience of institutional racism including unfair treatment in housing activities (renting, buying, and mortgage)	Cancer listed as underlying cause of death in death certificates	Women who reported experiencing unfair treatment in housing were no more likely to have cancer being listed as an underlying cause of death than those who did not report, after adjusting for age, education level, body mass index, family history of myocardial infarction at age younger than 50 y, physical activity, smoking status, neighborhood racial composition, marital status, occupation, health insurance status, and histories of hypertension, diabetes, and hyperlipidemia (aHR = 1.2, 95% CI = 0.9 to 1.5).

[a]aHR = adjusted hazard ratio; CI = confidence interval; IRR = incidence risk ratio.

with greater racial bias in mortgage lending, and this relationship persisted in sex-specific analyses. In contrast, Collin et al. (50) did not restrict the analyses to Black individuals and reported a decreased hazard of breast cancer–specific mortality among women residing in neighborhoods with higher racial bias in mortgage lending in the Atlanta metropolitan area. Residents of neighborhoods with higher racial bias in mortgage lending were more likely to be White and have high income and high educational attainment, as expected. The inconsistency of the findings suggests that evaluating the association between area-level housing discrimination and cancer outcomes by race need to be interpreted in light of racial residential segregation and exposure to other forms of racism (eg, interpersonal, institutional, systemic) in the United States.

Receipt of Housing Assistance and Cancer Control and Outcomes

Housing assistance refers to the programs that provide safe and affordable homes for low-income people and families as well as the elderly and disabled. Despite the success of housing assistance that reduces homelessness and increases housing stability (56), approximately fewer than one-quarter of eligible low-income households do not receive federal rental subsidies (57). Three studies evaluated the association between individual-level receipt of housing assistance (including receipt of vouchers, public housing, and multifamily housing) and cancer screening, prevalence, stage at diagnosis, treatment, and mortality (58-60); findings were mixed (Table 7). Receiving housing assistance was generally associated with improved access to cancer care and better health among low-income adults. Wong et al. (58) used data from the National Health Interview Survey linked with HUD administrative data to compare receipt of colorectal, cervical, and breast cancer screening among individuals

receiving different types of housing assistance. In multivariable analyses, receipt of housing assistance was not statistically significantly associated with receipt of cancer screening. Stone et al. (59) found that African American residents of large public housing developments in Louisville, KY, were 87.3% more likely to return the fecal immunochemical test kit provided during colorectal cancer screening outreach than those who resided in scattered housing or rental units on the private market (Supplementary Figure 5, available online). Berchuck et al. (60) identified individuals diagnosed with non-small cell lung cancer from the VA Central Cancer Registry and found that among veterans with any preexisting mental health disorders, participation in housing support programs was associated with lower odds of being diagnosed with late-stage disease. Additionally, participation in housing support programs was associated with receipt of stage-appropriate treatment for all stages of lung cancer and decreased risk of all-cause mortality and lung cancer–specific mortality.

Discussion

In this study, we conducted a systematic review of published research from 1980 through 2021 to synthesize the evidence on associations of housing and cancer care and outcomes in the United States. The 31 studies included in the review were heterogeneous in terms of the study populations, housing measures, methods, and outcomes evaluated. Nonetheless, most studies reported statistically significant associations between housing insecurity and worse cancer care and outcomes. The consistency of these findings underscores the need for greater awareness of housing challenges within cancer care delivery as well as better understanding of what individual-, institutional-, and policy-level housing interventions can effectively address and

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Table 6. Area-level housing discrimination and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Krieger et al. 2020 (47)	28 municipalities in MA, Massachusetts Cancer Registry data, Jan 1, 2001–Dec 31, 2015, 53 196 adults ≥18 y diagnosed with breast, colorectum, lung, and cervical cancer	Historically redlined areas based on HOLC grade	Late stage at diagnosis for cervical, breast, lung, and colorectal cancer	Living in historically redlined areas was more likely to have increased risk of late-stage diagnosis than living in nonhistorically redlined areas for women with breast cancer (aRR = 1.07, 95% CI = 0.98 to 1.17), men with lung cancer (aRR = 1.07, 95% CI = 1.02 to 1.13), and men or women with lung cancer, aRR = 1.03, 95% CI = 1.00 to 1.17, adjusting for sex, gender, and race or ethnicity)
Nardone et al. 2020 (48)	9 Cities, CDC 500 Cities database, 2018, 4061 adults aged >18 y diagnosed with a nondermatologic cancer	Historically redlined areas based on HOLC grade	Census tract level age-standardized cancer prevalence	Individuals living in historically redlined areas more likely to be diagnosed with nondermatologic cancer than living in non-historically redlined areas (r = −0.32, P < .001)
Poulson et al. 2021 (49)	Boston and surrounding suburbs, Boston Medical Center Clinical Database Warehouse and Lung Cancer Screening Program, March 1, 2015–March 31, 2017, 1063 adults aged 55–80 y	Historically redlined areas based on HOLC grade	Completion of lung cancer screening	With race as mediator, Black patients living in historically redlined areas 61% less likely to undergo screening than White patients (OR = 0.39, 95% CI = 0.24 to 0.64). Similarly, Black women and Black men living in historically redlined areas 61% less likely (OR = 0.39, 95% CI = 0.21 to 0.73) and 47% less likely (OR = 0.53, 95% CI = 0.29 to 0.98) to undergo screening than White men
Collin et al. 2021 (50)	Metropolitan Atlanta area, GA, Georgia Cancer Registry, 2010–2014, 8523 women aged ≥18 y diagnosed with breast cancer	Racial bias in mortgage lending, and neighborhood rate of mortgage denial	Breast cancer-specific mortality	For all women, after adjusting for age and stage at diagnosis, living in high (≥1) mortgage denial rate neighborhoods was more likely to have increased hazard of breast cancer mortality (aHR = 1.58, 95% CI = 1.37 to 1.82) than living in low (<1) mortgage denial rate neighborhoods. Living in neighborhoods with higher (≥3) racial bias in mortgage lending more likely to have decreased hazard of breast cancer mortality (aHR = 0.86, 95% CI = 0.75 to 0.99) than living in neighborhoods with lower (<3) racial bias in mortgage lending. For NHB and NHW women, living in high (≥1) mortgage denial rate neighborhoods more likely to have increased hazard of breast cancer mortality (aHR = 1.13, 95% CI = 0.90 to 1.42 and aHR = 1.39, 95% CI = 1.09 to 1.78, respectively) than living in low (<1) mortgage denial rate neighborhoods. For NHB and NHW women, living in neighborhoods with higher (≥3) racial bias no more likely to have increased hazard of breast cancer mortality (aHR = 1.08, 95% CI = 0.89 to 1.32, and aHR = 0.93, 95% CI = 0.74 to 1.16, respectively) than living in neighborhoods with lower (<3) racial bias in mortgage lending.
Beyer et al. 2021 (51)	National, SEER-Medicare, 2007–2015, 27 516 women aged 66–90 y diagnosed with breast cancer	Neighborhood mortgage denial rate	All-cause mortality and breast cancer-specific mortality	Residing in areas with higher mortgage denial rate more likely to have increased hazard ratios of all-cause mortality (low, aHR = 1.10, 95% CI = 1.06 to 1.14; moderate, aHR = 1.27, 95% CI = 1.17 to 1.38; and high, aHR = 1.39, 95% CI = 1.25 to 1.55) compared with reference level of 0.5 (corresponding to neighborhoods with lowest rate of mortgage denial) among women

(continued)

Table 6. (continued)

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
				with no comorbidities after adjusting for race and ethnicity. A similar pattern was found for breast cancer-specific mortality and for women with no comorbidities (low, aHR = 1.08, 95% CI = 1.02 to 1.13; moderate, aHR = 1.20, 95% CI = 1.05 to 1.37; and high, aHR = 1.28, 95% CI = 1.06 to 1.55).
Zhou et al. 2017 (52)	Milwaukee metropolitan area, WI Wisconsin Cancer Reporting System, 2002–2011, 5381 adults aged ≥18 y diagnosed with colorectal cancer	Racial bias in mortgage lending, and neighborhood rate of mortgage denial	All-cause and colorectal cancer-specific mortality	Residing in areas with higher (≥2) racial bias in mortgage lending more likely to have increased hazard of all-cause mortality (aHR = 1.37, 95% CI = 1.06 to 1.76) among Black colorectal cancer patients and among Black women (aHR = 1.53, 95% CI = 1.06 to 2.21), but not Black men, compared with residing in areas with lower (<2) racial bias in mortgage lending, after adjusting for age, sex, and stage at diagnosis.
Beyer et al. 2016 (53)	Milwaukee metropolitan area, WI Wisconsin Cancer Reporting System, 2002–2011, 1010 Black women aged ≥18 y diagnosed with breast cancer	Racial bias in mortgage lending, and neighborhood rate of mortgage denial	All-cause mortality and breast cancer-specific mortality	After adjusting for age, stage at diagnosis, and ZCTA population density, residing in areas with higher racial bias in mortgage lending more likely to have increased hazard of all-cause mortality (aHR = 1.16, 95% CI = 1.04 to 1.29) than residing in areas with lower racial bias in mortgage lending among Black women diagnosed with breast cancer. Residing in high mortgage denial rate neighborhoods more likely to have decreased hazard of all-cause mortality (aHR = 0.73, 95% CI = 0.59 to 0.90) than residing in areas with lower racial bias in mortgage lending among Black women diagnosed with breast cancer. After adjusting for age, stage at diagnosis, and ZCTA population density, residing in areas with higher racial bias in mortgage lending no more likely to have increased hazard of breast cancer-specific mortality (aHR = 1.12, 95% CI = 0.98 to 1.28) than residing in areas with lower racial bias in mortgage lending among Black women diagnosed with breast cancer. Residing in neighborhoods with higher racial bias in mortgage lending more likely to have decreased hazard of breast cancer-specific mortality (aHR = 0.76, 95% CI = 0.59 to 0.98) than residing in areas with lower racial bias in mortgage lending among Black women diagnosed with breast cancer.
Beyer et al. 2019 (55)	Large US MSAs, National Vital Statistics System, National Program of Cancer Registries, and SEER, 2009–2013, >500 000 adults aged ≥25 y	Racial bias in mortgage lending	Black-White disparity in cancer incidence and mortality rates	In areas with higher racial bias in mortgage lending, Black-White disparity in cancer mortality rate was larger (r = 0.32; P = .001). This relationship persisted in sex-specific analyses (females, r = 0.23; P = .02; males, r = 0.37; P < .001) and in models controlling for confounders. Adjusting for racial disparities in cancer incidence attenuated but did not eliminate correlation between racial bias in mortgage lending and racial disparities in mortality r = 0.24, P = .02; females, r = 0.22, P = .04; males, r = 0.22, P = .04.

ᵃaHR = adjusted hazard ratio; CI = confidence interval; CDC = Centers for Disease Control and Prevention; HOLC = Home Owners' Loan Corporation; HR = hazard ratio; IRR = incidence risk ratio; MSAs = metropolitan statistical areas; NHB = non-Hispanic Black; NHW = non-Hispanic White; RR = risk ratio; SEER = Surveillance, Epidemiology, and End Results Program; WONDER = Wide-ranging Online Data for Epidemiologic Research.

Table 7. Individual-level housing assistance and cancer outcomes[a]

Reference	Setting, data source, year, and sample size	Housing-related measures	Cancer outcomes	Key findings
Wong et al. 2019 (58)	National, NHIS, 2004–2012 linked with 2004–2012 HUD administrative data, 4673 quasi-waitlist adults in low-income households aged ≥18 y	Receipt of housing assistance in HUD data at time of the NHIS	Self-reported receipt of colorectal (men and women aged 50-75 y), breast (women aged 40-74 y), and cervical cancer screening (women aged 21-65 y) in past 12 mo	Receipt of housing assistance did not increase likelihood of receiving colorectal, breast, and cervical cancer screening compared with quasi-waitlist groups in both unadjusted models and adjusted models (aOR = 0.74, 95% CI = 0.23 to 2.29; aOR = 0.74, 95% CI = 0.23 to 2.43; aOR = 0.91, 95% CI = 0.40 to 2.05).
Stone et al. 2019 (59)	Louisville/Jefferson County, KY, HOPE VI program, July 15, 2016–July 14, 2017, 209 adults aged 37–74 y	Large public housing development residents vs scattered public housing residents vs residents receiving vouchers for rentals on regular housing market	Return of FIT kits for colorectal cancer screening	Residents of large public housing developments were 87.3% more likely to return FIT kit than residents who resided in scattered housing or in rental unit on private market adjusting for respondents' perception of their health status (OR = 1.87, 95% CI = 0.99 to 3.55, P = .055).
Berchuck et al. 2020 (60)	National, Veterans Affairs Central Cancer Registry, September 30, 2000–Dec 31, 2011, 55 315 veterans diagnosed with NSCLC and preexisting MHD, mean age = 68.1 y	Participation in housing support program	Stage at cancer diagnosis, receipt of stage-appropriate treatment, and mortality	After adjusting for age at diagnosis, year of diagnosis, sex, race, marital status, smoking history, substance use, and comorbid illness, NSCLC patients who participated in housing support programs were more likely to receive stage-appropriate treatment (aOR = 1.15, 95% CI = 1.01 to 1.31, P = .03) than patients who did not participate. NSCLC patients who participated in housing support programs were less likely to be diagnosed with late-stage disease (aOR = 0.64, 95% CI = 0.56 to 0.73, P < .001) than patients who did not participate. Lung cancer–specific mortality among NSCLC patients participating in housing support programs was lower than patients without housing assistance (aHR = 0.70, 95% CI = 0.65 to 0.76, P < .001).

[a]CI = confidence interval; FIT = fecal immunochemical test; HUD = US Department of Housing and Urban Development; HR = hazard ratio; MHD = mental health disorder; NHIS = National Health Interview Survey; NSCLC = non-small cell lung cancer; OR = odds ratio.

prevent the complex needs of individuals throughout the cancer care continuum.

Among the studies included in the review, the most consistent findings were among studies assessing associations of housing challenges and cancer stage at diagnosis and survival following diagnosis (25,29,30,60). Only 2 studies examined receipt of treatment and 3 examined survivorship care despite the strong conceptual basis for associations with housing challenges. For example, patients who are cancer survivors may need time away from work for treatment and surveillance with different specialty care providers, potentially resulting in lost wages and limited employment opportunities. Together with high medical expenses, it may be more challenging for these individuals to afford stable housing, and, conversely, unstable housing may make the receipt of their treatment and survivorship care more challenging (61,62). To date, associations of housing and cancer stage, treatment, and survival have been evaluated in only a limited number of cancers (25,60), and little is known about how associations might vary by cancer site, treatment type, or among racialized groups. Moreover, housing

challenges can lead to poor symptom management and care coordination, which are especially important for patients with cancer at the end of life (63,64). We did not identify any studies evaluating the association between housing and end-of-life care among individuals diagnosed with cancer. Further investigation of associations of housing and cancer treatment, survivorship, symptom management, and end-of-life care is warranted.

Several studies evaluated the association between exposure to housing discrimination, experienced through interpersonal, institutional, and structural racism, and cancer outcomes (45-47,50-52,65). Studies evaluating the association between individual-level exposure to housing discrimination (interpersonal racism) had mixed results, with 2 studies using historical redlining data to evaluate the association between exposure to area-level measures of housing discrimination (systemic racism) and cancer outcomes found that residing in historically redlined areas was associated with worse access to early cancer detection (47,49). Several studies evaluated the association between contemporary area-level measures of housing discrimination

(institutional racism) and cancer outcomes. Results from these studies varied depending on how the study population and exposure measures were selected. Future studies should evaluate factors contributing to these findings in light of currently high levels of racial residential segregation. The impact of exposure to different types of housing discrimination is likely to be cumulative, interact with exposure to other types of discrimination, and result in a long-term impact on cancer mortality. However, none of the identified studies included both individual- and area-level measures in evaluating the association between exposure to housing discrimination and cancer outcomes or examined experiences of discrimination over one's residential history.

Our review showed that studies tended to focus on a single aspect of housing challenges at either the individual or area level. However, multiple aspects of housing may affect individuals diagnosed with cancer at the same time, and these aspects may work individually and synergistically to adversely affect health outcomes. Future studies may seek to use measures that incorporate multiple domains, including the physical quality of housing (eg, mold, pest infestation, peeling paint, drafts and energy inefficiencies, physical crowding), housing affordability (eg, fear of eviction, housing costs, overcrowding), and stability (eg, frequent moves or homelessness) as well as different types of housing discriminations (eg, interpersonal racism and institutional racism). Relatedly, we did not identify studies that examined the intersection of individual- and area-level housing measures. It is possible that, for example, the adverse health consequences of exposure to individual-level housing instability and unaffordability may be especially detrimental for cancer care among people living in areas historically targeted for disinvestment. Working to investigate the impact of multiple dimensions of housing and their cross-level interaction represents an important direction for future research.

Our review identified only a handful of studies that specifically examined policy-oriented interventions designed to address housing needs and overcome barriers to cancer care (66). Housing assistance programs and policies may reduce disparities by increasing household financial resources and health-care access and improving the residential neighborhood context. These programs include homelessness assistance grants, housing tax credit and rental subsidies, improving housing quality and infrastructure, diminishing exposure to environmental hazards, and colocating housing with health centers and social services (67). During the COVID-19 pandemic, housing policies have been implemented to enhance housing stability for low-income people, including extending moratoriums on evictions and foreclosures and increasing emergency rental assistance (68). However, the results from Wong et al. (58) suggested that providing housing assistance may be insufficient to overcome the multiple barriers in access to stable quality housing and health resources faced by underserved populations. Other structural barriers at the health-care system, institution, and provider levels should be considered and addressed in improving cancer care access. Future research is needed to understand the extent to which these types of system-level housing interventions alone or in conjunction with other support are able to help support cancer care and reduce inequities.

In addition to policy-level interventions, health systems, and providers are considering other ways to address housing-related social needs. As exemplified by the Center for Medicare and Medicaid Innovation's Accountable Health Communities demonstration project, there has been an increasing move to screen for health-related social needs and connect people who have needs to community-based resources. Other health systems have instituted patient navigation programs and developed medical-legal partnerships, which may help address housing needs among their patients (69-72). There are also examples of health systems and insurers who have invested in affordable housing programs, often for medically vulnerable individuals without housing (73,74). We did not find published studies that investigated the extent to which these types of programs, from housing-related needs screening to direct investment, hold promise in cancer care; therefore, this is an important avenue for future research.

We did not identify any studies addressing the complexity of housing challenges across material (eg, problems paying rent or mortgage) and psychosocial (eg, worry, distress) domains, nor did we identify studies incorporating aspects of housing challenges at the individual and area levels; these will be important for future research and practice. Moreover, existing studies focused only on 1-dimensional measures of housing challenges for cancer patients. However, housing may affect individuals in multiple dimensions. For example, low-income individuals diagnosed with cancer might face multiple housing risks at the same time, including high housing cost burden (rent, mortgage, utility bills), more environmental hazards (radon, pollution, mold), poor infrastructure (temperature, etc), and less housing stability (eviction, foreclosure). Research should incorporate multi-dimensional measures of housing to provide a better assessment of its association with health outcomes among cancer patients.

There are several limitations in the studies included in this review. Most studies evaluating the association between individual-level measures of housing insecurity and cancer outcomes used a convenience sample of patients recruited at a single institution or health-care system, limiting the generalizability of findings. Similarly, most studies evaluating the association between area-level housing insecurity measures and cancer outcomes used patients' address information from (single or selected) local cancer registries, also limiting the generalizability of findings. Several studies were conducted in highly selected samples, such as patients with mental illness and HIV. Additionally, small sample sizes and lack of overlap in area-level housing measures between racialized groups due to racial residential segregation may lead to insufficient power to detect statistically significant associations between exposure to housing insecurity and cancer outcomes. Therefore, larger and more representative study populations are needed in future research. Integrating individual- and area-level measures of housing insecurity into nationally representative health surveys and cancer registry data collection can improve quality and capacity of research evaluating the association between exposure to housing insecurity and cancer outcomes. Moreover, the bidirectional relationship between housing and socioeconomic status or health status complicates the selection of individual- and area-level characteristics that should be included in statistical analysis.

An important strength of this systematic review is that we used multiple scientific publication databases to identify articles related to several housing measures and cancer care and outcomes. This strategy allowed for comprehensive evaluation of current knowledge regarding the association between housing challenges and health outcomes throughout the cancer care continuum as well as the identification of knowledge gaps. However, this systematic review also has several limitations.

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First, even though we included published studies starting in 1980 through 2021, we may have missed some relevant studies due to the inconsistent terms used to define housing-related measures. To minimize this limitation, we also hand-searched the reference lists of each included article for any additional related studies not captured in the initial search process. Second, because of heterogeneity of housing measures, study populations, methods, outcomes, and cancer sites in underlying studies, we could not conduct formal quantitative meta-analyses to estimate the pooled effects across published research. Our systematic review excluded studies that evaluated the association between housing and cancer care and outcomes outside of the United States (75-77) because of differences in health systems and social safety net programs. Understanding associations of housing challenges with access to cancer care and outcomes in countries with different health systems and social safety nets will be important in identifying potential interventions and policy strategies.

In summary, this systematic review synthesized a large body of research conducted in the United States over 4 decades. Most studies reported that housing challenges, including housing needs, homelessness, and housing discrimination, were associated with worse cancer care and outcomes. We also identified several research gaps and opportunities for addressing housing challenges and reducing cancer disparities. More research on cancer stage at diagnosis, treatment, survivorship, and end-of-life care is needed to better understand the association between housing instability with access to care and outcomes throughout the cancer care continuum. Furthermore, research with more representative study populations, different cancer types, and multidimensional housing measures is warranted to provide more evidence to create effective interventions and policies to tackle this problem. Our findings highlight the need for clinicians and health-care systems to consider screening for housing needs and, once identified, supporting changes to effectively address the needs of individuals throughout the cancer care continuum and advance equitable access to care.

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Notes

Data Availability

The data from this study are available from the PubMed, Embase, Scopus, and CINAHL databases.

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