


Association of US County-Level Eviction Rates and All-Cause Mortality



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BACKGROUND: Housing instability is a key social determinant of health and has been linked to adverse short- and long-term health. Eviction reflects a severe form of housing instability and disproportionately affects minority and women residents in the USA; however, its relationship with mortality has not previously been described.

OBJECTIVE: To evaluate the independent association of county-level eviction rates with all-cause mortality in the USA after adjustment for county demographic, socioeconomic, and health-related characteristics.

DESIGN: Cross-sectional.

PARTICIPANTS: Six hundred eighty-six US counties with available 2016 county-level eviction and mortality data.

EXPOSURE: 2016 US county-level eviction rate.

OUTCOME: 2016 US county-level age-adjusted all-cause mortality.

KEY RESULTS: Among 686 counties (66.1 million residents, 50.5% [49.7–51.2] women, 2% [0.5–11.1] Black race) with available eviction and mortality data in 2016, we observed a significant and graded relationship between county-level eviction rate and all-cause mortality. Counties in the highest eviction tertile demonstrated a greater proportion of residents of Black race and women and a higher prevalence of poverty and comorbid health conditions. After adjustment for county-level socio-demographic traits and prevalent comorbid health conditions, age-adjusted all-cause mortality was highest among counties in the highest eviction tertile (Tertile 3 vs 1 (per 100,000 people) 33.57; 95% CI: 10.5–56.6 $p=.004$). Consistent results were observed in continuous analysis of eviction, with all-cause mortality increasing by 9.32 deaths per 100,000 people (4.77, 13.89, $p<.0001$) for every 1% increase in eviction rates. Significant interaction in the relationship between eviction and all-cause mortality was observed by the proportion of Black and women residents.

CONCLUSIONS: In this cross-sectional analysis, county-level eviction rates were significantly associated with all-cause mortality with the strongest effects observed among counties with the highest proportion of Black and women residents. State and federal protections from evictions may help to reduce the health consequences of housing instability and address disparities in health outcomes.

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INTRODUCTION

Eviction represents a traumatic and severe form of housing insecurity and is an important social determinant of health. In the USA, growing wealth inequality and a housing crisis have resulted in high rates of eviction since 2000 and declines in home ownership.¹ Nationally, approximately 1.6 million households are displaced from their homes annually, with women renters and those of Black race disproportionately affected.²

Prior studies have demonstrated the impact of eviction on adverse maternal and fetal health, self-reported mental and physical health, and poor control of chronic medical conditions.^{3,4} Moreover, eviction has been tied to disparities in access to healthcare, with evictees demonstrating an increased risk of health insurance coverage loss, reduced utilization of ambulatory services, and reduced prescription drug fills.⁵ The relationship between eviction and health was highlighted during the COVID-19 pandemic, during which employment loss and the threat of a rapid rise in evictions prompted a federal eviction moratorium. However, the independent association of eviction with all-cause mortality and correlation of eviction practices on health among Black and women renters in the USA have not been previously described. Therefore, in this analysis, we sought to evaluate the independent association of eviction rate with all-cause mortality at the county level.

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METHODS

Data Sources

This cross-sectional study used publicly available, de-identified, county-level data to study the association between eviction rates and all-cause mortality. We obtained county-level eviction rates from the Eviction Lab at Princeton University, which assembles data from a combination of court records, publicly available landlord-tenant case reports, comprehensive datasets from LexisNexis Risk Solutions and American Information Research Services Inc., and direct contact with judiciaries regarding filings.¹ Data on individual evictions were geocoded and spatially joined to generate regional estimates. Our exposure of interest was county-level executed evictions in 2016, the most recent year for which eviction data were available.

Primary Outcome and Covariates

Our primary outcome of interest was county-level age-adjusted all-cause mortality rate in 2016, obtained from CDC WONDER, an online database of underlying cause of death derived from death certificates and classified by four-digit International Classification of Diseases 10th Revision (ICD-10) codes. We additionally collected data on county-level socioeconomic and demographic characteristics from the American Community Survey and health-related characteristics from the CDC Behavioral Risk Factor Surveillance System. County characteristics encompassed three domains, including demographic composition (age, sex, race), socioeconomic characteristics (poverty, renter households, and college educated), and health characteristics including prevalent comorbidities (diabetes, hypertension, obesity, chronic obstructive pulmonary disease, hyperlipidemia, chronic kidney disease, and mental health disorders) and health behaviors (smoking). County characteristics were identified based on review of housing insecurity literature, and are consistent with prior analyses evaluating eviction and health.⁶ The hypothesized relationships between eviction, covariates of interest, and mortality are summarized in Fig. 1. The most adjusted model included confounding variables known to associate with both eviction and mortality (prevalent comorbid disease, sociodemographic traits), and excluded characteristics hypothesized to mediate the relationship between eviction and all-cause mortality (incident disease and reduced access to healthcare). The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline⁷ and received exemption by the Institutional Review Board of the University of Texas Southwestern, Dallas.

Statistical Analysis

We categorized counties into tertiles by eviction rate ranging from lowest (Tertile 1) to highest (Tertile 3) and compared county characteristics across groups using Jonckheere-

Terpstra tests. To evaluate the independent associations of eviction and county characteristics with all-cause mortality, we constructed a linear mixed model, sequentially adjusting for sociodemographic and clinical characteristics, and reported adjusted associations as absolute or standardized estimates. To account for unobserved county-level heterogeneity, linear mixed models were constructed with random effects for phenogroup membership determined by county characteristics. This model accounted for the possibility that clustered counties within a phenogroup may have had similar unobserved confounding that could have affected the association between eviction rate and mortality. Methods for determining county phenogroup membership have been described previously.⁸ Briefly, county clusters were determined using unsupervised hierarchical clustering of principal components followed by K means consolidation across county-level social, economic, physical environment, health behavior, and clinical care characteristics. To assess for the potential of a non-linear relationship in the association between eviction rate and mortality, we constructed a restricted cubic spline with knots at the 10th, 50th, and 90th percentiles and plotted the fully adjusted change in mortality across the range of county eviction rates. Sensitivity analyses were additionally performed for random effects at the state level and using geographical weighted regression (GWR) to assess for geographic clustering in the exposure of interest. The GWR model accounted for potential spatial correlations between county characteristics based on their proximity to one another while state-level clustering accounted for potential correlations in county characteristics by state as eviction policies are often developed at regional and state levels. A third sensitivity analysis was performed to evaluate the relationship between 2012 eviction rates on 2016 mortality rates in a subset of counties with available data, providing a short, 4-year lag time. Additional interaction analyses examined if the effects of eviction on all-cause mortality were moderated by the proportion of Black individuals and women within counties, with subsequent analyses performed in subgroups above (high) and below (low) the median proportions of each. Analyses were performed using SASv9.4 with a 2-sided $P < .05$ considered significant.

RESULTS

County Characteristics

We evaluated all-cause mortality for 686 counties (66.1 million residents, 50.5% [49.7–51.2] women, 2% [0.5–11.1] Black race) after exclusion of counties with missing eviction rate ($n=2426$ counties) and all-cause mortality data ($n=30$) (Supplemental Table 1). Overall eviction rates ranged from 0 to 17.5 per 100 renter households while county mortality rates ranged from 410 to 1377 age-adjusted deaths per 100,000. Median eviction rates were 0.6% in the lowest eviction tertile and 3.6% in the highest eviction tertile ($p < 0.0001$). Counties in the high eviction group were more likely urban and more

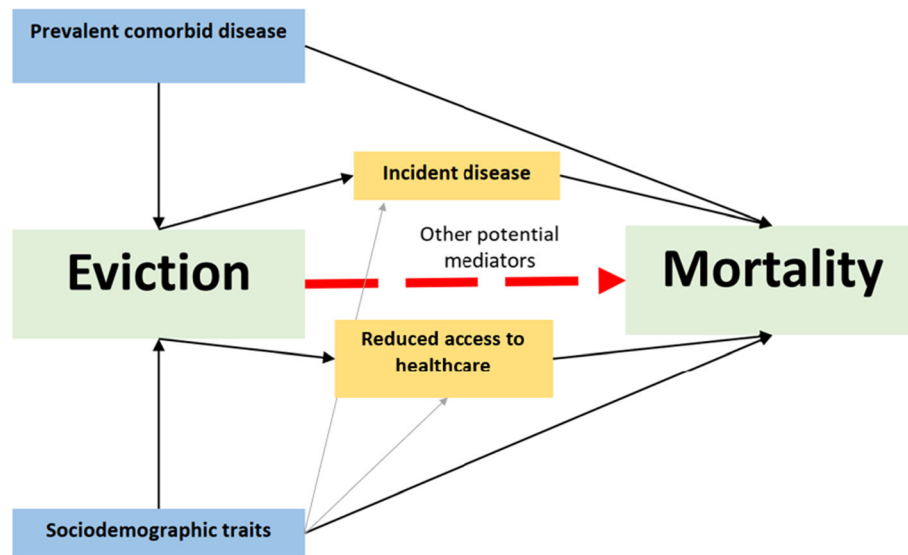


Fig. 1 Directed acyclic graph visualizing relationship between eviction and mortality

populous with higher proportions of residents of Black race and women, and a greater prevalence of poverty and comorbid health conditions (Table 1).

Primary Analysis of Eviction Rate and Mortality

In linear mixed modeling with clustering by county-level characteristics and adjusting for county-level demographic and social characteristics only, counties with the highest eviction rates had higher age-adjusted rates of mortality (Tertile 3 vs 1 [per 100,000 people] 40.31 (95% CI 17.24–63.38); $p=0.0007$). Addition of prevalent comorbid health conditions and behaviors to the model led to modest attenuation of the effect of eviction on mortality, but results remained significant in the fully adjusted model (Tertile 3 vs 1 [per 100,000 people] 33.57; $p=0.004$). Assessed continuously, higher county-level eviction rates were significantly associated with higher levels of all-cause mortality with every 1% increase in eviction rates corresponding to an increase in all-cause mortality of 9.32 deaths per 100,000 persons (95% CI (4.77, 13.89), $p<0.0001$) (Table 2). In cubic spline analysis, a strong linear association was observed between eviction rate and all-cause mortality across the range of county eviction rates such that higher eviction rates corresponded to higher levels of all-cause mortality (Fig. 2). In sensitivity analyses using state-level clustering and geographically weighted regression, we observed a consistent association between eviction and all-cause mortality such that for every 1% higher eviction rate, there was a statistically significant higher all-cause mortality (Table 3). Sensitivity analyses evaluating a subset of counties with available data on eviction rates for 2012 additionally demonstrated a consistent relationship between eviction and mortality (Table 3).

Interaction Analyses

Furthermore, the association between county-level eviction rates and mortality was modified by county-level proportion

of Black individuals ($p=0.03$) and women ($p<0.0001$). In stratified analyses by proportion of women, the relationship between eviction and mortality was strongest in the subgroup of counties with a proportion of women above the median (high), among whom mortality rates were 13.19 deaths (per 100,000 individuals) higher for every 1% higher eviction rate, representing a more than fivefold difference compared to counties with a lower proportion of women. Notably, in stratified analysis by proportion of Black residents, we observed similar point estimates between subgroups above and below the median, despite a previously positive interaction term.

DISCUSSION

This cross-sectional study analyzing Eviction Lab data demonstrates the linear relationship between eviction and mortality at the county-level and highlights the complex relationship between housing instability, race, and gender in the USA. We observed that counties with the highest rates of eviction experienced the highest rates of mortality, with persistent effects after adjustment for other commonly measured social determinants of health such as poverty and education level, which have previously been shown to associate with adverse health outcomes. We additionally observed effect modification in counties with the highest proportion of women, in particular, suggesting that the health impacts of eviction may be disproportionately felt in some communities, and highlighting the relationship between social disparities in housing and health disparities.

Our findings are consistent with a prior cross-sectional analysis of eviction and mortality within the Swedish population, and extend these findings to a US population.⁶ In categorical and continuous analysis of eviction rates, we demonstrate a consistent and graded relationship between eviction rates and all-cause mortality at the county level with

Table 1 County demographic, socioeconomic, and health characteristics by eviction-rate tertile

	All counties, median (25 th %, 75 th %) (n=686)	Eviction group, median (25 th %, 75 th %) ^c			P-Trend
		Low eviction (n=229)	Intermediate eviction (n=228)	High eviction (n=229)	
Eviction rate, per 100 rentals	1.5 (0.8, 2.9)	0.6 (0.3, 0.8)	1.5 (1.3, 1.9)	3.6 (2.9, 5.0)	<0.0001
Population, in thousands	24.5 (11.5, 71.5)	29.7 (5.8, 17.8)	29.7 (15.3, 72.2)	66.4 (28.7, 195.6)	<0.0001
Demographic characteristics^a					
Urban classification, mean (standard deviation)	36.3 (48.1)	12.6 (33.3)	34.2 (47.5)	62.0 (48.6)	<0.0001
Age 65+, %	19.0 (16.7, 21.6)	20.8 (18.3, 23.6)	19.0 (17.2, 21.6)	17.4 (15.4, 19.4)	<0.0001
Women, %	50.5 (49.7, 51.2)	50.0 (49.3, 50.7)	50.5 (49.8, 51.1)	50.9 (50.4, 51.6)	<0.0001
Hispanic, %	3.4 (1.9, 7.5)	2.7 (1.7, 6.2)	2.9 (1.7, 6.3)	5.0 (2.7, 8.8)	<0.0001
Non-Hispanic Black, %	2.0 (0.5, 11.7)	0.5 (0.2, 1.3)	1.4 (0.6, 6.0)	11.9 (3.7, 26.2)	<0.0001
Non-Hispanic White, %	87.6 (70.2, 94.1)	92.7 (83.7, 95.4)	89.5 (77.5, 94.4)	75.6 (58.4, 87.7)	<0.0001
Other, %	2.6 (1.8, 4.2)	1.9 (1.4, 3.0)	2.6 (1.9, 4.2)	3.5 (2.4, 5.0)	<0.0001
Socioeconomic characteristics^a					
Poverty, %	12.8 (10.1, 16.6)	12.2 (10.0, 16.0)	12.7 (9.5, 16.5)	13.8 (10.9, 16.9)	0.02
Renter households, %	27.3 (23.51, 31.52)	24.9 (21.81, 28.23)	27.2 (23.4, 31.1)	30.1 (26.1, 36.4)	<0.0001
College educated, %	18.4 (14.6, 23.9)	17.8 (14.6, 21.6)	17.9 (13.8, 24.0)	19.4 (15.1, 26.9)	0.007
Health characteristics^b					
Diabetes, %	10.1 (8.8, 11.8)	9.1 (8.4, 11.0)	9.9 (8.6, 11.8)	10.9 (9.8, 12.1)	<0.0001
Hypertension, %	30.7 (28.6, 34.4)	29.2 (27.9, 31.9)	30.1 (28.2, 34.5)	32.6 (30.7, 35.5)	<0.0001
Obesity, %	35.5 (32.9, 37.8)	35.9 (33.2, 37.8)	35.5 (32.7, 37.9)	35.2 (32.8, 37.5)	0.23
Current smoking, %	20.9 (18.6, 23.7)	19.8 (18.0, 23.1)	21.5 (18.8, 23.9)	21.7 (19.7, 23.8)	<0.0001
COPD, %	7.4 (6.3, 8.8)	6.6 (6.0, 8.8)	7.5 (6.2, 9.1)	7.9 (7.1, 8.7)	<0.0001
Hyperlipidemia, %	30.0 (28.9, 31.4)	29.5 (28.1, 31.2)	30.0 (29.1, 31.7)	30.4 (29.5, 31.4)	<0.0001
Chronic kidney disease, %	2.8 (2.6, 3.0)	2.7 (2.5, 2.9)	2.7 (2.5, 3.0)	2.9 (2.6, 3.1)	<0.0001
Mental health disorder, %	14.9 (13.0, 16.5)	13.4 (12.1, 16.3)	15.3 (13.1, 17.1)	15.4 (14.2, 16.4)	<0.0001

^aDemographic and socioeconomic traits were obtained from the American Community Survey, compiled by the U.S. Census Bureau. Methods and definitions of specific variables may be found at <https://www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html>

^bHealth characteristics are obtained from the CDC Behavioral Risk Factor Surveillance System. Common definitions for included health traits may be found at https://www.cdc.gov/bfss/annual_data/annual_2016.html

^cValues presented represent median (IQR) of mean estimates within each tertile

adjustment for a wide array of county-level characteristics. Prior literature has established the damaging effects of evictions on job loss and resulting financial hardship, social disruption, and further housing instability.^{9–11} Additionally, prior qualitative studies have demonstrated the links between eviction and health outcomes, with evictees reporting higher levels of psychosocial stress and adoption of unhealthy behaviors such as poor diet and smoking.^{4,12–14} Moreover, a prior longitudinal study of eviction among young adults found that individuals experiencing eviction were more likely to report poor general and mental health than their counterparts, with the greatest negative impacts occurring within the first 12

months following eviction respondents.¹⁵ In demonstrating an independent association between eviction and mortality, our findings suggest that the impacts of eviction may extend beyond intermediate social and health outcomes to contribute to county-level disparities in mortality.

We additionally report that counties with higher proportions of women and Black residents demonstrated the strongest association between eviction and mortality. Prior studies have shown that eviction rates are highest among Black and women renters: Black renters make up more than 30% of eviction filings despite representing less than 20% of renters nationally, while women experience a 2% higher risk of eviction than

Table 2 Association of county-level eviction rate with all-cause mortality in multivariable linear regression modeling

	Effect estimates (95% CI)	P value
Overall cohort		
Eviction Tertile 2 (vs T1)	13.26 (−5.6, 32.2)	0.17
Eviction Tertile 3 (vs. T1)	33.57 (10.5, 56.6)	.004
Mortality (per 100,000 people) per 1% increase in eviction rate	9.32 (4.77, 13.89)	<.0001
Subgroup with high proportion of Black individuals		
Mortality (per 100,000 people) per 1% increase in eviction rate	6.1 (0.64, 11.57)	0.03
Subgroup with low proportion of Black individuals		
Mortality (per 100,000 people) per 1% increase in eviction rate	6.89 (−4.1, 17.89)	0.22
Subgroup with high proportion of women		
Mortality (per 100,000 people) per 1% increase in eviction rate	13.19 (7.38, 19.01)	<0.0001
Subgroup with low proportion of women		
Mortality (per 100,000 people) per 1% increase in eviction rate	2.61 (−5.2, 10.43)	0.51

Adjusted model includes eviction rate + sociodemographic characteristics (urban categorization, population, and proportion above age 65, female, non-Hispanic Black race, Hispanic ethnicity, college educated, renters, and living in poverty) + clinical characteristics (county age-adjusted prevalence of diabetes, obesity, current smoker, hypertension, chronic obstructive pulmonary disease, hyperlipidemia, chronic kidney disease, and mental health disorders)
All models are represented as standardized estimated change in all-cause age-adjusted mortality per 100000 people (95% confidence interval) unless otherwise stated

men across all racial/ethnic groups.² We extend this observation in demonstrating a stronger association between eviction rates and all-cause mortality in counties with a higher than median proportion of women residents. Notably, although we observed interaction by the proportion of Black residents, point estimates in stratified analysis were similar in counties with a proportion of Black residents above and below the median, suggesting that effect modification by the proportion of Black residents may occur at the extremes rather than the median. Prior studies examining the experiences of eviction among racial and ethnic minorities and women similarly suggest higher levels of mental and physical stress and longer-

lasting impacts on health as a result of eviction, but results have been inconsistently shown.^{4,15}

Our study has significant public health implications and suggests the potential for discriminatory housing practices and policies to exacerbate racial and gender health disparities. Weeks after the end of the COVID-19 era federal eviction moratorium, 9.9 million adults were living in households at least 1 month behind in rent, placing millions at risk for impending eviction and potentially devastating downstream social and health consequences.¹⁶ By contrast, during the COVID-19 pandemic, strong state-wide protections against eviction were associated with a 2% absolute reduction in

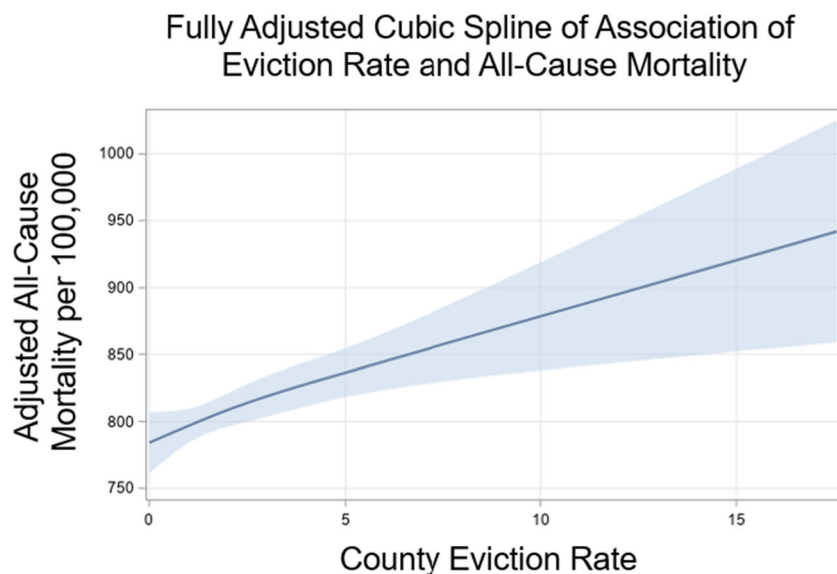


Fig. 2 Cubic spline of the fully adjusted association of eviction rate and age-adjusted mortality

Table 3 Sensitivity analyses modeling the association of eviction rate and 2016 all-cause mortality

	Tertile 1 (ref)	Tertile 2 (vs T1) effect estimate (95% CI)	Tertile 3 (vs T1) effect estimate (95% CI)
Sensitivity analysis #1: geographically weighted regression model	–	12.52 (12.2, 12.9)	35.65 (35.1, 36.2)
Sensitivity analysis #2: mixed linear regression model with state-level clustering	–	12.32 (–6.6, 31.2)	34.48 (9.28, 59.68)
Sensitivity analysis #3: mixed linear regression model with phenogroup-based clustering, using 2012 eviction cohort	–	18.68 (2.49, 34.87)	41.46 (21.38, 61.53)

Adjusted model includes eviction rate + sociodemographic characteristics (urban categorization, population, and proportion above age 65, female, non-Hispanic Black race, Hispanic ethnicity, college educated, renters, and living in poverty) + clinical characteristics (county age-adjusted prevalence of diabetes, obesity, current smoker, hypertension, chronic obstructive pulmonary disease, hyperlipidemia, chronic kidney disease, and mental health disorders)

All models are represented as standardized estimated change in all-cause age-adjusted mortality per 100000 people (95% confidence interval) unless otherwise stated

mental distress when compared to weaker protections.¹⁷ Policies aimed at increasing affordable housing by means of regulatory approaches and cushioning the stressors that contribute to housing instability may translate to improvements in downstream health disparities, while increased protections for renters may mitigate the psychosocial stress associated with eviction.¹⁸

Our analysis also has notable limitations. First, 2016 eviction data capture only 22% of US counties of which 2% of residents were of Black race due to incomplete or missing statewide reporting on evictions, limiting the generalizability of our findings. Second, we studied eviction enforcements through the judicial system rather than eviction filings or “informal evictions” that take place outside of the court system, which may result in an underestimation of eviction rates and their relationship with adverse health. The health impacts of eviction at the individual level may take years to accrue and may not be captured in the current cross-sectional design, though consistency of our results in sensitivity analysis using 2012 eviction data support the findings described. Though we attempted to account for mental health disorders which are commonly associated with higher levels of housing instability, this variable did not capture drug and alcohol use disorder rates, which may contribute to the association of eviction and mortality. Lastly, the mechanisms for eviction and mortality are likely multifactorial and we were limited in assessing mediating pathways in our study.

In this ecological analysis, we find a linear association between eviction rate and all-cause mortality at the county level. Future prospective longitudinal studies may elucidate the bidirectional relationship between housing instability and adverse health and identify opportunities for intervention.

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