Without shelter, people die: disproportionate mortality rates among King County's homeless
population, 2009 - 2019

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Abstract

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People living without benefit of decent housing suffer from a wide range of life-shortening health conditions and die younger than the general population. We created a dataset constructed from an ongoing list of homeless decedents who died in King County, maintained by a Seattle advocacy organization (Women's Housing Equality and Enhancement League), and the King County Medical Examiner's death certificate data, supplemented by in-depth mortality case notes. Medical and contextual information were reviewed and cross-checked to ascertain causes and modes of death for each case. The dataset for this study includes decedents who were *presumed to be homeless* upon death, and who died in King County between 2009 and 2019. Data were analyzed to observe cause-specific mortalities by year and compare to Washington state's general population. The average age at death among decedents in our study was 48.9, in comparison to the Washington state life expectancy of 80.3 years. Using the annual Point in Time Count as our denominator, we estimated the non-age-adjusted all-cause mortality rate among King County's homeless population to be, on average, 1.5x that of the general population for the eleven-year period. Homicide rates were, on average, 19x higher among homeless than the general population, and suicide was 5.5x times higher than the general population. Roughly

one-third of deaths were attributed to "natural causes" and another one-third to drug or alcohol acute intoxication. Mortality rates trended upward over time for the homeless population, while rates for the general population remained stable over the study period. Our study fills a gap in the literature about the high rates of death and disproportionate causes among those living on the streets of one of the wealthiest regions of the nation. Our project also offers a blueprint for how other counties can comprehensively track and report homeless deaths. Revealing the magnitude and causes of deaths for this vulnerable population may motivate policy change.

Introduction

People living without benefit of decent housing suffer from a wide range of life-shortening health conditions. Living unsheltered and in unstable conditions make individuals particularly vulnerable to weather, vehicles, and the actions of other humans. Those experiencing homelessness also have reduced access to health services, employ coping mechanisms and health behaviors with predictably adverse outcomes, such as substance use (Robertson, Zlotnick, & Westerfelt, 1997), are vulnerable to the effects of excessive stress (Geronimus, Hicken, Keene, & Bound, 2006), are more likely to be involved in and targeted by the justice system (Mogk, Shmigol, Futrell, Stover, & Hagopian, 2019), and in general suffer significantly poorer health outcomes until they die younger (Barrow, Herman, Cordova, & Struening, 1999; Kasprow & Rosenheck, 2000). Seattle/King County, Washington has the third highest number of people experiencing homelessness in the US, after New York City and Los Angeles County.

Academic studies of homeless health and mortality tend to focus on cohorts of persons who utilize local homeless social or health services. Because a significant proportion of homeless people stay off the grid of service providers, they are not captured in these studies. For example, the Philadelphia Homeless Death Review (Philadelphia Department of Public Health, 2017) found nearly one in four decedents were unknown to city homeless service systems, including emergency shelter and street outreach services. These findings suggest that homeless death counts based on homeless service utilization may significantly underrepresent the true scope of homeless mortality.

A new dataset - which includes data on presumed homeless decedents regardless of service utilization - provides a much needed tool to facilitate a broader look at disproportionate mortality amongst homeless individuals in King County.

Background

Housing status is a key predictor of health outcomes and life expectancy. Collecting mortality data and tracking changes in mortality rates are essential tools for revealing the health disparities that homeless individuals face, while providing evidence for much needed expansion of affordable housing. Studies indicate homelessness is linked with high morbidity rates and reduced life expectancies in comparison to the general population.

Homeless individuals die at an average of 51 years in Los Angeles, 49 years in Philadelphia, and 51 years in San Francisco, significantly shorter life spans than enjoyed by the average American (78.6 years) (LA County Department of Public Health, 2019; Philadelphia Department of Public Health, 2017; San Francisco Department of Public Health, 2019; Murphy, Xu, Kochanek, & Arias, 2018). US studies have found living unsheltered makes individuals especially vulnerable to extreme weather that lead to early death (Every, Richardson, & Osborn, 2019; Cusack, VanLoon, Kralik, Arbon, & Gilbert, 2013). An Arizona report found homeless individuals were overly represented among deaths related to heat exposure, while additional studies have shown high risk of skin cancer attributable to excessive sun exposure and limited use of sun protection (Putnam, Hondula, Urban, Berisha, Iniguez, & Roach, 2018; Truong, et al., 2018). A retrospective cohort study of homeless U.S. veterans found them nearly three times as likely to die as their housed counterparts (Schinka, Leventhal, Lapcevic, & Casey, 2018). A study of shelter users in New York City reported age-adjusted mortality rates four times higher

than the general US population; specifically, the cohort of women aged 25-44 experienced a death rate more than 14 times higher (Barrow, Herman, Cordova, & Struening, 1999). Homeless adults who utilized a Boston "health care for the homeless" program in the early 1990s had an average age of death at 47, and a crude mortality rate of 1,114 per 100,000 compared to the national average of 888 per 100,000 (Hwang, Orav, O'Connell, Lebow, & Brennan, 1997). In a similar study of homeless service utilizers, researchers in Philadelphia reported age-adjusted mortality rates 3.5 times that of the general city population. The homeless cohort's potential years of life lost before age 75 was 3.6 times greater than the general population (Hibbs et al, 1994).

While there is considerable evidence that homeless persons experience disproportionately higher rates of mortality, there is less exploration of cause of death, specifically violent death. One US-based study found almost half of all subjects surveyed said they had been victims of violence while homeless, and more than 60% said they had seen a peer violently attacked (Meinbresse, Brinkley-Rubinstein, Grassette, et al., 2014). Another analysis found one in five (21%) violent deaths among homeless people in Maryland were attributed to homicide, with an additional 14% attributed to suicide (Stanley, Jansson, Akinyemi, Clifford, & Mitchell, 2016). Sacramento County's review of homeless deaths from 2002-2017 found the homeless suicide rate to be 15 times higher, and homicide rate 23 times higher than the general population (Sacramento County Department of Health Services, 2018). Still, these studies fail to incorporate other injurious modes of death specifically associated with homelessness. These include getting hit by cars, being crushed in recycling bins while sleeping, tent fires, and drowning. An increase in train deaths among unhoused people has also been reported (Scheier, 2020).

To understand the national prevalence of homelessness, the U.S. Housing and Urban Development agency requires metro areas receiving certain federal grants conduct an annual Point in Time (PIT) count of people living without housing (WA Dept of Commerce, n.d.). The 2018 PIT count reported approximately 553,000 people in the United States were unhoused, one-third of whom were unsheltered and sleeping in public spaces (US Department of Housing and Urban Development, 2018). However, experts have warned true homelessness is significantly underestimated by PIT counts, which are typically conducted on one night during the coldest days of winter (National Law Center on Homelessness & Poverty, 2017). Additionally, variations in methodology from year to year and the complicated nature of locating and counting all people experiencing homelessness make PIT counts inexact, yet they remain the only comprehensive source of data on homeless populations and serve as the basis for our calculation of mortality rates in King County. Numbers from King County's PIT count have been steadily trending upward over the last eleven years, showing a more than 25% increase in homeless residents between 2009 and 2019 (8,916 to 11,199) (All Home King County, 2019).

Age, race, ethnicity, sex, and other demographic factors are regularly reported on death certificates across U.S. counties to allow for the calculation of mortality rates by subgroup, but housing status is not typically included. King County is unique in that the Medical Examiner Office has been tracking homeless mortality data since 2002/2003. Our study of homeless deaths, with a particular focus on injuries in the Seattle metro area, takes advantage of a relatively new data collection and verification effort in collaboration with King County's Medical Examiner Office and a local homeless advocacy organization, Women's Housing Equality and Enhancement League (WHEEL). Our study fills a gap in the literature on homeless mortality, while providing a blueprint for how other counties might begin comprehensively tracking homeless deaths.

Methods

This retrospective study explores cause of death for 1,271 decedents who died in King County between 2009–2019 and were *presumed homeless* upon death. As the Medical Examiner Office investigates only deaths under its jurisdiction, the count is likely an underestimate of the true number.

Data sources

The King County Medical Examiner Office (MEO), which has intentionally tracked and reported on homeless deaths since 2002/2003, uses a mix of contextual clues as well as information provided by family members, friends, and witnesses to determine a decedent's presumed housing status. The MEO uses the federal definition of *homeless*-- "individuals without evidence of permanent housing who lived on the streets or stayed in a shelter, vehicle, or abandoned building at the time immediately preceding death" (Public Health – Seattle & King County, 2019b). This does not include formerly homeless individuals living in supportive or transitional housing, or in other unstable situations.

The data set was constructed by a team of UW MPH students in 2019, including the lead author of this paper, and was built from two sources. The first is a list of the names and details of homeless deaths reported monthly by the MEO to community stakeholders, which includes more than 20 variables, including the decedent's name, age, race, ethnicity, sex, death date, event address, and diagnostic cause of death.

The second data source includes notes on each death provided by the Seattle community organization WHEEL/Women in Black, based on information from people in the homeless community.

Cause of death

We reviewed and cross-checked data abstracted from the additional narrative notes provided by both WHEEL/Women in Black and the MEO to create two variables characterizing the primary manners and causes of death. The first of these categorizes deaths as unintentional injuries, natural causes, drug-and-alcohol induced, homicide, suicide, or unknown/other.

We also created a second *subcategory* variable to add more detail. For example, within the category of *homicide*, subcategories included beaten, gun, stabbing, and other/unknown. When the manner or cause of death was uncertain (ex: bodies in advanced stages of decomposition), the deaths were classified as injury: other/unknown. Further, when the intentions of an action that resulted in death were unknown (ex: fall off bridge, struck by train), deaths were categorized as an unintentional injury unless there was reasonable evidence to presume suicide or homicide. An additional notes column flags potentially misclassified cases for future research efforts. It could be the case that drugs or alcohol played a role in chronic disease or accidental injury deaths, but nonetheless, we classified only clear overdoses and/or acute poisoning as "drug-and-alcohol induced."

We focus on injurious deaths in this analysis, including suicide, homicide, blunt force injuries caused by vehicles, and other instances where trauma is inflicted on the person. In general, deaths (or their immediately preceding incidents) must have taken place within King County to be included. More extensive methodology for reviewing case notes and classifying deaths is detailed in the Homeless Deaths Database Methodology document, developed by Kate Causey, MPH, with support from the other team members. This document is available upon request.

Table 1: Variables contained in the King County homeless deaths database

Demographic Variables							
Sex Age Race/Ethnicity							
Manner and causes of Death							
<u>Category</u>	Injury	Natural Cause	Homicide	Suicide	Drug- or Alcohol	Unknown/ Other	
<u>Subcategory</u>	Asphyxia Crushed Drowned Fall Fire Hypothermia Traffic-related Train Other/Unknown	Acute Infection Cardiovascular Disease Pulmonary Disease Liver Disease Diabetes Cancer Other/Unknown	Beaten Gun Stabbing Other/Unknown				

Data base created from King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, supplemented by case notes from the Women's Housing Equality and Enhancement League

Cleaning the data

Several cases in our data set were labeled as "Pending" at the time of our analysis. For the purposes of this paper, any case listed with a category as "Pending" was re-categorized as "Unknown/Other." If age was missing or unknown in our dataset, age was left as blank. If no exact age was given (i.e. age was listed in the data set as being in the 30-60 range), age was left as blank. For any fetal or infant deaths, age was categorized as zero. Where sex was missing in the data set, the authors used contextual clues from medical notes, WHEEL/Women in Black notes, and news reports to fill in the gaps. Where sex was still unknown due to lack of information or because the body was in an advanced stage of decomposition, sex was left as blank.

Our data sources reported Hispanic ethnicity as a separate variable from race. To match Federal and Washington State Department of Health data conventions, we created a new variable, RaceEthnicity, to include Hispanic/Latinx individuals. In our database, individuals whose race was listed as white and whose ethnicity was listed as Hispanic were categorized as Hispanic/Latinx in the RaceEthnicity variable. If Hispanic origin was unknown but the race was known, RaceEthnicity defaulted to the individual's identified race.

Several deaths were categorized in our dataset as Injury, Drug-and-Alcohol Induced, or Other/Unknown, however contextual notes indicate they may be homicides or suicides and require further investigation. These cases were left in their original category but flagged as an opportunity for further research and analysis.

We used Stata/SE 15 software for data analysis. We analyzed crosstabs for each cause of death in relation to independent demographic variables. We used chi squared tests to assess the

significance of any associations and t-tests to assess the significance of differences in age by demographic variables.

We constructed crude mortality rates for each category of death, for each of the years in our data set (2009-2019) and compared these to Washington state crude mortality rates. We also constructed standardized mortality ratios (SMR) for homicides, suicides, drug-and-alcohol induced deaths, and pedestrian deaths in the King County population.

Results

A total of 1,271 cases were included in our analyses, encompassing all recorded King County homeless deaths 2009-2019. The average age at death was 48.9 (sd= 13). Average age at death was 44.8 (sd=14) for females, and 49.9 (sd=12.7) for males. Characteristics of the decedents included in our analysis are displayed in Table 1.

Table 2: Demographics of King County homeless decedents, by year 2009-2019

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019*	All years
Age													
	<18	0	0	0	0	0	1	0	0	2	2	1	6
	18-24	1	2	1	1	3	3	6	2	5	6	3	33
	25-44	39	31	18	27	49	33	67	66	76	75	75	556
	45-64	32	21	26	51	55	49	52	63	87	101	77	614
	65+	4	2	2	2	1	6	5	8	4	12	8	54
	missing	1	0	0	1	0	0	0	2	0	0	4	8
	Total	77	56	47	82	108	92	130	141	174	196	168	1271
Race/Ethnicity													
	AIAN	3	4	2	4	10	3	7	11	11	7	9	
	Asian/PI	0	0	1	0	3	4	5	3	7	4	6	
	Black	11	4	7	9	10	16	13	19	26	28	29	
	Hispanic/Lat.	6	1	1	6	2	2	6	4	10	5	2	
	White	53	40	32	59	79	61	95	99	114	146	112	
	Other	0	0	2	0	0	1	1	1	3	4	3	
	missing	4	7	2	4	4	5	3	4	3	2	7	
	Total	77	56	47	82	108	92	130	141	174	196	168	1271
Sex													
	Female	8	15	10	11	18	12	27	26	32	36	40	
	Male	69	41	37	71	90	80	103	114	142	160	128	
	missing	0	0	0	0	0	0	0	1	0	0	0	
	Total	77	56	47	82	108	92	130	141	174	196	168	1271

Note: 2019 data may be incomplete or under renewal for accuracy.

All Cause Deaths

Over the course of the years in our analysis (2009-2019), King County's crude homeless mortality rate increased from 864 to roughly 1,500 per 100,000 people. By comparison, Washington State's crude overall mortality rates remained roughly stable during those same years, ranging from 714 to 780 per 100,000 people. Figure 1 compares crude mortality rates between these two populations over time.

Figure 1: King County Homeless and Washington State Crude Mortality Rates Over Time
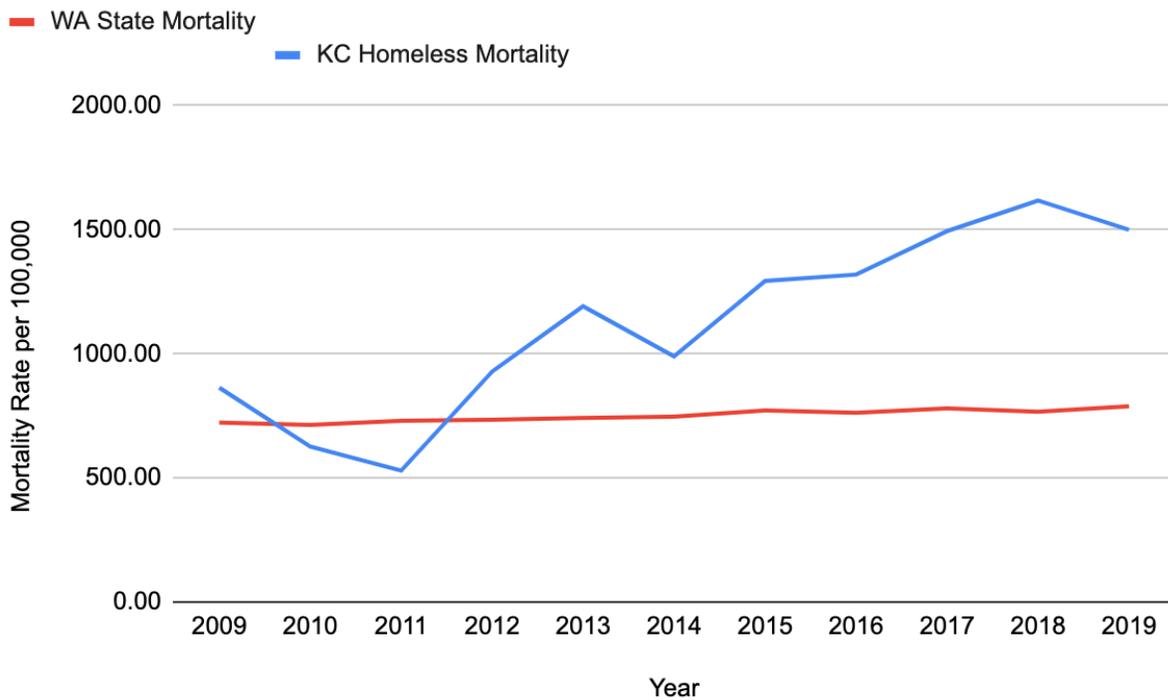
Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League, and Washington State Department of Health, Center for Health Statistics.

In our dataset, the crude mortality rate (per 100,000) among men was 944 and 214 among women. Women represented only 18.4% of the decedents in our analysis but tended to die younger than men (44.8 years and 48.9 years respectively). The crude mortality rate (per 100,000) was 812 among white decedents, 1157 for black decedents, 41 for Hispanic/Latinx, 65 for AIAN, and 30 for Asian/PI.

Causes of Death

The largest single category of death was "natural," at 34.5%, including chronic conditions such as diabetes mellitus, heart disease, pulmonary disease, cancer, and complications from chronic substance or alcohol use. A similar proportion of deaths were categorized as drug-or-alcohol induced, 33.52% of cases.

Injury deaths (15%), a focus of this paper, included traffic and train accidents, hypothermia, falls, and drowning. Among injury deaths, 30.3% (58/192) were traffic-related deaths (typically pedestrians or cyclists being hit by vehicles), 20% (40/192) were attributed to hypothermia, 13% (25/192) were caused by falls, and 5.7% (11/192) were drownings. Suicide accounted for approximately 7.3% of all homeless deaths, and homicide for 5.5%. Table 3 shows the numbers and total percentages of deaths attributed to each manner of death, by year. More than half (41/71) of all homicides were attributed to guns, and 18.3% (13/71) were stabbings. In 14% (6/41) of gun deaths, the firearm was discharged by a police officer.

Table 3: Category of King County Homeless Death Causes by Year, 2009-2019

Year	Drug-and-Alcohol Induced	Homicide	Injury	Natural	Other/Unknown	Suicide	Total
2009	19	4	10	32	2	10	77
2010	19	4	13	14	2	4	56
2011	18	1	9	14	1	4	47
2012	28	2	11	33	4	4	82
2013	45	7	15	32	3	6	108
2014	27	4	13	34	6	8	92
2015	47	10	21	38	5	9	130
2016	37	8	22	60	5	9	141
2017	59	9	29	63	1	13	174
2018	65	11	29	74	3	14	196
2019	63	11	20	45	16	13	168
Total	427 (33.6%)	71 (5.6%)	192 (15%)	439 (34.6%)	48 (3.8%)	94 (7.4%)	1271 (100%)

Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League.

Figure 2: Primary Categories of Homeless Deaths in King County by Year, 2009-2019
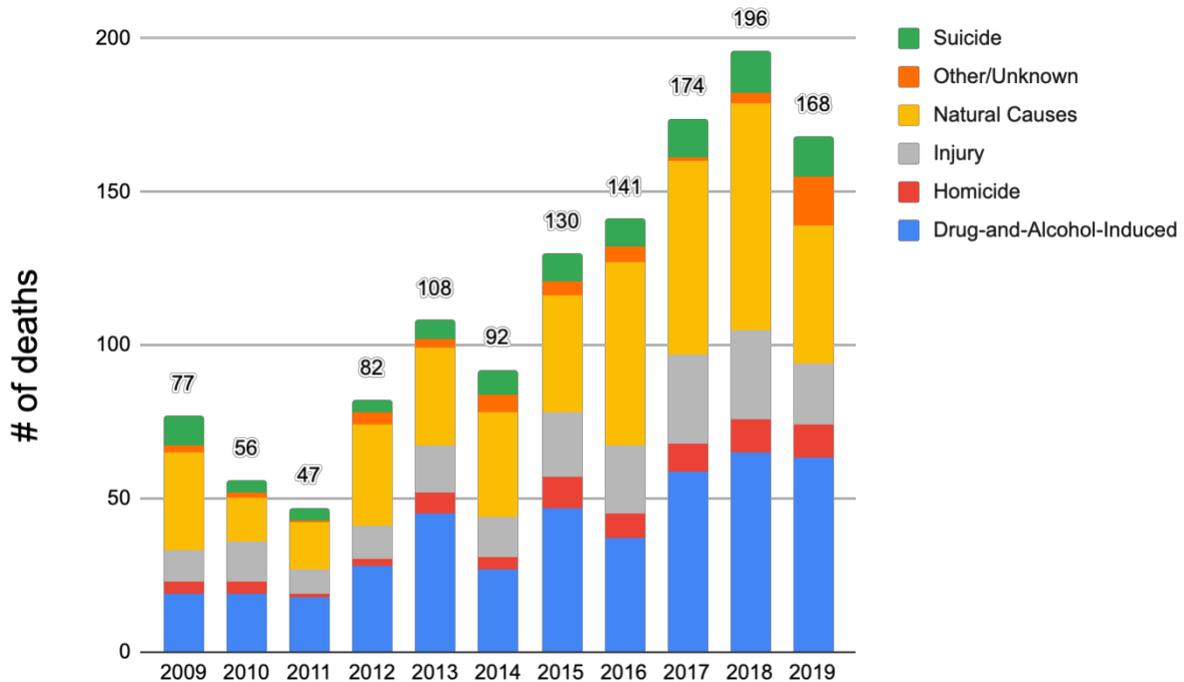
Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League.

Standardized Mortality Ratios (SMR) were computed for each year, to compare the homeless death rate in King County to the statewide population's death rate. We used the homeless population as reported in annual King County Point in Time counts as our denominator. We performed these calculations for categories of death where corresponding data were available for the Washington state population. See Table 4 and 5.

Table 4: King County Homeless Standardized Mortality Ratios, Homicide and Suicide, 2009-2019

Year	Homicide				Suicide			
	expected*	observed^	SMR	95% CI	expected*	observed^	SMR	95% CI
2009	0.26	4.00	15.47	0.31, 30.63	1.19	10.00	8.43	3.21, 13.66+
2010	0.24	4.00	16.58	0.33, 32.82	1.23	4.00	3.24	0.06, 6.42
2011	0.24	1.00	4.17	-4, 12.35	1.24	4.00	3.22	0.06, 6.37
2012	0.31	2.00	6.47	-2.50, 15.44	1.29	4.00	3.10	0.06, 6.14
2013	0.26	7.00	26.64	6.9, 46.37+	1.27	6.00	4.73	0.95, 8.51
2014	0.29	4.00	13.88	0.28, 27.49	1.43	8.00	5.59	1.72, 9.46+

2015	0.34	10.00	29.27	11.13, 47.42+	1.57	9.00	5.74	1.99, 9.49+
2016	0.32	8.00	24.95	7.66, 42.24+	1.59	9.00	5.65	1.96, 9.34+
2017	0.43	9.00	20.89	7.24, 34.54+	1.99	13.00	6.53	2.98, 10.08+
2018	0.46	11.00	23.90	9.78, 38.02+	1.96	14.00	7.14	3.4, 10.87+
2019	0.44	11	25.19	10.30, 40.07+	1.94	13	6.71	3.06, 10.35+

Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019 and Washington State Department of Health, Center for Health Statistics. SMR, as portrayed, represents the number of observed homeless deaths for homicide and suicide in King County, compared to the general state population. When the Standardized Mortality Rate (SMR) is higher than 1.0, this represents a higher number of deaths than expected. For example, the 2018 homicide rate in King County is 23.9 times higher than would be expected for the statewide population.

*Expected number of deaths based on WA state homicide mortality rate
^Observed number of deaths by homicide among KC homeless
*+Statistically significant, p < .05*

Figures 3 and 4 display a comparison of crude homicide and suicide rates, respectively, between the King County homeless population and the Washington state general population over time.

Figure 3: King County Homeless and Washington State Homicide Mortality Rates (2009-2019)
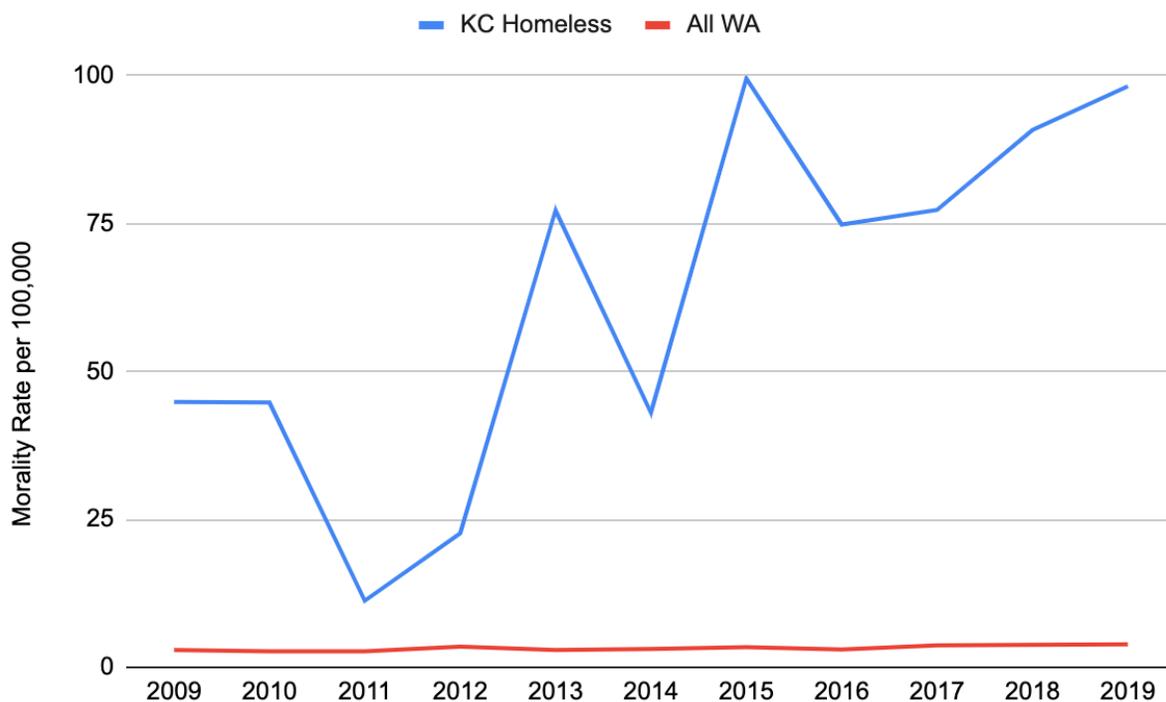
Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League, and Washington State Department of Health, Center for Health Statistics.

Figure 4: King County Homeless and Washington State Suicide Mortality Rates (2009-2019)
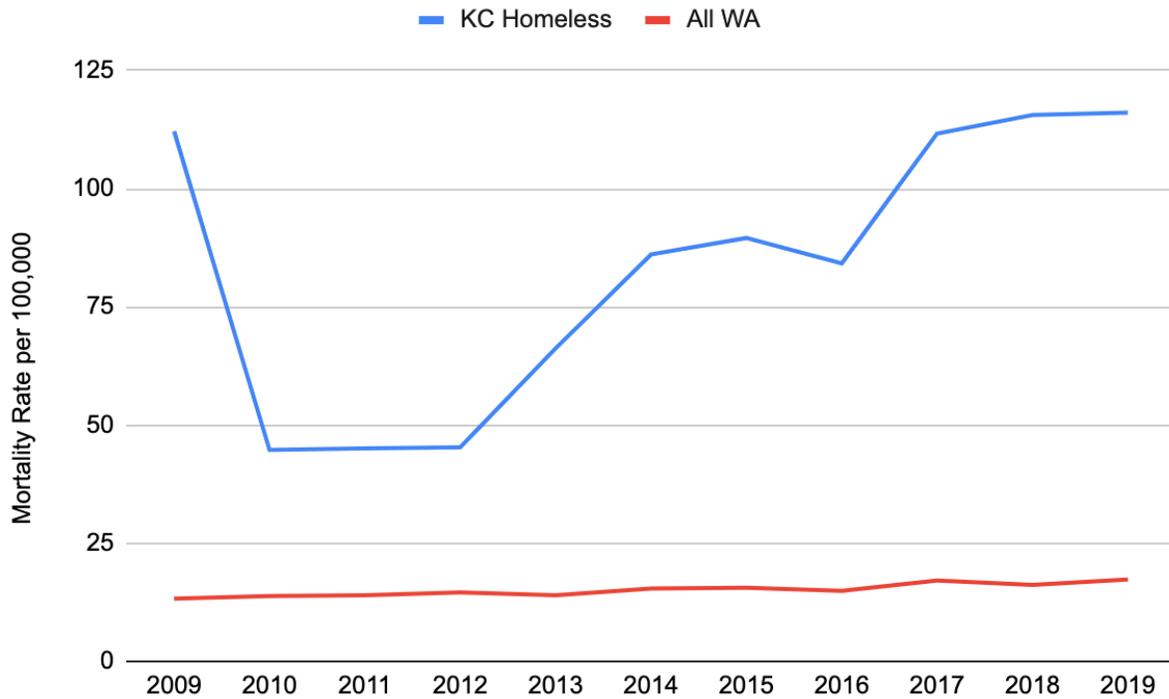
Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League, and Washington State Department of Health, Center for Health Statistics.

SMRs for Drug-and-Alcohol Induced deaths were also calculated. SMR calculations indicate deaths as a direct result of drug or alcohol poisoning or overdose were 7.75 to 16.70 times greater among the King County homeless population than among the general Washington population. Pedestrian deaths were up to 45 times higher among the King County homeless population. See Table 5.

Table 5: King County Homeless Standardized Mortality Ratios, Drug-and-Alcohol Induced and Pedestrian Deaths, 2009-2019

Year	Drug/Alcohol Induced				Pedestrian Death			
	expected*	observed^	SMR	95% CI	expected*	observed^	SMR	95% CI
2009	2.45	19	7.75	4.26, 11.23+	0.13	3	22.43	-2.95, 47.82
2010	2.40	19	7.93	4.36, 11.50+	0.13	6	44.76	8.94, 80.57+
2011	2.50	18	7.20	3.87, 10.52+	0.15	1	6.62	-6.36, 19.61

2012	2.57	28	10.88	6.85, 14.91+	0.14	3	21.23	-2.79, 45.26
2013	2.69	45	16.70	11.82, 21.58+	0.11	4	36.78	.74, 72.83
2014	2.80	27	9.65	6.01, 13.29+	0.17	4	23.91	.48, 47.34
2015	3.26	47	14.41	10.29, 18.53+	0.20	3	14.93	-1.96, 31.82
2016	3.3	37	11.2	7.59, 14.81+	0.21	7	32.75	8.49, 57.01+
2017	3.9	59	15.11	11.26, 18.97+	0.28	9	32.21	11.17, 53.25+
2018	4.1	65	15.85	12.00, 19.71+	0.28	12	43.08	18.70, 67.45+
2019	Pending	63	Pending	Pending	Pending	6	Pending	Pending

Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019 and Washington State Department of Health, Center for Health Statistics. SMR, as portrayed, represents the number of observed homeless deaths for drug and alcohol induced deaths in King County, compared to the general state population. When the SMR is higher than 1.0, there is a higher number of deaths than is expected. For example, the 2018 drug and alcohol death rate in King County is 15.85 times higher than would be expected for the statewide population.

*Expected number of deaths based on WA state homicide mortality rate
^Observed number of deaths by homicide among KC homeless
*+Statistically significant, p < .05*

Table 6 Homeless deaths in proportion to the King County homeless population, 2009-2019

Year	KC PIT Count Estimate	Total KC Homeless Deaths	Crude Mortality Rate per 100,000 people
2009	8,916	77	863.62
2010	8,937	56	626.61
2011	8,880	47	529.28
2012	8,830	82	928.65
2013	9,062	108	1191.79
2014	9,294	92	989.89
2015	10,047	130	1293.92
2016	10,688	141	1319.24
2017	11,643	174	1494.46
2018	12,112	196	1618.23
2019	11,199	168	1500.13

We used chi squared tests to assess the significance of associations for each category of death in relation to demographic variables (sex, RaceEthnicity, age categories) and found the correlation to be significant (p < 0.000, 0.001, 0.000 respectively).

The cause of death for 48% percent of American Indian and Alaska Natives in our dataset was drug or alcohol overdose. In comparison, decedents categorized as Black, Hispanic, White and Other had about one-third of deaths due to drugs or alcohol. Females had a higher percentage of death attributed to drug or alcohol overdose compared to males (47% vs 31%). Individuals of any gender aged 25-44 had higher percentage of deaths due to drug or alcohol overdose (48%) compared to other age groups. Individuals aged 18-24 had the highest percentage of death due to homicide (18%), followed by individuals aged 25-44 (7%).

Figure 5: Suicide, Homicide, and Drug/Alcohol Overdose Deaths Among King County Homeless, By Age, 2009-2019
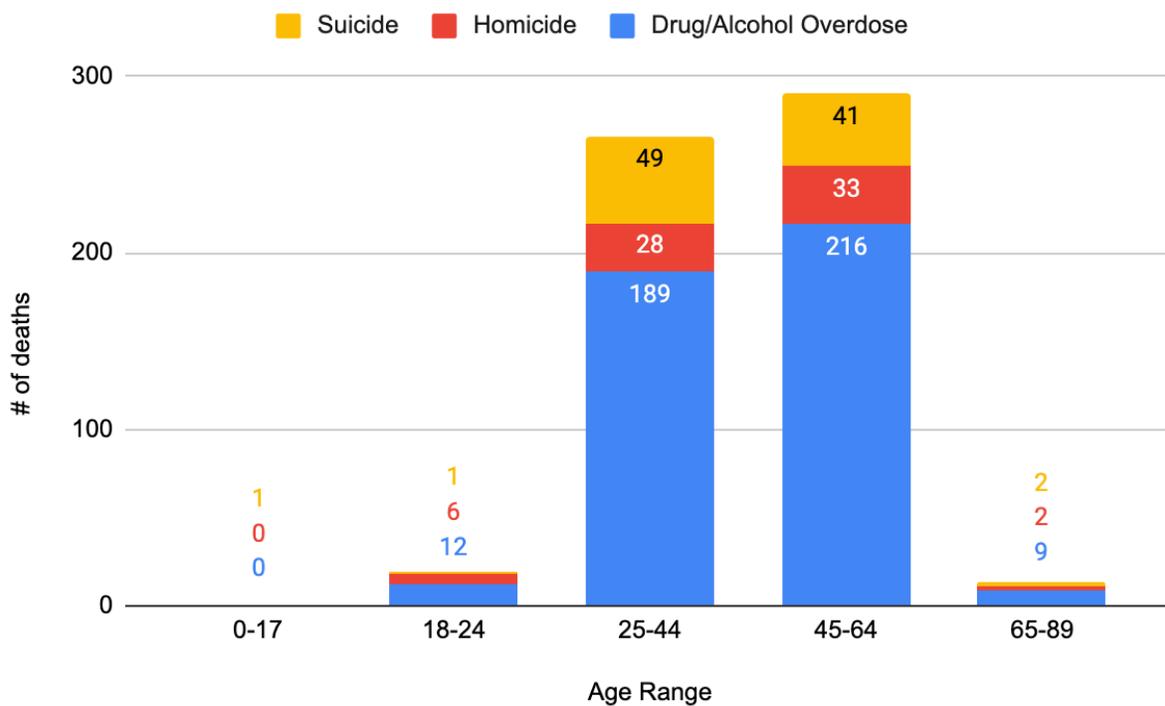
Data source is King County Medical Examiner reports of presumed homeless deaths for the years 2009-2019, along with supplemental case notes provided by the Women's Housing Equality and Enhancement League.

Discussion

We found King County homeless all-cause mortality for the last decade was 50% greater than that of the general Washington state population (1,119 homeless deaths per 100,000 people compared to 746 per 100,000 in the overall population). Our findings are in line with previous studies reporting homeless mortality rates at 1.3 to 4.7 times greater than the general population (Hwang, et al., 1997; Hibbs, et al., 1994; Sacramento County Department of Health Services, 2018; Los Angeles County Department of Public Health, 2019). Like other jurisdictions – such as Los Angeles County and Sacramento – mortality rates among King County's homeless

population are increasing annually (Sacramento County Department of Health Services, 2018; Los Angeles County Department of Public Health, 2019).

Deaths categorized as "natural" accounted for a third (35%) of cases in our study. Examining the case notes for these deaths reveals a more nuanced look at what "natural" deaths means for the unhoused population. Roughly 30% of natural deaths mentioned a history of chronic alcohol or substance use, at least two cases may have been related to complications from stab wounds, and in four cases, the decedent died in a hospital after being transferred from a jail.

Cardiovascular disease was also a common cause of natural deaths in the county during our study period. The American Heart Association reports that the vast majority of coronary heart disease deaths occur in those over age 64 (American Heart Association, 2013). In our study, the average age of death for those with cardiovascular disease was 49 years. Without proper access to health services like medication, chronic diseases are harder to control and lead to higher morbidity and mortality among the unhoused population. Additional risk factors for CVD include unhealthy diets, smoking, and excessive alcohol consumption, prevalent among unhoused populations (Ober, Carlson, & Anderson, 1997). Chronic stress and allostatic load also lead to the development of cardiovascular disease through psychological and physiological dysfunction (Logan & Barksdale, 2008). Psychological and environmental stressors rampant among people experiencing homelessness include the cumulation of life stress from victimization, material deprivation, and social isolation (Lippert & Lee, 2015).

The leading cause of injury deaths (excluding homicide and suicide deaths) were traffic-related and largely involved pedestrians or bicyclists being hit by vehicles. Mortality rates were 7 to 45 times higher among the King County homeless population[1]. Our findings are in line with a previous study that found significantly higher rates of pedestrian fatalities among unhoused people in Clark County, Nevada (Hickox, et al., 2014). High rates may be attributable to the placement of shelters and encampments near busy roads and highways, the reality of spending significant time outdoors, and impaired cognition due to mental health distress or substance use.

Mortality rates for train deaths, both accidental and intentional, were significantly higher among the King County homeless population. Standardized Mortality Ratios ranged from 0 to 138, although the statistics may be unreliable due to small numbers. We found no academic studies on train deaths among people experiencing homelessness, however recent news articles have linked increasing fatalities to the proximity of homeless encampments to train tracks (Dinkelspiel, 2019; Scheier, 2020).

Hypothermia was attributed to 20% of injury deaths. Wet or inadequate clothing and exposure to cold temperatures, wind, and rain contribute to hypothermia, and are conditions that unhoused people are unduly susceptible to (National Coalition for the Homeless, 2010). Additional risk factors for hypothermia include chronic or pre-existing conditions such as diabetes, infections, and malnutrition. Alcohol and substance use can inhibit shivering – a natural reflex that boosts protection from the cold – and may impair judgment and prevent the ability to seek health care services (Biem, Koehncke, Classen, & Dosman, 2013). These are all conditions and risk factors that unhoused individuals disproportionately experience.

An additional 13% of injury deaths were ascribed to falls. Five of these falls were from overpasses, illuminating the danger that unhoused people are exposed to on a daily basis. In another five the decedent was described as intoxicated at the time. As least two were possible suicides and another two were possible assaults. Several of the deaths were unwitnessed, thus

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[1] The WA state comparison data combines all deaths labeled "pedestrian," "cyclist," "other pedestrian," "other pedal cyclist."

delaying possible rescue efforts. Literature on falls among elderly homeless individuals states that this population is particularly vulnerable to falls due to the "high prevalence of conditions that increase risk" such as substance use and poor health, along with "heightened exposure to unsafe environments" that are ubiquitous when living in spaces not meant for human habitation (Abbs, Brown, Guzman, Kaplan, & Kushel, 2020).

Suicide accounted for 7.5% of all deaths in our study. The King County homeless crude suicide mortality rate across all years (2009-2019) was 5.5x higher than the Washington state general population (83 vs. 15 per 100,000 people). Our findings corroborate other studies that found suicide rates among homeless people to be anywhere from 2 to 23 times the rate of housed populations (Patterson & Holden, 2012; Sacramento County Department of Health Services, 2018; Philadelphia Department of Public Health, 2017). Mental health issues may precede an individual's homelessness, develop in response to, or be exacerbated by the challenges of living unhoused. Risk factors for suicide particularly correlated with homelessness include "feelings of isolation and alienation," a history of mental illness, distress, alcohol and substance use, and other Adverse Childhood Experiences (ACEs) (Lee, et al., 2017). Homelessness also is linked with reduced access to social support and mental health care, which further increases risk for suicide.

Homicide accounted for 5.5% of all deaths in our study in comparison to only 0.42% of deaths among the Washington general population. The King County homeless crude homicide mortality rate across all years (2009-2019) was 19x higher than the Washington state general population (62.2 vs. 3.2 per 100,000 people). Our findings support previous research that demonstrate living unhoused and unsheltered makes one particularly vulnerable to crime, violence, and conflict. Hate crimes against homeless people are of increasing concern; since 1999 more than 476 individuals have been killed in anti-homeless attacks[2] in the US (National Coalition for the Homeless, 2018). More than 8% of the homicides in our study were perpetrated by a law enforcement officer. There is little available data related specifically to killings of homeless people by police. However, the ongoing criminalization of homelessness "leaves a homeless individual as an easy target for police brutality" (National Coalition for the Homeless, 2018; National Law Center on Homelessness & Poverty, 2019) and aggressive policing during homeless sweeps have at times turned deadly (Vitale, 2017).

Deaths from acute drug and alcohol intoxication accounted for about 34% of all deaths in our study. Overdose deaths have been increasing in general in King County over the last seven years; most involve a combination of substances. A King County Medical Examiner Office report of overdose deaths report twice as many deaths involving a combination of stimulants and opioids occurred in 2018 compared to 2009. The number of overdose deaths involving fentanyl also nearly doubled between 2017 and 2018. People experiencing homelessness are disproportionally impacted by overdose deaths; approximately 16% of all drug and alcohol deaths across King County are among unhoused people (Public Health – Seattle & King County, 2019a).

Roughly half of all deaths in our study were attributed to suicide, overdose/acute intoxication, or complications related to chronic substance or alcohol use. Proliferation of these types of death have been linked to isolation and hopelessness caused by rising social and economic inequality, declining unionization, and other social determinants of health that create the conditions for homelessness in the first place (Zeglin, Niemela, Baynard, 2018; Eisenberg-

2 Defined as "acts of violence against homeless individuals by housed perpetrators". (National Coalition for the Homeless, 2018).

Guyot 2019). These types of deaths may be referred to as "deaths of despair," which describes deaths related to increasingly desperate conditions among the working class and other poor communities (Case & Deaton, 2020). This framing helps us understand why those experiencing homelessness die at such high rates from suicide, overdose, and chronic substance use.

Our population of homeless decedents included considerably fewer homeless women (18%) than men (82%). But mean age at death among homeless women was 44.8 (sd = 14), that is, 5.1 years lower than homeless men (mean=49.9, sd= 12.7) (t-test, p-value <0.001). This is atypical for most populations, where women live longer than men.

Washington state has one of the longest life expectancies in the United States, at 80.3 years (US Burden of Disease Collaborators, 2018). The homeless population in Washington state's largest and wealthiest county, by contrast, reports an average age at death of merely 48.9 years. Although we cannot directly compare these two data points, the gap between these related measures is significant, with the age of death among the homeless well below the Washington state average life expectancy.

Data from King County Point in Time counts suggest the unhoused population in King County has increased by more than 25% between 2009 and 2019. This compares to an overall King County population increase of 16% and an overall Washington state population growth of 11% over the same period. Rents have risen in response to economic growth in the region and rapid influx of high-wage workers. McKinsey & Company report that from 2010-2017, the Seattle market rent rose 52% while housing supply only rose 8% (Maritz & Wagle, 2020). Simply, demand for affordable housing has outpaced the supply; affordable units have even been torn down to make room for expensive housing.

Our findings support previous research reporting unhoused individuals die at disproportionately higher rates and at significantly younger ages compared to housed populations. Violent and injurious deaths from preventable causes were particularly disproportionate.

Limitations

As noted in other homeless mortality studies, the unreliable nature of homeless population estimates, and resulting miscategorization, makes it difficult to calculate mortality rates. In particular, demographic details of deceased homeless individuals in our database may not align with how those individuals identified in life. For example, our database includes only binary gender data, which we recognize leaves out nonbinary and transgender individuals, who are likely to be at especially high risk while experiencing homelessness. Further, data on racial and ethnic data on homeless decedents is extremely limited.

Medical Examiners, coroners, or funeral homes often rely on next-of-kin to help determine demographic information on death certificates. For decedents who were homeless at the time of death, next-of-kin may be difficult or impossible to reach. When death investigators resort to guessing racial and ethnic data for decedents, it leads to high possibility for misclassification. This is particularly true for AIAN peoples, who are not only already at high risk for homelessness due to the ongoing effects of colonialism and land dispossession, but also are significantly underrepresented and misclassified in public health data (Jim, et al., 2014; Arias, Heron, & Hakes, 2016).

Distinguishing between natural deaths related to chronic substance use, deaths due to acute intoxication / overdoses, and injuries sustained while under the influence is also difficult.

Additionally, in some cases, investigators could not determine if overdoses were intentional or not. These cases were not listed as suicide. For some injuries (including, falls, blunt-force trauma, and drowning), investigators indicated a potential for homicide or suicide as the mode of death. These were not included in our analysis of homicide and suicide cases.

Although we have supplemented our database with additional information from community members, our dataset of presumed homeless decedents is likely an underestimate of the true scope of homeless mortality. Because the MEO investigates only "suspicious" deaths, cases related to violence, suspicious circumstances, contagious disease, and other unnatural causes (such as overdose) may be overrepresented in the data. As indicated in their methodology, the King County Medical Examiner Office does not investigate or report on all deaths in the county. Differences and discrepancies in definitions of homelessness (which often leave many people out) could result in misclassification of housing status, leading to artificially lower mortality rates in our analysis. Family members may ask to have a name redacted from the list for privacy purposes, to avoid the societal stigma associated with homelessness, or other reasons.

Finally, there are challenges involved with using the King County Annual Point in Time count to define the homeless population. Changes in methodology year to year, limitations of the procedures used to count individuals, narrow definitions of homelessness, limited window of time for the count, the use of volunteers with limited training, and other limitations as identified in All Home King County's annual report, suggest that the PIT count severely underrepresents the true number of people experiencing homelessness.

Conclusion

Future research could look at potential racial misclassification, including linking our database with homeless services databases to find and correct errors. There may also be opportunities to update the process for collecting racial and ethnic data for homeless decedents. Research could also review decedents' medical records to determine when people who died by suicide had last interfaced with a medical professional or social support service to spotlight gaps in mental health treatment for the population. Community-identified needs also include comparing the solution rate for homeless homicides with the solution rate for homicides among the housed population. Additionally, it is necessary to investigate why the average age of death is lower for homeless women – a finding echoed in similar homeless mortality studies (Sacramento County Department of Health Services, 2018).

The efforts put forth to create this database may lead to illuminating gaps in the literature, advising policy, and providing a template for other jurisdictions to track and report on homeless mortality. Our works reveals a critical need for homeless mortality data. Surveillance data for public health is essential for understanding and addressing the issue, for showing the power of data, and for revealing that without shelter, people are more likely to die.

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