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Cold weather conditions: Health outcomes among people experiencing homelessness and interventions to prevent mortality and morbidity

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Abstract: People experiencing homelessness (PEH) are at more risk than the general population for cold-related health impacts, while people experiencing unsheltered homelessness (PEUH), are at even greater risk. With rising numbers of PEH in Canada in recent years, including the increased proportion of PEUH, there is an urgent need to better understand the health impacts of cold-weather exposure among these populations. This rapid review summarizes evidence on cold-related mortality, injuries, and other health impacts, as well as interventions designed to address these outcomes among PEH. While evidence on cold-related mortality is limited, recent evidence shows that PEH face disproportionately higher rates of cold-related illness, often with delayed care, severe injuries, and higher risk of complications. There is limited evidence on the effectiveness of interventions to reduce cold-weather health impacts on PEH. More research is needed on the specific weather conditions and severity of cold that drive these harms, as well as on preventative interventions.

Key words: people experiencing homelessness, PEH, unsheltered homelessness, mortality, morbidity, cold-related injury, frostbite, hypothermia, cold-weather response, emergency shelter, warming centre

Introduction

Prolonged exposure to cold weather can lead to serious health impacts such as hypothermia, frostbite, and in some cases death. A recent analysis of U.S. death certificate data, determined that cold-related mortality rates in the United States (U.S.) more than doubled from 1999 to 2022 (Liu et al., 2025), possibly driven by more frequent severe weather episodes due to climate change (Cohen et al., 2021).

Homelessness is defined as a potentially fluid living condition that can change over time and includes a range of housing situations, including unsheltered, emergency sheltered, provisionally accommodated, and at risk of homelessness (Gaetz, 2012). People experiencing homelessness (PEH), are at a greater risk than the general population for cold-related injuries and other health impacts caused by cold weather exposure (Gronlund et al., 2018). People experiencing unsheltered homelessness (PEUH), who live and sleep in places not intended for human habitation, such as streets, parks, transit stations, vehicles, abandoned buildings, and other outdoor or public locations, are at an even greater risk for health impacts caused by cold weather exposure.

Homelessness in Canada has risen in recent years. The 2024 Everyone Counts point-in-time (PiT) enumeration of homelessness in Canada, recorded a dramatic 79% increase in the number of PEH, rising from approximately 32,000 in the 2020–2022 PiT counts to nearly 60,000 in 2024 (Government of Canada, 2025a). Indigenous peoples have been consistently overrepresented among PEH for as long as homelessness has been systematically counted in Canada. At the time of writing, combined sociodemographic variable results for 2024 were unavailable, but in the 2020–2022 PiT count, 31% of PEH identified as Indigenous (24% identified as First Nations, 6% as Métis, and 1% as Inuit) (Government of Canada, 2023). Given 5% of Canadians identify as Indigenous (Statistics Canada, 2023), these numbers demonstrate substantial disproportionality in Indigenous homelessness. This disparity is widely considered to be a consequence of past and ongoing systemic anti-Indigenous racist and colonial policies in Canada (Thistle, 2017; Truth and Reconciliation Commission, 2015). There has also been an increase in the number of older adults seeking emergency shelter due to affordability issues, especially for those on fixed incomes (Supplementary references: CBC News Vancouver, 2025; Homeless Services Association of BC, 2025).

The number of PEUH in Canada in 2024 increased by 107%, compared to 2020–2022, with 29% counted in encampments

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and 71% counted in other outdoor locations (Government of Canada, 2025a) Unsheltered homelessness now makes up a much larger share of the total homelessness count than before (Government of Canada, 2025a). While there was a sharp downturn in shelter use during 2020 due to COVID-19 pandemic restrictions, shelter access and use has rebounded in the post-pandemic era. Key findings from the 2024 Shelter Capacity report by Housing, Infrastructure and Communities Canada show that many provinces experienced increases in the number of shelter beds per 10,000 population between 2021 and 2024 (Government of Canada, 2025c). Although some provinces saw declines, overall shelter occupancy remained between 80% and 90% during this period, suggesting that shelter capacity was relatively stable during this period (Government of Canada, 2025b).

Several factors can reduce the resilience of PEH to cold weather exposure, compounding the health risks. PEH have higher rates of chronic diseases (Al-Shakarchi et al., 2020), mental health conditions

(Barry et al., 2024), substance use disorder (Austin et al., 2021), infectious conditions like tuberculosis (Litvinjenko et al., 2023) and nutritional deficit (Huang et al., 2022) compared to the general population. Cold weather exposure can increase susceptibility to acute infectious respiratory illnesses like pneumonia (Huang et al., 2023), a major cause of death among PEH (Smaha et al., 2024). Older adults experiencing homelessness have increased susceptibility to frostbite and the risk of amputation, due to their higher rates of chronic illnesses, cognitive decline, cardiovascular diseases and skin-related conditions (Om et al., 2022).

Qualitative research highlights that PEH are uniquely susceptible to cold weather due to structural inequities, social isolation, and the cumulative effects of trauma and unstable living conditions (Every et al., 2019). PEH have reduced ability to access services, or the means to take safe and protective action to avoid exposure and maintain person hygiene, compared to other people. While many temporary winter emergency shelters in larger Canadian cities (e.g. Toronto, Regina, Edmonton), provide continuous indoor access, some located in other cities and smaller communities operate only during the night, and require people to leave early in the morning, with their belongings. This means that many PEH can be exposed to daytime cold weather, even if they are provided night-time shelter. In these precarious situations, PEH spend substantial time seeking adequate warmth, clothing, and food, while also seeking restrooms and medical care. Through efforts to keep warm with small camp stoves, PEUH bear additional, increased risk of stove burn injuries, carbon monoxide poisoning, smoke inhalation, and death (BC Centre for Disease Control, 2023).

This review provides an overview of the evidence on cold weather-related risks of mortality and morbidity among PEH in Canada and other high-income countries, and on interventions that may work to reduce these health outcomes.

Methodology

We searched the scholarly and grey literature for evidence on mortality, and morbidity among PEH during cold weather conditions. EBSCOhost databases (includes MEDLINE, CINAHL, Academic Search Complete, ERIC), Google Scholar and Google were scanned for results. Relevant English-language results were collected. Supplemental searches of scholarly peer-reviewed and grey literature were performed using Google, Google Scholar, and PubMed to gain additional evidence on interventions. Search terms included variants and Boolean operator combinations of terms related to homelessness, extreme cold and cold weather conditions, and interventions including emergency warming shelters. Additional literature was identified through forward and backward chaining of relevant literature retrieved from the search results, along with supplemental searches, as necessary. A single reviewer assessed the retrieved papers for inclusion, and the findings were synthesized narratively.

Results

Cold related health outcomes among people experiencing homelessness

Mortality

Emerging evidence also suggests that cold-related mortality persists even as public health attention increasingly focuses on addressing heat-related deaths. In a regression analysis examining temperature-attributable mortality among PEH across two urban U.S. counties, though most temperature-attributable deaths were associated with heat exposure, a significant proportion remained attributable to cold exposure in Los Angeles County (Lin et al., 2024).

There are surprisingly few published studies that have explored mortality among PEH during cold weather conditions. A recent systematic review identified four studies reporting that PEH face a substantially increased risk of mortality from hypothermia (Akhanemhe et al., 2025). Evidence from Tokyo from 1974–1983, France from 2008–2010, and New York City from 2005–2014 demonstrated that PEH accounted for most outdoor hypothermia deaths in certain urban settings and experienced mortality rates several times higher than those observed in the general population (Supplementary references: Lane et al., 2018; Tanaka & Tokudome, 1991; Vuillermoz et al., 2016). These findings suggest that homelessness is a dominant risk factor for fatal cold exposure in high-income countries with cold climates. Similarly, a retrospective analysis of emergency department (ED) and coroner's office records from Toronto between 2004 and 2015; (Zhang, Wiens, et al., 2019b) found that the odds of hypothermic injury or death among PEH increased by 1.6-fold for every 5°C decrease in minimum temperature below 0°C, and 1.10-fold for every 1 mm increase in precipitation. This study also demonstrated that while hypothermia risk rose with decreasing temperature among PEH, 72% of cases occurred during periods of above −15°C.

An additional retrospective study from northern Poland (2010–2016) reported that all-cause mortality among PEH using emergency shelters was more than three times higher during cold weather periods compared with warmer periods (Supplementary references: Romaszko et al., 2017). Deaths from hypothermia were recorded at a rate 13 times higher among the homeless population than in the general population. This finding emphasizes the vulnerability of unstably housed populations to cold-related mortality even when shelter access exists.

Cold-related injuries, hospitalizations and health care utilization

Cold-related injuries include frostnip, chilblains, and trench foot, and more severe injuries of frostbite and hypothermia (Heil et al., 2016). Recent literature consistently demonstrates that PEH bear a disproportionate burden of cold-related injuries, particularly in urban settings and during periods of extreme or unseasonably cold weather. A cohort study from Toronto (2004–2009) that found male PEH ($N = 587$) had higher ED attendance for cold-related injuries than housed low-income men (6.7 ED visits vs. 0 per 1000 person years of observation), though overall admissions were low (Zhang, Bassil, et al., 2019a). Women experiencing homelessness had a much lower rate of ED visits than men, and there was no significant difference between unhoused and housed women. Another Toronto study over 4 years (2018–2022) confirmed markedly higher rates of cold-related injuries for PEH than housed individuals, including hypothermia and frostbite, with female PEH at greater risk than males (Richard et al., 2023).

The severity of cold-related injuries may be impacted by housing status. A cohort study of 5,311 frostbite cases in Ontario (2010–2018) found that deep frostbite was more commonly associated with marginalization and homelessness, with 10% of deep frostbite cases occurring among PEH (Ahmed et al., 2025). Non-urgent visits can also spike during cold weather. An Ontario cohort study found that non-urgent ED visits among PEH in Ontario rose 27% overall and 70% in Toronto between 2018/2019 and 2022/2023, with no similar increase among housed patients, likely due to limited shelter and warming access (Richard et al., 2024).

Elsewhere in Canada, studies show similar patterns of cold-related injuries among PEH. Among PEH admitted to the University of Alberta Hospital burn center (Jan 2022–Jun 2024) 35% were admitted due to frostbite, whereas only 10% of housed people were admitted due to frostbite (Lee et al., 2025). During an unseasonably cold December in 2022 in British Columbia, the Interior Health region identified 77 cold-related ED visits across 21 hospitals, mainly for frostbite and hypothermia (Perrich et al., 2025). PEH accounted for 39% of cases, comprising over half of urban presentations but only 10.3% of rural cases.

In the U.S., national level administrative health data consistently show that PEH bear a disproportionate burden of cold-related injury. Between 2016 and 2018, national frostbite incidence was estimated at 0.83 per 100,000 population ($N = 8,085$ cases), with 34.6% of cases occurring among PEH (Endorf & Nygaard, 2021). PEH were more likely to present with severe frostbite (43.8% vs. 29.2%), and amputation rates were higher among PEH than PNEH (26.4% vs. 15.6%). Subsequently, a national U.S. cross-sectional study found that, after adjusting for confounders, PEH had significantly higher odds of receiving a temperature-related injury diagnosis, encompassing both cold- and heat-related events (Harris & Albrecht, 2024).

Similar patterns were observed in colder regions of the U.S. Analysis of Alaska Trauma Registry data (2012–2021) showed that, after adjustment for demographic factors and substance use, PEH had 8.3 times the odds of experiencing a cold-related injury compared with housed individuals (McLaughlin & Parrish, 2024). The risk associated with cold exposure is widespread and not necessarily confined to traditionally cold regions. Following the February 2021 Texas Winter Storm Uri, a region not typically exposed to extreme cold, a retrospective chart review reported 13 frostbite patients treated at one burn center, nine of whom were homeless and directly exposed to the elements, with delayed presentation contributing to severe injuries requiring surgical treatment options (Cindass et al., 2023). Wisconsin hospital discharge data from 2013–2023 identified 13,565 cold-related illness and death cases, with 14.7% of ED visits and 4.2% of hospitalizations including a Z code for homelessness, far exceeding rates of 0.2% and 0.4% in all other ED visits and hospitalizations, respectively (Andreychak et al., 2025).

Outside of North America, data show that people sleeping rough have higher rates of hypothermia than housed patients. A retrospective case-control study examined acute illness mortality in Bratislava, Slovakia, from 2010 to 2023, found that PEUH patients who died had higher incidence of hypothermia ($p < 0.0001$) upon admission compared to housed patients (Smaha et al., 2024).

Cold related injuries among PEH tend to lead to subsequent increases in health care utilization later. Among Minneapolis frostbite patients (2009–2018), homelessness and substance use independently predicted 1-year unplanned readmission, with readmitted patients less likely to have stable housing and more likely to have psychiatric or substance use disorders (Endorf et al., 2022). Eighteen percent of cases required amputation, highlighting the ongoing healthcare burden of cold injuries in vulnerable populations.

Further, self-reported data suggest that the true burden of cold-related injury may be higher than estimated by administrative data. In a 2023 survey of 105 PEH in Chicago (February–June 2023), 29.5% self-reported a past frostbite injury, yet only 6.3% had been diagnosed in a clinical setting, and 60.7% of those with frostbite did not seek medical care, highlighting under-recognition and treatment gaps (Lewer et al., 2025).

In contrast with all these studies above, a time-series analysis of 148,177 "no fixed abode" and 20,804 homelessness-coded hospital admissions in London, United Kingdom (2011–2019), found that although high temperatures were associated with significantly increased hospitalization risk, no significant associations were observed for cold temperatures (Hajat et al., 2023). This is possibly due to interventions such as the U.K.'s Severe Weather Emergency Protocol (Supplementary references: Homeless Link, 2020) and the milder weather comparted to winters in North America.

Other morbidities

Cold weather exposure can lead to other types of morbidity outcomes among PEH. A cross-sectional analysis of social network, health and outdoor exposure data from Nashville, Tennessee ($N = 246$), found that PEUH had their lowest self-reported quality of life survey scores during the winter months (Anderson et al., 2021). A review of case records for 597 consecutive attendees at a UK winter shelter over a week

in December in 2002, found that psychiatric morbidity and comorbid substance misuse were common (36.0% and 20.4%), with current symptoms linked to higher use of health services and repeated shelter medical visits (Supplementary references: Hayward, 2007) However, weather conditions and other general health impacts of the winter season were not accounted for in this study. A large survey study interviewed 600 men and 300 women experiencing homelessness (both sheltered and unsheltered) in St. Louis, Missouri to explore the potential association of psychiatric diagnoses with weather conditions (both summer and winter) (Supplementary references: North et al., 1998). For men, both a lifetime diagnosis of major depression and of drug use disorder were associated with both cold and wet weather, and current depression was associated with wet, but not cold weather. There were no associations for women between any of the psychiatric diagnoses and weather conditions.

Future research considerations on cold-weather mortality and morbidity

Although extreme cold weather poses substantial risks for human health, moderate cold can also be associated with increased risk of health impacts. Statistical modelling of deaths attributable to nonoptimal temperatures in British Columbia between 2001 to 2021 found that of just over 7% of deaths that were temperature-related, the majority were due to cold exposure (Shrestha et al., 2024). Mortality rates were highest for moderate cold, followed by extreme heat, extreme cold, and moderate heat. This study did not identify the number of people who died following exposure to moderate cold weather. Instead, it estimated the number of deaths statistically attributable to nonoptimal cold temperatures, many of which could be due to respiratory or cardiovascular illnesses that are more likely to occur under colder conditions. It is also possible, that when temperatures are moderately cold, PEH are more likely to be outside, and more health impacts may be seen at temperatures that are outside of extreme cold thresholds. In their recent systematic review, Akhanemhe et al. (2025) found insufficient evidence to assess how health effects vary by type of PEH or by definitions of cold exposure. More research is therefore needed to parse out extreme and moderate cold weather-related deaths, injuries, and associated morbidities among PEH, and to understand the types of PEH that are at most risk.

Interventions to reduce exposure to cold weather conditions for PEH

Weather warnings, and alerts

Environment and Climate Change Canada delivers weather information through a weather alert system comprised of warnings, advisories, and watches. This system has recently been updated, and now every weather warning, advisory and watch includes a colour code from yellow, to orange, to red that indicates the severity of the alert (Environment and Climate Change Canada, 2025):

- **Yellow alerts** are the most common and signal that hazardous weather *may* cause **moderate, localized, or short-term impacts, disruptions, or health effects**.
- **Orange alerts** are less frequent and indicate weather that is likely to cause **significant, widespread, or multi-day impacts**.
- **Red alerts** are rare and reserved for **very dangerous, potentially life-threatening weather** that could result in **extensive, prolonged disruption or damage**

These new Canadian weather alerts will inform triggers for cold weather response plans, such as decisions about when to open shelters and warming, and how to communicate to partners and the public about what the risks are associated with the alert. Organizations will be able to track resources allocation for each type of alert, which will help with budget planning. Alert fatigue may however, complicate communication.

Cold weather response plans

There are a range of different types of cold weather response plans, programs, or strategies, which are dependent the local climate, population demographics, and available resources (Rosenkrantz, 2022; Trudeau et al., 2025). Plans typically include an alert system triggered by specific local meteorological conditions. Local, Indigenous, and regional authorities activate cold or extreme weather response plans at different temperature thresholds. These range from near-freezing conditions in Vancouver, to −15°C or −20°C wind chill in Toronto, to extreme cold of −40°C in Winnipeg (Supplementary references: City of Toronto, 2025; City of Vancouver, 2025; City of Winnipeg, 2025). The opening of emergency shelters or warming centers is a common component of plans, as is street outreach. Outreach services coordinated by municipal authorities and regional health partners, and in partnership with Indigenous-led community programs, faith-based groups, and other nonprofits, are also part of cold or extreme weather response plans (BC Housing, 2025). These services include the provision of transportation to shelters or blankets, sleeping bags, and hot meals or drinks, helping to meet immediate needs. Additional wrap-around services such as public health outreach and promotion, medical care coordination, and harm reduction services are provided by municipalities and health authorities.

Shelters and warming centres

There are different types of shelters that are used to accommodate PEH during the winter months. Emergency weather response shelters are pre-planned and activated when specific thresholds are met and are usually located in identified community and resource centres, or churches. These shelters are often open 24 hours, but for some areas, for example in Vancouver, they are open only at night. Urban areas also often have temporary winter shelters, as part of ongoing housing support systems, often open the whole winter, and can be accessible 24 hours a day (Supplementary references: City of Vancouver, 2025).

During extreme cold weather events, pop-up shelters may be used on an ad-hoc basis in non-traditional spaces such as arenas, tents, and repurposed buildings to provide basic protections and services. Increasingly, warming buses have been used as mobile

shelters in Canadian cities such as Windsor, Regina, and Kelowna (Supplementary references: City of Kelowna, 2025; City of Regina, 2025; Windsor Star, 2024). Another type of relatively low cost immediate shelter is an individual emergency shelter, which can ensure the warmth and safety of individuals during the extreme winter temperatures, without needing site preparations (Ene et al., 2024). Modular flat-pack emergency shelters and housing alongside converted buildings can provide more extended transitional emergency solutions, while tiny home shelters can provide longer term semi-permanent shelter for up to years (Supplementary references: BC Housing, 2024; CBC News Halifax, 2024; City of Vancouver). There are many reasons why people may not want to attend a shelter during cold weather conditions. Shelters may be full at peak times (90% is considered high occupancy), or unevenly distributed geographically, or inaccessible due to curfews, sobriety, and ID requirements. Shelters may have constraints, such as time limits and restrictions on personal belongings. A Canadian study illustrates how policy and service environments influence risks that PEH face from cold exposure (Kerman et al., 2024). Drawing on in-depth interviews with 49 PEH in Ontario, the study demonstrated how service restrictions such as temporary or permanent bans on individuals, implemented by emergency shelters directly contributed to unsheltered homelessness and subsequent cold-related injuries. PEH can be separated from their partners or pets and often don't receive access to medical care. These factors can undermine older adults' autonomy and sense of dignity, leading some to feel isolated, discriminated against, or neglected (Atsma & Lane, 2021). PEH may avoid shared accommodations due to concerns about exposure to infectious diseases. In addition, shelters may not be safe or suitable for couples, families LGBTQ2S+, or those with trauma histories. Negative past experiences, lack of privacy, fear of theft or violence, and mistrust of institutions can further discourage shelter use, even during extreme weather.

Daytime access to heated spaces can protect PEH from extreme cold. Warming centres are a key part of cold weather response plans in Canada, often using spaces such as community centres, church halls, and libraries, and are often connected to shelter systems. Several challenges have been reported with warming centres and winter cold-weather services in Canada, especially in larger cities like Toronto, Montreal, Vancouver, and smaller municipalities. These include lack of spaces, funding and staff shortages, communication challenges, and temperature thresholds that are too high (Supplementary references: CBC News Manitoba, 2025; CTV News, 2025; Toronto Today, 2025).

Long-term housing solutions

While shelters, warming centres, and temporary housing solutions are needed, long-term, more permanent housing solutions are essential to reducing homelessness and reliance on emergency measures. Evidence shows that Housing First approaches are an effective way to improve housing stability, health, and wellbeing by prioritizing rapid access to permanent housing. Within Housing First, physical housing can be paired with wrap-around supports such as mental health care, addictions services, income assistance, and case management (Gaetz, 2013).

Neighborhood and community push back

Neighborhood and community opposition to services for PEH have been an ongoing issue across Canada, often driven by stigma and misconceptions (Adams et al., 2023). These apprehensions can also impact the viability of long-term and affordable housing initiatives, which further impact housing security for PEH. Early engagement with communities is likely important for the success of interventions aimed at cold weather shelter provision, along with stronger partnership working between local authorities and charities, churches, and other organizations that support PEH.

Evidence of successful cold weather interventions for PEH

Akhanemhe et al. (2025) identified seven studies that reported on interventions to reduce health risks from cold exposure among PEH. Most interventions were multi-component, with prompt shelter access as a key feature. Shelter strategies included emergency and pop-up shelters, warm spaces, and private housing funding. Other components involved provision of clothing, winter supplies and food, risk identification, transportation support, hypothermia alerts, harm-reduction services, expanded outreach, and modified hospital discharge planning. Only one intervention, investigated and reported a decrease in deaths despite a rise in numbers of PEH (O'Connell et al., 2005). Another study demonstrated a near 50% reduction in PEUH following the opening of a Rough Sleepers Night Club, as part of the Severe Weather Emergency Protocol (SWEP) in London (Homeless Link, 2018). Follow up research in 2025 has shown that 56% of PEH were not sleeping rough within 6 months of their SWEP stay (Homeless Link, 2025). Akhanemhe et al. (2025) highlighted that there are considerable gaps in research concerning interventions to address cold weather risks for PEH. Although studies suggest interventions can reduce health impacts, more robust studies are needed that investigate the degree to which interventions can improve rates of health outcomes from cold exposure. These studies are difficult to conduct, due to lack of access to information about PEH.

What can environmental health professionals do to advance health protection of PEH in winter?

Environmental health professionals (EHPs) in Canada are uniquely positioned to advance health protection of PEH from cold weather health impacts. While scope for health protection action varies within municipalities and health authorities, all EHPs can increase their awareness and understanding of the difference between of weather alerts, work with partners to support interventions, and evaluate successes and issues. Importantly, any health promotion and communication about evidence on cold weather risks for PEH should be co-created with those who have lived experience. The same is true for shelter and other housing option design. When planning interventions for cold weather response, early engagement with local authorities, and charities, churches, and other organizations that support PEH is essential to ensure the chance of success. Residents of communities and neighborhoods should be proactively engaged, using evidence to counter misconceptions, and with clearly communication about

where accountability lies. As lessons are learned from the COVID-10 pandemic, EHPs need to plan for future emergencies and disasters that can be anticipated to exacerbate cold-related health outcomes PEHs already face.

Summary

In summary, although evidence on cold-related mortality is limited, studies indicate that risks are substantial for PEH and warrant ongoing surveillance, targeted prevention measures, and policy attention alongside heat-related risks. There is growing evidence, across diverse geographic settings and populations, that PEH consistently experience disproportionately high rates of cold-related illness and injury, including hypothermia and frostbite, with delayed presentation to care, higher severity of injury, and increased risk of complications such as amputation. Additional investigations could also parse out extreme versus moderate cold-related deaths, injuries, and other morbidities among PEH, and more generally on the types of weather conditions that are associated with these harms. There is a need for targeted public health interventions, improved surveillance, and accessible shelter and healthcare services to mitigate the disproportionate impacts of cold exposure among PEH. These interventions can be informed by those with lived experience, which can daylight their perspectives. Longer-term housing options are desperately needed, as well as addressing the upstream causes of homelessness, including lack of housing affordability and systemic racism.

Supplementary material

Supplementary references are available with the article at https://doi.org/10.5864/d2026-003.

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