

Long-term effects of homelessness on mortality: a 15-year Australian cohort study

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Homelessness is an important public health issue in Australia.¹ The number of people identified as homeless nationally on any given night increased by approximately 30% from 89,728 in 2006 to 116,427 in 2016,² with this number likely being an underestimation.¹ This increase has occurred despite the Australian Government's 2008 commitment to halve the homeless population by 2020.³ Consequently, homelessness services in Australia are assisting an increasing number of individuals each year.⁴

There is a close link between housing and health. The Sustainable Development Goals (SDGs), adopted in 2015,⁵ recognise the role of housing as a determinant of health, with Goal 11.1 calling for access to adequate, safe, and affordable housing and basic services for all by 2030, and Goal 1.1 calling for every person, especially those who are poor or vulnerable, to have equal rights to basic services, among other resources. Being homeless is associated with poorer health outcomes, including higher rates of preventable acute and chronic medical conditions, traumatic injuries and assaults, serious psychiatric disorders and mental health issues, and disability.^{1,6-10} Homelessness has been strongly associated with emergency department (ED) presentations involving a primary psychiatric or drug/alcohol diagnosis.^{3,8,11,12} Homeless individuals are more likely to present to the ED,^{7,13} and to have a greater

Abstract

Objective: To examine the effect of homelessness on mortality.

Methods: This 15-year retrospective longitudinal cohort study compared mortality outcomes of homeless and non-homeless adults attending the emergency department of an inner-city public hospital in Melbourne, Victoria between 1 January 2003 and 31 December 2004. Homeless individuals had ≥ 1 recorded episodes of homelessness within the recruitment period, categorised by type: primary, secondary, tertiary, marginally housed. Non-homeless individuals were stably housed throughout.

Results: Over 15 years, homeless individuals had a higher mortality rate (11.89 vs. 8.10 per 1,000 person-years), significantly increased mortality risk (rate ratio 1.47, 95% confidence interval [CI] 1.26-1.71) and younger median age at death (66.60 vs. 78.19 years) compared to non-homeless individuals. Using adjusted Cox proportional hazards models, primary (hazard ratio [HR] 2.05, 95%CI 1.67-2.50), secondary (HR 1.60, 95%CI 1.23-2.10) and tertiary (HR 1.72, 95%CI 1.16-2.56) homelessness were independent risk factors for premature mortality.

Conclusion: At least one recorded episode of primary, secondary, or tertiary homelessness was associated with premature mortality and younger age at death over a 15-year period.

Implications for public health: Accurately identifying individuals experiencing primary, secondary or tertiary homelessness at the emergency department may enable targeted interventions that could potentially reduce their risk of premature mortality.

Key words: homeless persons, mortality, emergency medicine, longitudinal studies

number of ED presentations¹¹⁻¹⁴ and re-presentations^{3,11,12,14,15} compared to the general population. Furthermore, there is evidence internationally to suggest that homelessness is also a risk factor for premature mortality.^{6,7,9,10,16-19}

Studies indicate that homeless individuals have an increased mortality rate throughout their lifetime, being most marked in younger age groups.^{9,17-21} Deaths among younger homeless individuals are commonly related to accidental and/or drug/alcohol causes, while

deaths among older homeless individuals are most often related to cardiovascular disease and cancer.^{6,22} It has also been found that nearly one-third of these deaths in homeless individuals are from conditions amenable to timely and appropriate provision of healthcare.⁶

A limited number of studies have examined mortality outcomes of homeless individuals in Australia. One study found that the suicide rate of homeless individuals in Queensland (n=92) was almost two times higher than

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non-homeless individuals over a 20-year period.²⁰ Another study found that the mortality rate of homeless individuals with schizophrenia (n=708) was 3–4 times higher than the general population of New South Wales over a 10-year period.²¹ However, these studies are limited to a subset of homeless individuals (i.e. those who died by suicide or those who have schizophrenia) and do not examine the mortality outcomes of Australian homeless individuals in general.

To date, no studies have examined mortality among a large cohort of individuals experiencing homelessness in Australia over an extended period of time. Moreover, it is not known whether the type of homelessness among individuals who present to the ED is associated with premature mortality. This study aimed to compare the mortality patterns of homeless and non-homeless individuals who presented to an urban ED over a 15-year period, with the homeless individuals being grouped by type of homelessness.

Methods

This was a single-site, retrospective longitudinal cohort study at the ED of a single 600-bed inner-city tertiary hospital in Melbourne, Victoria. This ED has established supports for patients experiencing homelessness, which are provided in both the ED and the community. Ethics approval was obtained from the Human Research Ethics Committee (HREC/18/SVHM/236).

Participant selection

A database containing 64,213 presentations to the hospital ED from 1 January 2003 to 31 December 2004, which was related to 40,978 unique patients, was obtained and linked with data from the hospital medical record system by the patient's unique record (UR) number. Individuals included in the present study were adults aged 18 years or older who presented at least once for care at the ED between 1 January 2003 and 31 December 2004. As such, individuals aged less than 18 years (n=853) were excluded. Individuals without a documented date of birth were also excluded (n=2). For further information, see Moore et al.^{3,15}

Homeless group

Individuals whose medical record documented their usual accommodation for at least one ED presentation as 'no fixed

abode' or as an address that corresponded to emergency or transitional accommodation, a boarding house, or public housing were categorised into the homeless group.

Acknowledging the dynamic nature of homelessness,^{8,23} a single author (GM) reviewed the medical records pertaining to the ED presentations of these individuals over the two-year recruitment period and assigned a type of homelessness based on the average of their documented usual accommodation.^{3,15} Therefore, the assigned type of homelessness is representative of the individual's average housing status during 2003 and 2004.

The type of homelessness was based on the three levels of homelessness described by the Chamberlain and Mackenzie cultural definition of homelessness^{3,23} and a fourth sub-group that included individuals who were marginally housed (housing situation close to the minimum standard, including living in public housing and requiring rental assistance or other unstable rental arrangement).^{3,15} The Chamberlain and Mackenzie cultural definition outlines three levels of homelessness: primary (without conventional accommodation, such as living on the streets, sleeping in parks, squatting in derelict buildings, or using cars or railway carriages for temporary shelter); secondary (moving between various forms of temporary shelters, including emergency or transitional accommodation [e.g. youth refuges, hostels], other households [e.g. friends], and boarding houses on a short-term basis [12 weeks or less]); and tertiary (living in a single room in a private boarding house on a medium- to long-term basis without a separate bedroom and living room, private bathroom and kitchen, or security of tenure).²³ Since homelessness has been recognised as a component of marginal housing in Australia,²⁴ the inclusion of the marginally housed group broadened the definition of homelessness in this study and housing instability, an important risk factor for homelessness, was captured.

Non-homeless group

Matching homeless and non-homeless individuals was considered for this study; however, it was decided that applying Cox-regression models would be more powerful, as previously shown in the literature.²⁵ Therefore, a random sample of individuals without documented homelessness who presented at least once to the ED within the

same time period (n=39,528) was selected in a 3:1 ratio of non-homeless to homeless individuals.

Outcomes and analysis

Mortality was the main outcome variable. Date of death was recorded in the hospital medical record system when the patient died as an inpatient or when the hospital received notification of death from an external source, such as a general practitioner, case manager or an ambulance service.

Mortality was compared across four discrete time periods (0 to 3 years, >3 to 5 years, >5 to 10 years, and >10 to 13 years), as well as at 15 years from the index ED presentation in 2003 or 2004 to 31 December 2017. The cohort was described using percentages, medians, interquartile ranges, means, and 95% confidence intervals (CI), depending on the distribution of the variable. Patient characteristics were compared using Pearson's χ^2 and Mann-Whitney U tests as appropriate. Mortality incidence rates and rate ratios (RR) with 95% CIs were calculated for comparisons across the four discrete time periods.

Statistical analyses were performed using IBM SPSS Statistics version 25 and Stata version 15.1. Kaplan-Meier (KM) survival analysis was performed to assess survival, with log-rank tests used to assess significance ($p < 0.05$). KM survival curves were calculated for the following variables: homelessness, gender, age, born in Australia, Aboriginal or Torres Strait Islander status, English as preferred language, veteran status, primary psychiatric diagnosis, primary substance use diagnosis and frequent attender status. The primary diagnosis for the individual's presentation at study inclusion was grouped into categories according to the 2003 version of the International Statistical Classification of Diseases and Related Health Problems – 10th Revision (ICD-10),²⁶ including primary psychiatric diagnosis and primary substance abuse diagnosis. A frequent attender was defined as an individual with ≥ 3 ED presentation within one calendar year²⁷ and was applied to those attending the ED from 1 January to 31 December in 2003 or 2004.

A multivariable Cox-regression model was fitted to estimate the effect of the type of homelessness on all-cause mortality. As a continuous variable, age violated the assumption of proportionality. Therefore, age was categorised into three groups (18–40

years, 41–60 years, >61 years) based on tertiles. All KM survival curves were significant and did not cross, with the exception of Aboriginal or Torres Strait Islander status. As such, after excluding Aboriginal or Torres Strait Islander status, nine variables were included in initial multivariable Cox-regression models. The following variables violated the assumption of proportionality when assessed with Schoenfeld residuals: homelessness, primary psychiatric diagnosis, primary substance use diagnosis and frequent attendee status. A correlation matrix of these variables demonstrated collinearity, and as such, only homelessness was retained in the final model. Variables included in the final model were homelessness, gender, age, born in Australia, English as a preferred language and veteran status.

All tests were considered significant at the $p < 0.05$ level.

Results

The study cohort of 6,300 individuals included 1,575 homeless individuals and 4,725 non-homeless individuals. Compared to non-homeless individuals, significantly more homeless individuals were male, born in Australia, identified as Aboriginal or Torres Strait Islander, and had English documented as their preferred language (see Table 1) at their index ED presentation. There were three individuals without any documentation of whether English was or was not their preferred language at study inclusion. The majority of homeless individuals (44.1%) were experiencing secondary or

tertiary homelessness within the two-year recruitment period from 2003 to 2004 (see Table 1). Significantly more individuals experiencing primary, secondary, and tertiary homelessness were male, compared to those who were marginally housed. Individuals identified as experiencing primary homelessness were significantly younger at their index ED presentation, relative to those experiencing other types of homelessness.

Mortality

There were 735 individuals with a recorded date of death in the hospital medical record system at the end of the 15-year study period. Over the 15-year study period, homeless individuals had a higher mortality rate than non-homeless individuals (11.89 vs. 8.10 per 1,000 person-years, see Table 2). Homeless

Table 1. Demographics of homeless (n=1,575) and non-homeless (n=4,725) individuals at study inclusion.

	Homelessness Status			Type of Homelessness				
	H	NH	p	Primary ^a	Secondary ^b	Tertiary ^c	Marginal ^d	p
Number (%)	1,575	4,725		361 (22.9)	257 (16.3)	438 (27.8)	519 (33.0)	
Male (%)	1,178 (74.8)	2,539 (53.7)	<0.001	296 (82.0)	197 (76.7)	339 (77.4)	346 (66.7)	<0.001
Born in Australia (%)	1,169 (74.2)	2,698 (57.1)	<0.001	287 (79.5)	184 (71.9)	326 (74.4)	372 (71.7)	>0.05
ATSI (%)	102 (6.5)	48 (1.0)	<0.001	27 (7.5)	23 (8.9)	25 (5.7)	27 (5.2)	>0.05
EPL (%)	1,513 (96.1)	4,203 (89.0)	<0.001	357 (98.9)	251 (98.8)	419 (95.7)	486 (93.8)	<0.001
Veteran status (%)	12 (0.8)	52 (1.1)	>0.05	0 (0.0)	0 (0.0)	1 (0.2)	11 (2.1)	<0.001
Age (years)								
- Median	41.02	40.27	>0.05	34.25	37.13	42.88	48.73	<0.001
- IQR	30.01–55.35	27.47–62.11		26.88–45.24	26.47–48.08	31.54–55.80	34.05–68.07	

Notes:

Significant findings ($p < 0.05$) are in bold.

ATSI = Aboriginal or Torres Strait Islander, CI = confidence interval, EPL = English as preferred language, H = homeless individuals, IQR = interquartile range, NH = non-homeless individuals

a: Primary = without conventional accommodation (e.g. on the streets, sleeping in parks, squatting in derelict buildings, using cars or railway carriages for temporary shelter)

b: Secondary = moving between various forms or temporary shelters, including emergency or transitional accommodation, other households, and boarding houses

c: Tertiary = living in a single room in a private boarding house on a medium- to long-term basis without a separate bedroom and living room, private bathroom and kitchen, or security of tenure

d: Marginally housed = living in public housing requiring rental assistance or other unstable rental arrangements

Table 2: Mortality outcomes of homeless (n=1,575) and non-homeless (n=4,725) individuals across 15 years.

Time period (years)	0 to 3			> 3 to 5			> 5 to 10			> 10 to 13			0 to 15		
	H	NH	p	H	NH	p	H	NH	p	H	NH	p	H	NH	p
Alive at BTP	1,575	4,725		1,461	4,481		1,423	4,416		1,365	4,295		1,575	4,725	
Alive at ETP	1,461	4,481		1,423	4,416		1,365	4,295		1,342	4,240		1,338	4,227	
Deaths (%)	114 (7.2)	244 (5.2)	<0.005	38 (2.6)	65 (1.5)	<0.005	58 (4.1)	121 (2.7)	<0.05	23 (1.7)	55 (1.3)	>0.05	237 (15.0)	498 (10.6)	<0.001
IR (per 1000 p-y)	25.21	17.86		13.19	7.30		8.33	5.57		5.67	4.30		11.89	8.10	
RR (95% CI)	1.41 (1.13–1.76)			1.81 (1.21–2.69)			1.50 (1.09–2.05)			1.32 (0.81–2.15)			1.47 (1.26–1.71)		
Age at death (years)															
- Median	66.49	75.68	<0.005	66.31	84.27	<0.001	66.36	77.15	<0.001	69.22	81.61	<0.005	66.60	78.19	<0.001
- IQR	54.18–80.92	63.54–83.56		56.18–82.13	77.82–89.35		55.06–75.32	68.56–84.35		55.45–74.81	66.71–87.44		54.65–79.89	66.85–85.47	
- Mean (95% CI)	66.45 (63.17–69.73)	72.76 (70.84–74.68)	<0.001	68.71 (63.22–74.20)	81.65 (79.14–84.17)	<0.001	64.92 (60.85–68.98)	75.55 (73.29–77.81)	<0.001	65.85 (61.19–70.51)	77.01 (73.32–80.70)	<0.001	66.56 (64.44–68.68)	75.28 (74.04–76.52)	<0.001

Notes:

Number of deaths, age at death, and rate ratio of homeless and non-homeless participants were compared across four time-periods and the overall study period of 15 years. The four time periods included: 1) 0 to 3 years; 2) >3 to 5 years; 3) >5 to 10 years; 4) >10 to 13 years post-study inclusion. Significant findings ($p < 0.05$) are in bold.

BTP = beginning of time period, CI = confidence interval, ETP = end of time period, H = homeless individuals, IQR = interquartile range, IR = incidence rate, NH = non-homeless individuals, p-y = person-years, RR = rate ratio

individuals consistently had a higher mortality rate within each discrete time period. Homeless individuals had a higher risk of mortality than non-homeless individuals over the 15-year study period (RR 1.47, 95%CI 1.26–1.71, see Table 2). This difference was statistically significant within each discrete time period, except within the discrete time period of >10 to 13 years. The median age at death was significantly younger among homeless individuals (66.60 vs. 78.19 years, $p < 0.001$, see Table 2) over the 15-year study period and within each discrete time period.

The first multivariable Cox-regression model, which did not account for type of homelessness, demonstrated that one episode of any type of homelessness significantly increased the risk of death over 15 years with a hazard ratio (HR) of 1.76 (95%CI 1.49–2.08), after adjusting for gender, age, being born in Australia, having English as a preferred language and having been a veteran (see Table 3).

The second model, which accounted for type of homelessness, showed that primary (HR 2.05, 95%CI 1.67–2.50), secondary (HR 1.60, 95%CI 1.23–2.10) and tertiary (HR 1.72, 95%CI 1.16–2.56) homelessness were independent factors that significantly increased the risk of death over 15 years, relative to non-homeless individuals (see Table 3).

Male gender was associated with an increased risk of death when included in the second model (HR 1.19, 95%CI 1.02–1.40). As expected, increasing age was associated with a greater risk of death in both models.

Discussion

The present study demonstrates that, over a 15-year period, ED attendees who have experienced at least one episode of primary, secondary, or tertiary homelessness within a two-year period are at approximately double the risk of mortality compared to those who were non-homeless. This increased risk of mortality was apparent after accounting for the effects of demographic variables (e.g. gender, age, born in Australia, English as a preferred language, veteran status). Furthermore, homeless individuals died almost 12 years younger than non-homeless individuals. These findings suggest that once-off placement in crisis accommodation, couch surfing, or rough sleeping confers an increased risk of mortality to an individual no matter if they were homeless or housed previously.

The increased risk of homelessness on mortality in this Australian study (HR 1.76, 95%CI 1.49–2.08) was smaller compared to countries such as Finland (HR 5.38, 95%CI

4.39–6.59)⁷ but similar to Scotland (adjusted HR 1.6, 95%CI 1.3–1.9).¹⁰ Prior studies have differed in their comparison groups, as well as in how homelessness was defined. Notably, the recent European studies mentioned above compared homeless ED patients to the general population, whereas our comparison group comprised non-homeless ED attendees. ED attendance itself has been associated with a higher risk of death in the general population (HR 1.81 for men, HR 1.93 for women).²⁸

Furthermore, the present study may have included a broader range of homeless individuals experiencing different types of homelessness than in other studies. Since other studies have mostly focused on individuals who were living on the streets or used homeless shelters, the most comparable subgroups may be the homeless individuals experiencing primary homelessness, who had a HR of 2.05 (95%CI 1.67–2.50), and secondary homelessness, who had a HR of 1.60 (95%CI 1.23–2.10). Accounting for these two factors, the HR for individuals experiencing primary homelessness versus the general population in the present study would be 3.71 for men and 3.96 for women. If these estimates are considered, then the present study aligns with a 2005 literature review¹⁸ that concluded that the mortality rate for homeless individuals is 3–4 times that of the general population.

Finding a slightly lower mortality rate in the present Australian study, set in a temperate climate, may be expected when compared to the mortality observed in rough sleepers in colder climates.²⁹ Furthermore, it is possible that individuals experiencing secondary and tertiary homelessness, which comprised the majority of our homeless group, may be less at risk of premature mortality. This supports findings reported in a 10-year cohort study conducted in the United States.³⁰ Moreover, given the dynamic nature of homelessness,^{8,23} some individuals in the homeless group may have been homeless for only a brief time during the recruitment period and the 15-year observation period may have allowed for transition out of homelessness into stable housing. This would be in accordance with Henwood et al. who reported that mortality risk was reduced over a period of six years among formerly homeless individuals who attained stable accommodation.²²

The median age at death for the homeless individuals in this study was higher than the median age at death reported in other

Table 3: Cox-regression hazards models (n=6,257) of predictors of mortality over the 15-year study period by homelessness status (model 1) and type of homelessness (model 2).

	Model 1		Model 2	
	HR (95% CI)	p	HR (95% CI)	p
Non-homeless individuals	1.00		1.00	
Homeless individuals	1.76 (1.49–2.08)	<0.001		
Primary ^a			2.05 (1.67–2.50)	<0.001
Secondary ^b			1.60 (1.23–2.10)	<0.005
Tertiary ^c			1.72 (1.16–2.56)	<0.01
Marginal ^d			1.13 (0.72–1.77)	>0.05
Age				
18–40 years	1.00		1.00	
41–60 years	7.44 (5.33–10.39)	<0.001	7.35 (5.27–10.27)	<0.001
>61 years	27.57 (20.16–37.69)	<0.001	26.40 (19.28–36.16)	<0.001
Male gender	1.17 (1.00–1.36)	>0.05	1.19 (1.02–1.40)	<0.05
Born in Australia	1.15 (0.96–1.37)	>0.05	1.15 (0.97–1.38)	>0.05
English as preferred language	0.63 (0.51–0.79)	<0.001	0.64 (0.51–0.79)	<0.001
Veteran	1.14 (0.72–1.79)	>0.05	1.10 (0.70–1.73)	>0.05

Notes:

Variables with significant Kaplan-Meier survival curves that did not cross were included in the models as potential independent risk factors for mortality.

Significant findings ($p < 0.05$) are in bold.

CI = confidence interval, HR = hazard ratio

a: Primary = without conventional accommodation (e.g. on the streets, sleeping in parks, squatting in derelict buildings, using cars or railway carriages for temporary shelter)

b: Secondary = moving between various forms or temporary shelters, including emergency or transitional accommodation, other households, and boarding houses

c: Tertiary = living in a single room in a private boarding house on a medium- to long-term basis without a separate bedroom and living room, private bathroom and kitchen, or security of tenure

d: Marginally housed = living in public housing requiring rental assistance or other unstable rental arrangements

studies (66.60 vs. 43 years),^{6,7,10,16,17,30} although the median age at study inclusion for the homeless individuals in the present study was similar to the median age at study inclusion of other studies (41.02 vs. 41 years).^{7,10,17,30} The present study had a more inclusive definition of homelessness compared to prior studies. As a result, individuals experiencing secondary or tertiary homelessness who were older at study inclusion may have contributed to this higher median age at death.

Although the age at death was older in the present study than in previous studies,^{7,10,17,30} the approximate 12-year difference in the age at death between the homeless and non-homeless groups (66.60 vs. 78.19 years, ~11.6-year difference) is similar to the difference found in a study conducted in Scotland (41 vs. 53 years, 12-year difference).¹⁰

The significant long-term risk of mortality found in the present study within homeless individuals experiencing primary, secondary and tertiary homelessness suggests that the accurate identification of a homeless individual's type of homelessness could be important in determining appropriate interventions post-medical care in the ED. In their scoping review, Canham et al.³¹ emphasised the importance of confirming the housing status of homeless individuals at both presentation and discharge. Health professionals in the ED are well-placed to make these housing status assessments since homeless individuals are more likely to rely on the ED for medical care.^{3,7,11-15,31} The results of the assessment, based on the assigned type of homelessness, may inform the kind of supports homeless individuals may require post-discharge and improve their transition to more stable housing.³¹ This suggests a need to optimise the ability of Australian ED services to appropriately and adequately provide the necessary post-discharge care and supports for individuals experiencing homelessness.

Housing strongly influences health. In Australia, housing with insecure tenure has been associated with worse physical and mental health.³² Analysis of supportive housing programs, such as the Australian Common Ground Alliance³³ and other similar Housing First initiatives internationally,^{1,22,34} has shown that stable housing improves health and social outcomes. In the present study, only the marginally housed group, which included individuals who were living in public housing requiring rental assistance, had a similar HR to non-homeless

individuals, which suggests that access to government-run public housing may reduce the long-term risk of mortality associated with homelessness. As such, providing more stable forms of accommodation to those experiencing primary, secondary and tertiary homelessness, such as public housing, may reduce their risk of premature mortality. This should be considered in the context of the higher rate of mortality found in those transitioning to stable housing,²² such that intensive support may be required for individuals experiencing primary, secondary or tertiary homelessness as they transition to more stable housing.

Through the adoption of the SDGs framework, the United Nations declared that every person has the right to a basic standard of living, including through a social protection system,⁵ which is reflected in Goal 1.4 and Goal 11.1. As a signatory to this framework, Australia and its government has a responsibility to uphold these values and achieve its goals. Indeed, the Victorian State Government recently released a Homelessness and Sleeping Rough Action Plan that focuses on the provision and maintenance of stable accommodation in their initiatives, with targeted action plans for different groups of homeless individuals.⁴ This Victorian action plan is supported by Australia's National Housing and Homelessness Agreement, which broadly aims to contribute to a well-functioning social housing system that assists priority homeless groups and an effective homelessness service system that supports those who are homeless or at risk of homelessness to obtain and maintain housing.^{35,36} This governmental support is significant given that 24,817 people were identified as homeless on a single night in Victoria in 2016² and a network of more than 100 Victorian homelessness services provides assistance to more than 100,000 people each year.³⁶

Strengths and limitations

One strength of the present study is that it included a large sample of homeless and non-homeless individuals with a long follow-up period. Additionally, using a broader definition of homelessness enabled us to test whether differing types of homelessness conferred differing levels of risk, which is a novel contribution to the literature and serves as another strength of the study.

Homeless individuals were identified via medical record chart review. Underestimation

of homelessness may have occurred due to a lack of systematic methods for documenting housing status or usual accommodation, which is a common problem in medical records. Individuals who were experiencing secondary or tertiary homelessness may have been particularly likely to go unidentified as being homeless. For example, individuals who were 'couch surfing' but able to supply a home address at their index ED presentation may have been erroneously classified as non-homeless. Similarly, individuals who provided an address for a boarding house that was not recognised as such could have been mistakenly classified as non-homeless. Although the number of homeless individuals identified in the present study may have led to an underestimation of the number of homeless ED attendees, this risk is likely minimal due to the comprehensive method undertaken to assign the type of homelessness.^{3,15}

The actual numbers of patient deaths may have been underestimated in this study, as deaths were based on the medical record system of a single hospital. Although the hospital where this study was conducted is renowned for its care of people who experience homelessness in Melbourne, research indicates that homeless individuals are more likely to use more than one healthcare provider than non-homeless individuals,^{8,23,31} meaning the deaths of some individuals may not have been identified. Thus, the risk of mortality associated with homelessness may have also been underestimated in the present study. Despite this, the large metropolitan public hospital where the present study took place has a highly consistent catchment within the central business district in Melbourne. Such consistency in seeking care may balance the two factors noted previously. Future studies should consider linking hospital and national data to obtain comprehensive mortality data.

It is likely that some individuals identified as homeless moved between the types of homelessness over the 15-year study period, outside of the two-year recruitment period, due to the dynamic nature of homelessness.^{8,23} A prospectively designed study to record the type of homelessness on an ongoing basis could address this issue. Alternatively, linking patient information to external datasets (e.g. trauma registries, public housing, homelessness services) in future studies would enable a more thorough investigation of the association between health and housing trajectories.

Conclusion

A single episode of primary, secondary or tertiary homelessness in ED attendees was significantly and independently associated with an almost two-fold increased risk of mortality over a 15-year period and an almost 12-year reduction of age at death, relative to non-homeless ED attendees. This is estimated to represent an increased mortality rate of nearly four-fold when compared with the general population.

Implications for public health

These results highlight the importance of identifying individuals experiencing homelessness, including type of homelessness, at pivotal points of intervention, such as in the ED. Identification may enable provision of supports to stabilise housing and, ultimately, improve health and mortality outcomes.

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