

## OTHER ORIGINAL ARTICLES

# Homelessness as an independent risk factor for mortality: results from a retrospective cohort study

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**Background** Homelessness is associated with increased risks of mortality but it has not previously been possible to distinguish whether this is typical of other socio-economically deprived populations, the result of a higher prevalence of morbidity or an independent risk of homelessness itself. The aim of this study was to describe mortality among a cohort of homeless adults and adjust for the effects of morbidity and socio-economic deprivation.

**Methods** Retrospective 5-year study of two fixed cohorts, homeless adults and an age- and sex-matched random sample of the local non-homeless population in Greater Glasgow National Health Service Board area for comparison.

**Results** Over 5 years of observation, 1.7% (209/12 451) of the general population and 7.2% (457/6323) of the homeless cohort died. The hazard ratio of all-cause mortality in homeless compared with non-homeless cohorts was 4.4 (95% CI: 3.8–5.2). After adjustment for age, sex and previous hospitalization, homelessness was associated with an all-cause mortality hazard ratio of 1.6 (95% CI: 1.3–1.9). Homelessness had differential effects on cause-specific mortality. Among patients who had been hospitalized for drug-related conditions, the homeless cohort experienced a 7-fold increase in risk of death from drugs compared with the general population.

**Conclusions** Homelessness is an independent risk factor for deaths from specific causes. Preventive programmes might be most effectively targeted at the homeless with these conditions.

**Keywords** Homeless, deprivation, poverty, inequality, mortality

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## Introduction

Homelessness increases the risk of death from a variety of causes. Eight large cohort studies have been carried out on mortality among homeless people.

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Three are from large American cities on the eastern seaboard,<sup>1–3</sup> two are from Europe (Copenhagen<sup>4</sup> and England<sup>5,6</sup>), two from Canada<sup>7–10</sup> and one from Australia.<sup>11</sup> Standardized mortality ratios for women and men of 5.6 and 2.8, respectively, in hostel residents in Copenhagen<sup>4</sup> are of a similar order to those of New York shelter users<sup>2</sup> and homeless psychiatric patients in Sydney, Australia.<sup>11</sup> Mortality rates among younger homeless people are greater still.<sup>10,7,4</sup>

It is not clear whether the observed mortality risk among the homeless can be explained by their high prevalence of morbidity or whether homelessness itself is an independent risk factor for death. There are important differences in the implications for health and social interventions. Evidence from cross-sectional surveys indicates that homeless individuals have high prevalences of alcohol and substance misuse and smoking.<sup>12,13</sup> Hospitalizations for psychiatric disorders and substance misuse represent larger proportions of inpatient admissions among the homeless compared with non-homeless patients.<sup>14–16</sup> In addition, homelessness may either potentiate the risks associated with morbidities, for example because of lack of access to medical care,<sup>17</sup> or impose additional risks through exposure to hazardous environments<sup>18</sup> including sex working.<sup>19</sup>

A further question is whether homeless mortality rates are similar to those of other socio-economically deprived groups, with which they share many similarities. Mortality rates in the homeless are usually standardized against the general population but when more deprived standard populations are used mortality ratios may be almost halved.<sup>2</sup>

New validated research on deaths among homeless people is needed<sup>20</sup> for two reasons. First, analyses are needed to adjust for prevalent morbidity—including substance misuse—and for the known effects of socio-economic deprivation. Secondly, it is important to assess whether social and medical interventions have changed the rate and diagnostic casemix of deaths in the homeless.

The aim of this study was to describe mortality among a cohort of homeless adults using linked hospitalization records to assess morbidity and an age and sex stratified random sample of the local non-homeless population to infer socio-economic differentials in mortality.

## Methods

### Selection and description of participants

We obtained full names, dates of birth and sex of all adult homeless presentations to Glasgow City Council in the calendar year 2000 and supplied them to the Information Services Division of National Health Service National Services Scotland (ISD). Homelessness is defined by the Council using legal criteria<sup>21</sup> that include having no accommodation, overcrowded or dangerous accommodation, lack of shelter of any kind, or insecure tenancy in which eviction is likely. ISD matched repeat presentations by the same individual to create a dataset of unique individuals. A comparison population was obtained from an age- and sex-stratified random sample of the local general population drawn from Greater Glasgow Health Board Community Health Index. The Community Health Index<sup>22</sup> identifies all

individuals in Scotland who are registered with National Health Service primary care services. The general population cohort was sampled in a 2:1 ratio to reduce the probability that the lower event rate would result in empty age- and sex-specific strata. ISD matched both homeless and non-homeless cohorts to all general hospital records and death records using probability matching techniques, described elsewhere.<sup>23</sup> The linked file was coded with International Classification of Disease and Related Health Problems 10th revision (ICD-10) diagnoses and an anonymized file returned to the author for analysis.

### Ethical approval

Permission to use Glasgow City Council's homeless data was provided by their solicitor. The Director of Public Health for NHS Greater Glasgow gave permission to use the CHI to identify matched general population cohort for the study. ISD's Privacy Advisory Committee gave permission to link both sets of data to their linked hospitalization and death record dataset.

### Socio-economic classification

Individuals' socio-economic status was inferred for each non-homeless participant based on the characteristics of their area of residence. We used the 2001 DEPCAT score,<sup>24</sup> a validated seven-category ordinal score that ranks all postcode sectors from one (most affluent) to seven (most deprived) using four Census variables that have been shown to best correlate with health outcomes—car ownership, male unemployment, occupational Social Classes IV and V and overcrowding. Where an individual's first record did not contain a postcode we used the next record (for example, a hospital admission or death record) that contained this information. Homeless individuals were ascribed 'homeless' socio-economic status.

### Statistics

All analyses were carried out using SPSS version 15.0 software. Comparisons of mean ages between groups were tested using the *t*-test of independent samples, not assuming equal variances. Risk time was calculated from the number of days between entry into the study in 2000 until death or censorship in September 2005. Cox proportional hazards models<sup>25</sup> were constructed entering age in three categories (18–34, 35–54 and  $\geq 55$ ), DEPCAT grouped into three conventional bands (1–2, affluent; 3–5, intermediate; and 6–7, deprived), and sex all as categorical variables. Age was grouped because it does not satisfy the proportionality assumption—that is—it has non-linear effects on hazard. Log-minus-log plots were used to confirm that the proportionality assumption was valid for all variables used in the hazards model. The National Health Service (NHS) provides universal

hospital care in Scotland that is free at the point of access. A Scottish Morbidity Record 1 (SMR01) is completed at discharge for all daycases and inpatients treated in NHS acute general hospitals in Scotland. It records up to six diagnoses for each hospitalization. Any occurrence of a diagnosis within an SMR01 was classified within the groupings shown in Results, so that an individual might have more than one morbidity recorded.

## Results

A total of 6757 adults presented to Glasgow City Council as homeless throughout the calendar year 2000. An age- and sex-matched random cohort of 13514 non-homeless individuals was obtained from Greater Glasgow Health Board Community Health Index at 30 June 2000. Of the cases, 1497 were excluded: 1323 were aged <18 and 174 non-homeless controls had no information on their socio-economic circumstances, leaving a final sample comprising 6323 homeless and 12451 general population comparisons. Stratified sampling resulted in both cohorts having equal proportions of each sex (65% men, 35% women) and mean ages to the first decimal place of a percent. In both cohorts, men were older than women when they entered the cohort in 2000 (male and female mean ages 33 and 30 years, respectively; *t*-test of independent samples,  $P < 0.001$ ). A total of 32321.8 person-years of observation were obtained for the homeless cohort and 64848.4 person-years for controls, with mean follow-up periods of 5.1 and 5.2 years, respectively.

Two hundred and nine (1.7%) of the general population and 457 (7.2%) of the homeless cohort died. The absolute risks of death in homeless and non-homeless cohorts were 14.1 and 3.1 deaths per 1000 person-years, respectively, giving homelessness a crude mortality ratio of 4.5. The mean age at death among homeless people was 41 years and among non-homeless controls it was 53 years (*t*-test of independent samples,  $P < 0.001$ ). Women died younger than men in both cohorts although the difference did not achieve conventional statistical significance in controls. Mean ages of death in the homeless were 42 vs 37 ( $P < 0.001$ ) and in the general population were 54 vs 51 ( $P = 0.410$ ) in men and women, respectively.

Cox proportional hazards models for all-cause mortality are shown in Table 1. The univariate hazard ratio of homeless to non-homeless mortality (not shown) was 4.4 (95% CI: 3.8–5.2). Non-homeless individuals living in the most deprived areas were at nearly three times greater risk of death than those in the most affluent areas. Compared with those in the most deprived areas, homeless individuals had a hazard ratio of 3.2 (95% CI: 2.6–3.8). Increasing age, male sex and previous hospitalization for all causes

except assault were associated with increases in mortality risk.

The multivariate model shows that after adjustment for age, sex and morbidity, homelessness remains an independent risk factor for death with an adjusted hazard ratio of 1.6 (95% CI: 1.3–1.9) (not shown). Compared with the most deprived non-homeless group, homelessness had a reduced hazard ratio of 1.4 (95% CI: 1.1–1.7). Table 1 shows no independent effect of deprivation after adjustment for other factors. Increasing age remains a risk factor but the hazard in individuals of  $\geq 55$  is less than half after adjustment. The risk of mortality associated with being male falls from 2.6 to 1.6 in this multivariate model. Previous hospitalization for cancer treatment is associated with the greatest risk of subsequent death within the 5-year follow-up period. Hospitalizations for alcohol-related conditions treble the risk of death and admissions for drug use double it. Admissions for assault are associated with a small reduction in risk of death. Hospitalizations for intentional self-harm, infectious diseases and diseases of the nervous system do not independently predict subsequent all-cause mortality.

Table 2 gives the cause-specific hazard ratios of death after adjustment for previous hospital admission for the same condition. Each row represents a separate Cox model for cause-specific death comprising age, sex, prior hospitalization for the same condition recorded as the main cause of death, and homelessness. In these models, the non-homeless population was not stratified by socio-economic group both because it resulted in empty strata and because socio-economic status was not found to be an independent risk factor in the all-cause model shown in Table 1. Neoplasms and endocrine diseases were excluded because of empty cells. Table 2 also shows the hazard ratio associated with homelessness in each multivariate model. In general, previous admission for a given condition raises the risk of subsequent death from it. Previous admission for an infectious or parasitic disease is associated with a 73-fold increase in subsequent death from an infectious disease and homelessness confers no additional risk. This diagnostic group of 11 deaths included four deaths from non-confirmed respiratory tuberculosis and two deaths from HIV. Previous hospitalization for an alcohol-related condition is associated with a 42-fold increase in death from alcoholic causes. In this model also homelessness adds no further risk. That is, patients hospitalized with infectious diseases and alcohol-related conditions are at no greater risk of mortality from them if they are homeless. Admissions for drug-related conditions raise the hazard of death by  $\sim 4$ -fold but among this group homelessness adds a further 7-fold risk. Homelessness doubles the risk of mortality among patients admitted for circulatory diseases, and triples it among respiratory patients. Compared with the overall model in which

**Table 1** Proportional hazards models for all-cause mortality by socio-economic status, age, sex and cause-specific hospitalization up to 5 years prior to death

	All-cause mortality	
	Univariate	Multivariate
<b>Socio-economic status</b>		
Affluent (15/1811)	1	1
Intermediate (42/4087)	1.2 (0.7, 2.2)	1.1 (0.6, 2.2)
Deprived (152/6553)	2.8 (1.7, 4.8)	1.7 (0.9, 3.1)
Homeless (457/6323)	8.9 (5.2, 15.0)	2.4 (1.3, 4.3)
<b>Age (years)</b>		
18–34 (253/12332)	1	1.0
35–54 (250/5456)	2.3 (1.9, 2.7)	2.0 (1.6, 2.5)
≥55 (163/986)	8.7 (7.1, 10.6)	3.6 (2.7, 4.8)
<b>Sex</b>		
Female (115/6566)	1	1.0
Male (551/12208)	2.6 (2.1, 3.2)	1.6 (1.3, 2.0)
<b>Hospitalization<sup>a</sup></b>		
Drug (F11-16, F18-19, Y10-12, Y14) (168/1083)	1.6 (1.3, 2.0)	1.9 (1.4, 2.5)
Alcohol (Y15, F10, K70) (105/1189)	4.7 (4.0, 5.6)	2.8 (2.3, 3.5)
Circulatory (I00-99) (106/1331)	2.8 (2.3, 3.3)	1.2 (>1.0, 1.5)
Respiratory (J00-99) (49/1084)	2.8 (2.3, 3.4)	1.4 (1.2, 1.7)
Intentional self-harm (X60-84) (42/774)	1.4 (1.1, 1.8)	1.0 (0.8, 1.3)
Neoplasms (C00-97) (80/166)	10.3 (8.1, 13.1)	7.2 (5.5, 9.3)
Assault (X85-Y09) (22/841)	1.2 (0.9, 1.5)	0.7 (0.5, 0.9)
Infectious, parasitic (A00-B99) (11/879)	2.2 (1.8, 2.7)	1.2 (<1.0, 1.5)
Endocrine (E00-90) (9/407)	2.7 (2.1, 3.5)	1.3 (>1.0, 1.8)
Nervous (G00-99) (12/471)	2.6 (2.1, 3.3)	1.2 (<1.0, 1.6)

Number of deaths/number in stratum in brackets.

<sup>a</sup>Excludes 62 smaller other diagnostic groups.

**Table 2** Age- and sex-adjusted cause-specific hazards of death by previous hospitalization for the principal cause of death

Cause of death (ICD-10)	Hazard ratio (95% CI)	
	Hospitalized for cause of death	HR homeless/non-homeless
Drugs (F11-16, F18-19, Y10-12, Y14)	3.9 (2.6, 5.9)*	7.2 (3.4, 15.2)*
Alcohol (Y15, F10, K70)	42.0 (20.8, 84.5)*	0.7 (0.4, 1.1)
Circulatory (I00-99)	6.0 (3.6, 10.3)*	1.8 (1.1, 2.9)*
Intentional self-harm (X60-84)	7.0 (2.8, 17.4)*	3.3 (0.9, 11.7)
Respiratory (J00-99)	5.9 (3.1, 11.2)*	2.9 (1.4, 5.9)*
Assault (X85-Y09)	3.5 (0.9, 13.8)	3.4 (0.7, 17.1)
Infectious and parasitic (A00-B99)	73.0 (8.9, 598.0)*	1.2 (0.3, 4.7)
Nervous system (G00-99)	28.5 (6.8, 118.8)*	0.7 (0.2, 2.6)

Adjusted homeless/non-homeless hazard ratio (HR) also shown. All homeless patients who died from neoplasms had been previously hospitalized for neoplastic disease and all patients who died from endocrine causes had been previously hospitalized for endocrine diseases.

\*Significant at the 95% level.

hospitalization is not included (hazard ratio=4.4), these suggest that some but not all of the excess risk associated with homelessness can be explained by the general risks of morbidity.

## Discussion

Increased mortality risks associated with homelessness can partly be explained by the high prevalence

of morbidity but homelessness itself confers additional risk. The risks associated with homelessness vary with diagnosis. Patients with drug misuse, circulatory and respiratory disorders were at raised risk of dying from their conditions if they were homeless. For most other conditions there was no independent risk associated with homelessness although upper confidence limits did not exclude an effect. For all patients, previous hospitalization for infectious diseases- and alcohol-related problems were associated with very high risks of subsequent death. The clinical implications of these findings are that homelessness should be considered an independent risk factor for subsequent mortality for some conditions and efforts to engage homeless patients with social and welfare support programs on discharge from hospital may reduce death rates.

The health risks of homelessness have been reported before, but this study adds several new perspectives. First, we consider homelessness as a form of deprivation and place it in the context of socio-economic mortality differentials in the local non-homeless population. Comparison with the most deprived populations indicates that homelessness is not simply a misfortune that affects poor people: it is a hazard beyond conventional area-based measures of poverty. Secondly, we adjusted for morbidity to distinguish between the risks of illness and homelessness itself. Thirdly, our use of local population controls improves the precision of risk estimates above standardization, which has been used on all published cohort studies of homeless people. Standard populations do not experience competing risks and are assumed to contribute full person-time to any period of observation. This latter assumption is particularly non-valid when event rates are high. Local controls also reduce the likelihood of local 'area effects' in death record coding practices. Fourthly, we have not limited our sample of homeless people to particular circumstances (such as rough sleepers,<sup>5</sup> or users of specialist health services<sup>1</sup> or night shelters<sup>8,9,2</sup>) and thus our sample is uniquely comprehensive. Our homeless cohort is either larger<sup>4,3,10,6,2,11</sup> or has a longer follow-up period<sup>9,8,1,7</sup> than most other cohort studies on this group. The excess mortality among men was only partially explained by age, socio-economic circumstances and morbidity. The adjusted hazard of 1.6 in men compared with women is likely to reflect the mortality rate ratio in the general Scottish population, which is about 2 in 35–44-year olds.<sup>26</sup> Comparisons of mortality between homeless men and women have often been made using indirectly standardized rates, which compare each sex to its reference population rather than directly to one another. The results have been mixed with some reporting an excess of mortality in men<sup>1,11</sup> (such as Hwang's male to female crude rate ratio of 2.5 among homeless 25–44-year olds in Boston),<sup>3</sup> some reporting higher SMRs among women<sup>2,4</sup> and some reporting similar death rates in each sex.<sup>8</sup>

Our study has a number of limitations. Homeless people who do not use local authority services at any point in a year will be excluded. Reliable data to track individuals' homeless status do not exist. There is no agreed incident event when homelessness is resolved and it was therefore not possible to say whether homeless people remained homeless, or temporarily or permanently resolved their homelessness during the follow-up period. There is some evidence that recent homelessness is associated with greater risk of death,<sup>7,27</sup> although Hwang found that the strength of the relationship depended on whether time was modelled as a categorical or continuous variable.<sup>27</sup> It is likely that some homeless circumstances, such as rough sleeping, are associated with greater hazards than others, such as fleeing a unique domestic emergency, but the dataset did not include such information. More generally, cohort studies often assume that individuals' socio-economic circumstances at the beginning of follow-up are an indicator of their future status. Our aim, however, was to estimate the risks associated with homelessness and to this extent our classification is valid for future prediction of risks. It is not possible to say from our data whether major risk factors—such as drug and alcohol misuse—preceded or were consequences of being homeless. Reliable data are not available, partly because people are reluctant to declare their addictions problems when seeking the help of a local authority to find accommodation, and partly because self-medication by drugs and alcohol may be confounding rather than causal factors in the path to homelessness. The great majority of individuals with drug and alcohol problems do not become homeless. The area-based DEPCAT measure was used as a proxy for individuals' socio-economic status because individual-level data were not available from the routine dataset used to identify the non-homeless group. Populations within postcode sectors are heterogeneous and there is an ecological fallacy in assuming that a given individual shares the socio-economic characteristics of their area.<sup>28</sup> However, the DEPCAT was developed to provide reasonably valid estimates of socio-economic differentials in health outcomes at a population level.<sup>29</sup> The use of hospitalization as a proxy measure of morbidity may overestimate prevalent conditions in the general population<sup>30</sup> but its validity in the homeless has not been reported. Over-estimation of morbidity as a result of high rates of hospital use among the homeless may introduce a form of Berkson's bias<sup>31</sup> or lack of access, particularly to elective treatment, may under-estimate prevalent morbidity.

Glasgow City Council receives applications for assistance of homeless individuals from a variety of statutory and voluntary agencies but the majority of applicants are self-referred. While the Council is the largest provider of homeless accommodation and support services in the West of Scotland, charities also

provide about a third of all beds.<sup>32</sup> A group of uncertain size of 'hidden homeless' (including rough sleepers and those living temporarily at friends' houses) also exists. Many of these individuals will be included in the Glasgow City Council database, however. For example, ~13% of applicants report having slept rough the night before presenting to the Council.<sup>33</sup> Thus, while Glasgow City Council's database is not completely comprehensive it is likely to be representative of the local homeless population.

Homeless people are young and at greater risk of premature death than the most deprived populations defined by conventional measures of socio-economic circumstances. Some evidence is available on effective

health interventions among the homeless<sup>34,35</sup> although outcomes are often limited to service delivery or reductions in hospitalization rates. Further work is needed to determine if interventions to alleviate homelessness in patients with drug misuse, circulatory and respiratory disorders are effective in reducing the excess mortality we found.

## Funding

NHS Greater Glasgow and Clyde Board but they had no role in the conduct or conclusions of the work.

**Conflict of interest:** None declared.

### KEY MESSAGES

- It was not known whether the high mortality among homeless people was typical of other socio-economically deprived populations, could be explained by a higher prevalence of morbidity, or was an independent risk of homelessness itself.
- After adjustment for age, sex and morbidity requiring hospitalization, homeless individuals had a mortality hazard 1.6 times greater than local non-homeless residents and 1.4 times greater than residents of the most socio-economically deprived areas.
- For individuals with some morbidities, such as drug use, being homeless conferred a much higher hazard of death.
- Homelessness is more hazardous than being in conventional deprived socio-economic circumstances and may benefit from more intensive targeted health and social interventions.

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