

Mortality among residents of shelters, rooming houses, and hotels in Canada: 11 year follow-up study

Stephen W Hwang, research scientist,¹ associate professor,² Russell Wilkins, senior research analyst,³ adjunct professor,⁴ Michael Tjepkema, senior research analyst,⁵ MHS candidate,⁶ Patricia J O'Campo, director,¹ professor,^{6,7} James R Dunn, chair in applied public health,¹ associate professor^{6,8,9,10}

¹Centre for Research on Inner City Health, Keenan Research Centre, Li Ka Shing Knowledge Institute, St Michael's Hospital, Toronto, ON, Canada

²Division of General Internal Medicine, Department of Medicine, University of Toronto, Toronto

³Health Information and Research Division, Statistics Canada, Ottawa

⁴Department of Epidemiology and Community Medicine, University of Ottawa, Ottawa

⁵Health Information and Research Division, Statistics Canada, Toronto

⁶Dalla Lana School of Public Health, University of Toronto, Toronto

⁷Department of Population, Reproductive and Family Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

⁸Department of Geography and Programme in Planning, University of Toronto, Toronto

⁹Successful Societies Program, Canadian Institute for Advanced Research, Toronto

¹⁰Department of Health, Aging and Society, McMaster University, Hamilton, ON

Correspondence to: S W Hwang, Centre for Research on Inner City Health, St. Michael's Hospital, 30 Bond Street, Toronto, ON, Canada M5B 1W8
hwangs@smh.toronto.on.ca.

Cite this as: *BMJ* 2009;339:b4036
doi:10.1136/bmj.b4036

ABSTRACT

Objective To examine mortality in a representative nationwide sample of homeless and marginally housed people living in shelters, rooming houses, and hotels.

Design Follow-up study.

Setting Canada 1991-2001.

Participants 15 100 homeless and marginally housed people enumerated in 1991 census.

Main outcome measures Age specific and age standardised mortality rates, remaining life expectancies at age 25, and probabilities of survival from age 25 to 75. Data were compared with data from the poorest and richest income fifths as well as with data for the entire cohort

Results Of the homeless and marginally housed people, 3280 died. Mortality rates among these people were substantially higher than rates in the poorest income fifth, with the highest rate ratios seen at younger ages. Among those who were homeless or marginally housed, the probability of survival to age 75 was 32% (95% confidence interval 30% to 34%) in men and 60% (56% to 63%) in women. Remaining life expectancy at age 25 was 42 years (42 to 43) and 52 years (50 to 53), respectively. Compared with the entire cohort, mortality rate ratios for men and women, respectively, were 11.5 (8.8 to 15.0) and 9.2 (5.5 to 15.2) for drug related deaths, 6.4 (5.3 to 7.7) and 8.2 (5.0 to 13.4) for alcohol related deaths, 4.8 (3.9 to 5.9) and 3.8 (2.7 to 5.4) for mental disorders, and 2.3 (1.8 to 3.1) and 5.6 (3.2 to 9.6) for suicide. For both sexes, the largest differences in mortality rates were for smoking related diseases, ischaemic heart disease, and respiratory diseases.

Conclusions Living in shelters, rooming houses, and hotels is associated with much higher mortality than expected on the basis of low income alone. Reducing the excessively high rates of premature mortality in this population would require interventions to address deaths related to smoking, alcohol, and drugs, and mental disorders and suicide, among other causes.

INTRODUCTION

Many studies have shown that low socioeconomic status, as measured by income, education, or occupation, is strongly associated with higher mortality.^{1,2} These

differences are believed to exist, at least in part, because income, education, and occupation are markers for the material conditions of everyday life. Another such marker might be the type of housing in which a person lives. At the extreme end of the spectrum are homeless people sleeping rough on the street. More often, homeless people live in shelters, hostels, and missions.³ Somewhat less disadvantaged individuals, who are sometimes referred to as being "marginally housed," might live in low cost collective dwellings such as YMCA/YWCA facilities, rooming and lodging houses, and single room occupancy hotels, where each resident has a bedroom and shared access to bathroom facilities.^{4,5} Individuals with limited housing options might also live in motels, sometimes with rent subsidised by welfare agencies. These housing situations can be important indicators of socioeconomic deprivation beyond that which can be determined on the basis of income alone.

Previous research on mortality among individuals living in settings consistent with severe disadvantage has focused primarily on homeless people. These studies have found high levels of excess mortality among the homeless compared with the general population. Most of these studies have been limited to homeless people in a single city, most notably Philadelphia,⁶ Boston,⁷ New York City,⁸ Copenhagen,⁹ Stockholm,¹⁰ Toronto,^{11,12} and Montreal.¹³ Additional studies have reported mortality rates in specific subgroups of homeless individuals, such as those with HIV infection living in San Francisco,¹⁴ those with schizophrenia living in Sydney, Australia,¹⁵ and United States military veterans with mental illness.¹⁶ Little information is available on mortality rates in a nationwide representative sample of homeless people or on mortality rates among those who are homeless and living in shelters compared with those who are marginally housed and living in other categories of collective dwellings.

Our main goal was to determine age and sex specific mortality rates, causes of death, and probabilities of survival to various ages in a representative nationwide sample of homeless and marginally housed people living in shelters, rooming houses, and hotels in Canada. To overcome some of the limitations of previous

Table 1 | Census respondents, study cohort, linkage rate, deaths ascertained, and person years at risk, non-institutional population aged 25 and over at baseline, 1991*

Sex and category	Census respondents	Study cohort	Linkage rate (%)	No of deaths	Person years at risk
Both sexes					
Entire cohort	3 576 500	2 735 200	76	260 820	27 618 420
Shelters, rooming houses, hotels	41 800	15 100	36	3280	141 660
Shelters	5 700	1500	26	338	14 130
Rooming houses	19 200	7800	41	1864	72 380
Hotels	16 900	5800	34	1078	55 150
Poorest income fifth	715 400	470 400	66	75 229	4 589 150
Richest income fifth	715 100	587 400	82	36 593	6 033 060
Men					
Entire cohort	1 738 000	1 358 400	78	153 552	13 580 340
Shelters, rooming houses, hotels	29 700	10 500	35	2359	97 690
Shelters	3900	900	23	219	8 390
Rooming houses	13 500	5500	40	1267	50 670
Hotels	12 300	4100	33	873	38 640
Poorest income fifth	306 000	197 300	64	35 839	1 895 900
Richest income fifth	372 300	309 900	83	23 638	3 161 140
Women					
Entire cohort	1 838 500	1 376 800	75	107 268	14 038 080
Shelters, rooming houses, hotels	12 100	4600	38	921	43 970
Shelters	1800	600	33	119	5 750
Rooming houses	5700	2400	42	597	21 710
Hotels	4600	1700	36	205	16 510
Poorest income fifth	409 400	273 000	67	39 390	2 693 250
Richest income fifth	342 700	277 500	81	12 955	2 871 930

*Census population counts rounded to nearest 100. Percentages calculated before rounding. Person years at risk rounded to nearest 10.

research, which included a narrow set of comparison groups—typically only the general population, we also compared mortality rates among various categories of homeless and marginally housed people with rates in people in the poorest and richest fifths of income of the general population. By using these comparison groups, we sought to detect excess mortality associated with homelessness and marginal housing beyond that associated with low income alone.

METHODS

We used data from the Canadian census mortality follow-up study, which tracked mortality in a 15% sample of the adult population of Canada.¹⁷ People were eligible for the study cohort if they were aged 25 or older and a usual resident of Canada on the day of the census (4 June 1991), were not a long term resident of an institution such as a prison, hospital, or nursing home, and had been selected for census enumeration with a detailed “long form” questionnaire. About 3.6 million people met these criteria. The long form questionnaire was administered to one in five private households and to all people living in non-institutional collective dwellings, including the following types of collective dwellings serving homeless and marginally housed individuals: shelters and hostels for the homeless, missions, and YMCA/YWCA facilities (“shelters”); rooming and lodging houses (“rooming houses”); and hotels, motels, and tourist homes (“hotels”). For

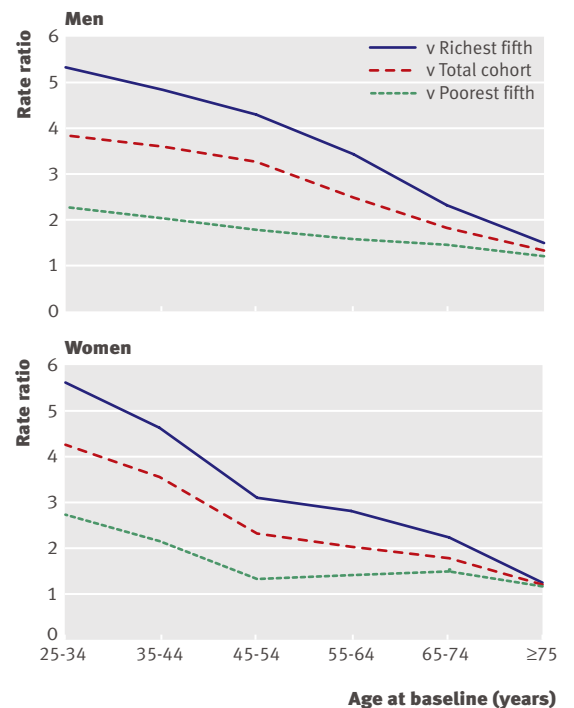


Fig 1 | Mortality rate ratios for men and women living in shelters, rooming houses, and hotels compared with entire cohort and poorest and richest income fifths

Table 2 | Demographic and socioeconomic characteristics of entire cohort, cohort members living in shelters, rooming houses, and hotels, and all census respondents living in shelters, rooming houses, and hotels, by sex, at baseline, 1991. Figures are column percentages unless stated otherwise

Category	Men			Women		
	Entire study cohort	Cohort members in shelters, etc	All census respondents in shelters, etc	Entire study cohort	Cohort members in shelters, etc	All census respondents in shelters, etc
No of people	1 358 400	10 500	29 700	1 376 800	4600	12 100
Age 25-44	53	47	50	56	43	45
Age 45-64	32	39	36	28	29	28
Age ≥65	15	14	14	16	28	27
Married or common law	79	11	13	69	21	23
Education less than high school graduation	35	54	52	35	49	50
Employed (any occupation)	72	43	45	58	45	42
Poorest two income adequacy fifths	34	80	79	39	82	84
Major source of income from government transfers	16	44	41	21	47	46
Visible minority	7	7	8	8	6	9
Aboriginal	4	5	6	4	6	7
Born outside Canada	21	16	15	21	14	15
Any activity limitation	11	30	23	10	28	24

purposes of brevity, we use the term “shelters, rooming houses, and hotels” to refer to these three categories of collective dwellings. For the 1991 census, no attempt was made to enumerate homeless people sleeping outside, and these individuals were not included in this study.

The electronic 1991 census database did not contain names, which were needed for ascertainment of mortality. To obtain names, census records were linked to tax filer data from 1990 and 1991 with probabilistic matching on the basis of dates of birth and postal codes of the individual and his or her spouse or common law partner (if any), as previously described.¹⁷ Deaths in the cohort were ascertained by linkage of census records to the Canadian mortality database with probabilistic methods described elsewhere.^{18 19} Ascertainment of deaths in the cohort followed for mortality was estimated to be about 97%.¹⁷

Data obtained from the 1991 census long form included marital status, education, occupation, income, ethnic origins, Aboriginal status, place of birth, place of residence, and self reported limitation in activity. Data obtained from the Canadian mortality database included date of death and underlying cause of death. Cause of death was coded according to ICD-9 (international classification of diseases, ninth revision) for deaths occurring in 1991-9 and ICD-10 (10th revision) for deaths occurring in 2000-1. Causes of death were grouped by ICD-9 chapter, categories within chapters, and by risk factors (smoking related, alcohol related, drug related, or amenable to medical intervention) (see appendix A on bmj.com).^{20 21}

To construct income adequacy fifths, we determined the total pre-tax income from all sources for each household or unattached individual. For each applicable family size and community size group we calculated the ratio of total income to the 1991 low income cut-off from Statistics Canada. The population was then ranked according to this ratio, and income fifths

were determined within each census metropolitan area, census agglomeration, or rural area.

For each member of the cohort, we calculated person days of follow-up from the day of the census (4 June 1991) to the date of death or the last day of the study period (31 December 2001). Person days of follow-up were divided by 365.25 to obtain person years at risk. We used mortality rates specific for age, sex, income fifth, and collective dwelling by five year age groups to calculate age standardised mortality rates, using the cohort population structure (person years at risk), both sexes together, as the standard population. Corresponding 95% confidence intervals for age standardised mortality rates were calculated by using previously described methods.²²

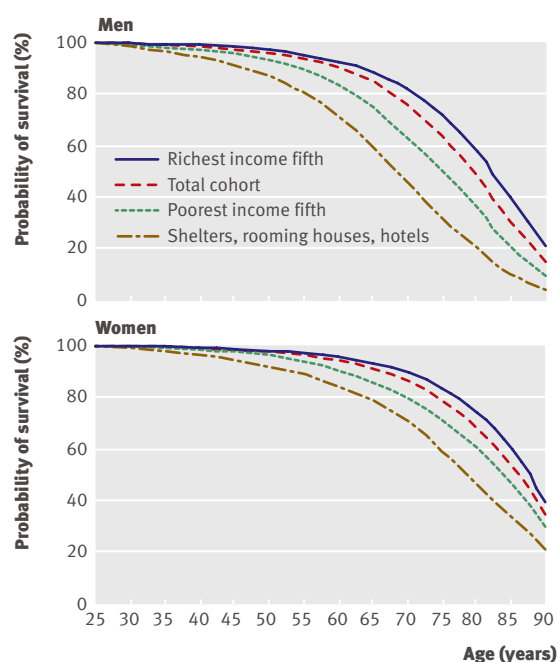


Fig 2 | Probability of survival for men and women conditional on survival to age 25

Table 3 | Deaths and age standardised mortality rates per 100 000 person years at risk for entire cohort, poorest and richest income fifths, and those living in shelters, rooming houses, and hotels, Canada, 1991-2001*

	Entire cohort		Poorest fifth		Richest fifth		Shelters, rooming houses, hotels	
	Deaths	Rate (95% CI)	Deaths	Rate (95% CI)	Deaths	Rate (95% CI)	Deaths	Rate (95% CI)
Men								
Total	153 552	1229 (1223 to 1235)	35839	1650 (1633 to 1668)	23638	981 (967 to 995)	2359	2467 (2365 to 2573)
Age (years):								
25-34	4481	115 (111 to 118)	1142	193 (182 to 204)	595	82 (76 to 89)	112	440 (366 to 530)
35-44	8122	219 (214 to 224)	1779	392 (374 to 411)	1371	163 (155 to 172)	194	787 (684 to 906)
45-54	14 804	590 (581 to 600)	2915	1089 (1050 to 1129)	3739	445 (431 to 459)	411	1911 (1734 to 2106)
55-64	31 674	1701 (1682 to 1720)	7413	2666 (2605 to 2728)	6298	1225 (1195 to 1256)	695	4214 (3912 to 4540)
65-74	50 359	4289 (4251 to 4326)	10 735	5321 (5221 to 5422)	6504	3314 (3234 to 3396)	526	7698 (7060 to 8393)
≥75	44 112	10721 (10621 to 10823)	11 855	11913 (11700 to 12130)	5131	9478 (9218 to 9745)	421	13 933 (12 626 to 15 376)
Women								
Total	107 268	703 (699 to 707)	39390	884 (874 to 894)	12955	592 (582 to 603)	921	1260 (1166 to 1361)
Age (years):								
25-34	2449	58 (56 to 60)	734	90 (84 to 97)	302	44 (39 to 49)	27	247 (169 to 361)
35-44	5368	140 (137 to 144)	1321	231 (219 to 244)	913	107 (101 to 115)	46	495 (371 to 661)
45-54	8264	352 (344 to 359)	1951	616 (590 to 644)	1955	263 (252 to 275)	64	816 (639 to 1043)
55-64	14 726	897 (882 to 911)	4324	1292 (1254 to 1332)	2332	643 (617 to 670)	99	1799 (1476 to 2192)
65-74	29 871	2273 (2248 to 2299)	10134	2718 (2665 to 2772)	3209	1815 (1753 to 1879)	172	4038 (3470 to 4698)
≥75	46 590	6665 (6605 to 6726)	20 926	6926 (6832 to 7022)	4244	6456 (6264 to 6654)	513	7894 (7164 to 8699)

*Reference population (person years at risk) for age standardisation was taken from total cohort age distribution (5 year age groupings).

Mortality rate ratios and rate differences were used to compare age standardised mortality rates for those living in shelters, rooming houses, and hotels with those in the poorest income fifth, the richest income fifth, and the entire cohort. Mortality rate ratios and rate differences were also calculated separately for each of the subcategories of shelters, rooming houses, and hotels compared with the entire cohort.

We used the actuarial method²³ to calculate life tables for each sex and income fifth and for different housing categories after transforming age from age at baseline to age at the beginning of each year of follow-up. Deaths and person years at risk were calculated separately for each year or partial year of follow-up, then pooled by age at the beginning of each year of follow-up, before the calculation of the life tables. Life tables were used to construct survival curves and to determine probability of survival to age 75, contingent on survival to age 25.

RESULTS

Table 1 shows the linkage rate for residents of shelters, rooming houses, and hotels combined and for each category separately. In total, 36% of the population living in those types of collective dwellings were successfully matched to the name file, resulting in 15 100 cohort members followed for mortality, of whom 3280 had died by the end of the follow-up period, during 141 660 person years at risk. Among the three categories of non-institutional collective dwellings studied, rooming houses had the highest linkage rate (41%) and shelters had the lowest linkage rate (26%).

Table 2 shows that, despite the lower linkage rates, the demographic and socioeconomic profile of cohort

members living in shelters, rooming houses, and hotels was similar to that of all the census respondents living in those types of collective dwellings. Table 2 also compares the baseline characteristics of cohort members living in shelters, rooming houses, and hotels with the entire cohort. For cohort members living in shelters, rooming houses, and hotels compared with the entire cohort, men were somewhat more likely to be middle aged (45-64), while women were more likely to be older (≥65). Compared with the entire cohort, for both men and women, those living in shelters, rooming houses, and hotels were far less likely to have been married and were less likely to have completed a high school education or to have been born outside Canada. As expected, the income distribution of those residing in shelters, rooming houses, and hotels in 1991 differed from the entire cohort. In the entire cohort, only 34% of men and 39% of women were in the poorest two fifths, while among those living in shelters, rooming houses, and hotels the corresponding figures were 80% and 82%. In the entire cohort, 72% of men and 58% of women were employed compared with 43% of men and 45% of women living in shelters, rooming houses, and hotels.

Table 3 presents age standardised mortality rates per 100 000 person years for men and women in the entire cohort, the poorest and richest income fifths, and those living in shelters, rooming houses, and hotels. Figure 1 shows mortality rate ratios for men and women (see also appendix B on bmj.com). In all comparisons rate ratios were higher at younger than at older ages. Rate ratios were highest for shelters, rooming houses, and hotels compared with the richest income fifth—with rate ratios for both men and

Table 4 | Remaining life expectancy at age 25 and expected survivors from ages 25 to 75, for entire cohort, those living in shelters, rooming houses, and hotels, and for poorest and richest income fifths, by sex, Canada, 1991-2001 (95% confidence interval in parentheses)

Category	Men	Women
Remaining life expectancy at age 25 (years)		
Total, entire cohort	52.6 (52.6 to 52.7)	59.0 (58.9 to 59.1)
Shelters, rooming houses, hotels	42.3 (41.6 to 42.9)	51.6 (50.4 to 52.7)
Shelters	39.2 (37.0 to 41.5)	50.6 (47.5 to 53.7)
Rooming houses	41.4 (40.5 to 42.3)	49.7 (48.0 to 51.4)
Hotels	44.3 (43.4 to 45.3)	53.8 (51.9 to 55.7)
Poorest income fifth	48.4 (48.3 to 48.6)	56.4 (56.3 to 56.5)
Richest income fifth	55.3 (55.2 to 55.4)	60.7 (60.5 to 60.8)
Expected survivors from ages 25 to 75 (%)		
Total, entire cohort	64.0 (63.8 to 64.2)	79.0 (78.8 to 79.2)
Shelters, rooming houses, hotels	32.1 (30.2 to 33.9)	59.6 (56.0 to 63.1)
Shelters	27.0 (21.1 to 32.9)	51.3 (40.8 to 61.9)
Rooming houses	30.6 (28.0 to 33.2)	53.9 (48.9 to 58.9)
Hotels	35.2 (32.3 to 38.2)	69.4 (63.5 to 75.3)
Poorest income fifth	50.6 (50.1 to 51.1)	71.5 (71.0 to 71.9)
Richest income fifth	72.4 (72.0 to 72.8)	83.8 (83.4 to 84.2)

women exceeding 5 at ages 25-34 and well over 4 at ages 35-44. Even when compared with the poorest income fifth, rate ratios were 2 or more at those ages for both men and women. In all comparisons, rate ratios converged toward 1 at ages 75 and over.

Figure 2 shows the probability of survival to various ages (conditional on survival to age 25) for men and women in the entire cohort, the poorest and richest income fifths, and those living in shelters, rooming houses, and hotels. For both men and women, the survival curves were considerably more rectangular for the richest fifth and for the entire cohort compared with the poorest fifth or with those living in shelters, rooming houses, and hotels, reflecting a more favourable mortality pattern.

Figure 3 shows the probabilities of survival to age 75 obtained from the life table analyses. Men living in shelters, rooming houses, and hotels had the lowest probability of survival to age 75 (32.1%, 95% confidence interval 30.2% to 33.9%). This was 19 percentage points lower than the probability of survival to age 75 for the poorest fifth (50.6%, 50.1% to 51.1%) and 40 percentage points lower than for the richest fifth (72.4%, 72.0% to 72.8%). For women, the differences between the groups were notably smaller. For women living in shelters, rooming houses, and hotels, the probability of survival to age 75 (59.6%, 56.0% to 63.1%) was 12 percentage points less than for the poorest fifth (71.5%, 71.0 to 71.9), and 24 percentage points less than for the richest income fifth (83.8%, 83.4% to 84.4%).

Table 4 shows life expectancy at age 25. The results are presented for the same four groups plus the three subcategories of the shelter, rooming house, and hotel population. For both men and women, remaining life expectancy was much lower for the combined category of shelters, rooming houses, and hotels compared with

the richest income fifth, the entire cohort, or the poorest income fifth. Among the subcategories, it was lowest for people living in shelters and rooming houses, followed by people living in hotels.

For men, remaining life expectancy in the combined shelter, rooming house, and hotel category (42.3 years, 41.6 to 42.9) was 10 years lower than in the entire cohort, 13 years lower than in the richest income fifth, and six years lower than in the poorest income fifth. For men in the subcategory of shelters, remaining life expectancy (39.2 years, 37.0 to 41.5) was another three years lower than for the combined category. For women, remaining life expectancy in the combined shelter, rooming house, and hotel category (51.6 years, 50.4 to 52.7) was seven years lower than in the entire cohort, nine years lower than in the richest income fifth, and five years lower than in the poorest income fifth. For women in the subcategory of rooming houses, remaining life expectancy (49.7 years, 48.0 to 51.4) was another two years lower than for the combined category.

We also analysed cause specific mortality. Age standardised mortality rates for the total cohort, the poorest and richest income fifths, and those living in shelters, rooming houses, and hotels in 1991 are presented in appendix C (on bmj.com), while tables 5 (men) and 6 (women) and figure 4 show the rate ratios and rate differences for the entire cohort compared with those living in shelters, rooming houses, and hotels. Compared with the entire cohort, rate ratios for both sexes were higher for mental disorders (4.8 and 3.8 for men and women, respectively), cirrhosis of the liver (3.7 and 5.6), and external causes of death (3.3 and 3.7). Among the external causes, rate ratios for men were particularly higher for homicide (11.3) and poisoning (10.3), while rate ratios for women were highest for suicide (5.6) and all other external causes of death (4.2). For men, the rate ratio was also higher for deaths caused by diseases of the blood and blood forming organs (4.6). For both men and women, rate ratios were higher for deaths related to drugs (11.5 and 9.2, respectively) and alcohol (6.4 and 8.2). For both men and women, the largest rate differences (per

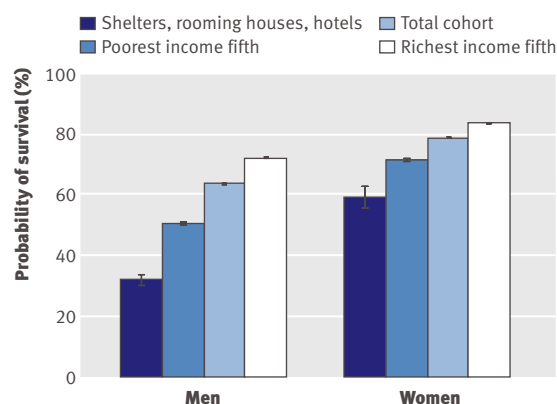


Fig 3 | Probability of survival to age 75, conditional on survival to age 25

Table 5 | Mortality rate ratios and rate differences* (per 100 000 person years at risk), by major causes of death, comparing men living in shelters, rooming houses, and hotels† with men in entire cohort‡, Canada, 1991-2001

Cause	Ratio (95% CI)	Difference (95% CI)
Total, all causes of death	2.01 (1.92 to 2.09)	1237.8 (1134.6 to 1341.0)
Infectious diseases	2.80 (2.07 to 3.78)	30.8 (16.3 to 45.3)
Cancer	1.56 (1.44 to 1.70)	219.1 (168.9 to 269.4)
Trachea, bronchus, and lung	1.91 (1.67 to 2.18)	107.2 (77.2 to 137.3)
Intestine and rectum	1.39 (1.08 to 1.78)	18.7 (1.8 to 35.7)
Oesophagus and stomach	1.22 (0.86 to 1.74)	5.7 (-5.4 to 16.7)
Pancreas	1.19 (0.75 to 1.86)	3.4 (-6.3 to 13.1)
Prostate	0.95 (0.69 to 1.31)	-2.5 (-17.3 to 12.3)
Urinary system	1.27 (0.85 to 1.90)	5.9 (-5.2 to 17.0)
Lymphatic tissue and leukaemia	0.90 (0.62 to 1.31)	-3.6 (-15.7 to 8.5)
Other cancer	2.18 (1.86 to 2.55)	85.9 (60.8 to 111.0)
Endocrine system diseases	2.01 (1.58 to 2.56)	38.4 (19.8 to 57.0)
Diabetes mellitus	1.75 (1.31 to 2.34)	23.1 (7.4 to 38.7)
Other endocrine	3.12 (2.01 to 4.84)	15.4 (5.4 to 25.4)
Blood and blood forming organs	4.59 (2.67 to 7.87)	14.1 (4.3 to 23.9)
Mental disorders	4.82 (3.93 to 5.92)	80.1 (59.2 to 101.0)
Nervous system diseases	1.93 (1.47 to 2.54)	28.8 (12.5 to 45.0)
Circulatory system diseases	1.71 (1.59 to 1.84)	328.3 (269.1 to 387.6)
Ischaemic heart disease	1.63 (1.48 to 1.80)	182.4 (137.0 to 227.7)
Heart failure	1.74 (1.24 to 2.46)	17.1 (3.3 to 30.8)
Cerebrovascular disease	1.87 (1.55 to 2.25)	64.5 (38.8 to 90.1)
Other circulatory diseases	1.82 (1.53 to 2.17)	64.5 (39.8 to 89.1)
Respiratory system diseases	2.56 (2.26 to 2.90)	175.6 (139.5 to 211.6)
Pneumonia	2.30 (1.82 to 2.91)	44.5 (25.9 to 63.2)
Bronchitis, emphysema, and asthma	2.92 (2.49 to 3.42)	118.7 (90.0 to 147.4)
Other respiratory system diseases	1.75 (1.18 to 2.61)	12.3 (0.9 to 23.8)
Digestive system diseases	3.07 (2.58 to 3.65)	87.9 (65.0 to 110.7)
Cirrhosis of liver	3.66 (2.83 to 4.75)	37.3 (23.9 to 50.7)
Other digestive system diseases	2.78 (2.20 to 3.50)	50.5 (32.1 to 69.0)
Genitourinary system diseases	1.51 (1.01 to 2.26)	10.6 (-2.1 to 23.4)
Musculoskeletal system diseases	2.52 (1.29 to 4.94)	5.7 (-0.7 to 12.1)
Ill defined conditions	5.08 (4.01 to 6.43)	55.9 (39.2 to 72.6)
External causes	3.34 (2.92 to 3.81)	158.4 (128.0 to 188.8)
Motor vehicle	1.68 (1.09 to 2.60)	9.3 (-0.6 to 19.2)
Suicide	2.33 (1.76 to 3.07)	29.5 (15.0 to 43.9)
Falls	3.06 (2.23 to 4.21)	26.5 (13.9 to 39.0)
Homicide	11.29 (7.21 to 17.69)	18.4 (9.0 to 27.8)
Poisoning	10.34 (7.37 to 14.50)	30.2 (18.6 to 41.8)
Other external causes	4.15 (3.21 to 5.38)	44.6 (29.2 to 59.9)
Other and unknown§	2.00 (0.98 to 4.07)	4.0 (-1.7 to 9.8)
Smoking related	2.39 (2.18 to 2.62)	281.3 (236.5 to 326.1)
Alcohol related	6.35 (5.25 to 7.69)	80.8 (62.2 to 99.4)
Drug related	11.50 (8.79 to 15.04)	48.3 (33.6 to 63.0)
Amenable to medical intervention (<75 years)	3.16 (2.72 to 3.68)	113.1 (88.1 to 138.1)

*Rate ratios and rate differences based on age standardised mortality rates (per 100 000 person years at risk).

†Shelters, rooming houses, and hotels include homeless shelters and hostels, missions, YWCA/YMCAs, rooming and lodging houses, hotels, motels, and tourist homes.

‡Reference population (person years at risk) for age standardisation taken from total cohort age distribution (5 year age groupings).

§Includes deaths from diseases of skin (n=123), congenital anomalies (n=169), unknown (205 deaths ascertained from tax filer data only).

100 000) were for smoking related diseases (281 and 88, respectively), ischaemic heart disease (182 and 105), respiratory diseases (176 and 61), and deaths amenable to medical intervention (113 and 55).

DISCUSSION

Homeless and marginally housed individuals living in shelters, rooming houses, or hotels have significantly higher mortality rates than individuals with incomes in the lowest fifth of the distribution. The probability that a 25 year old living in shelters, rooming houses, or hotels would survive to age 75 was only 32% for men and 60% for women compared with 51% and 72%, respectively, in the lowest income fifth. To put this in context, men living in shelters, rooming houses, or hotels had about the same probability of surviving to age 75 as men in the general population of Canada in 1921 or men in Laos in 2006 (see appendix D on bmj.com).^{24 25} Women had about the same probability of surviving to age 75 as women in the general population of Canada in 1956 or women in Guatemala in 2006.

Our study, while consistent with previous studies showing excess mortality among people living in shelters, provides new information on disparities in the life expectancy of those living in shelters and those living in other categories of marginal housing. Compared with the entire cohort, life expectancy was shorter by 13 years for men and eight years for women living in shelters; 11 and nine years, respectively, for those living in rooming houses; and eight and five years, respectively, for those living in hotels.

Other studies

Most previous studies provided only age specific relative risks of death or standardised mortality ratios for homeless individuals in a single city.⁶⁻¹³ By contrast, we present survival curves and life expectancy estimates with a comparatively high level of precision based on 3280 deaths ascertained over an 11 year follow-up period among 15 100 people enumerated in shelters, rooming houses, and hotels across Canada. Perhaps the only previous study to estimate life expectancy among people living in shelters and other categories of marginal housing was based on much smaller samples in single cities—39 deaths among 103 shelter users in Oxford and 104 deaths among 927 residents of bed and breakfasts and bedsits in Brighton.²⁶

Implications

A large part of the premature mortality in people living in shelters, rooming houses, and hotels was potentially avoidable. Many excess deaths were attributable to diseases related to alcohol and smoking and to violence and injuries, much of which might have been related to substance misuse. There were also many excess deaths related to mental disorders and suicides. Other research suggests that expanding the implementation of recent innovations in supported housing programmes for people with addictions and mental illness²⁷ could be instrumental in reducing the number of excess deaths. Enhanced availability of treatment for substance misuse and smoking cessation programmes for homeless and marginally housed people could also play an important role in reducing disparities in mortality.²⁸

Table 6 | Mortality rate ratios and rate differences* (per 100 000 person years at risk), by major causes of death, comparing women living in shelters, rooming houses, and hotels† with women in entire cohort‡, Canada, 1991-2001

Cause	Ratio (95% CI)	Difference (95% CI)
Total, all causes of death	1.79 (1.66 to 1.94)	556.7 (459.3 to 654.1)
Infectious diseases	1.37 (0.56 to 3.38)	2.7 (-6.2 to 11.5)
Cancer	1.38 (1.18 to 1.62)	93.0 (39.7 to 146.3)
Trachea, bronchus, and lung	1.73 (1.26 to 2.36)	37.8 (9.6 to 65.9)
Intestine and rectum	1.67 (1.12 to 2.51)	20.6 (-0.1 to 41.2)
Oesophagus and stomach	1.48 (0.70 to 3.15)	4.4 (-5.8 to 14.6)
Pancreas	0.73 (0.29 to 1.82)	-3.5 (-12.2 to 5.2)
Female breast	1.58 (1.11 to 2.24)	26.4 (1.2 to 51.7)
Uterus, ovary, adnexa	1.25 (0.71 to 2.20)	5.5 (-10.1 to 21.0)
Urinary system	0.76 (0.27 to 2.12)	-1.7 (-7.3 to 3.8)
Lymphatic tissue and leukaemia	1.26 (0.72 to 2.22)	5.4 (-9.4 to 20.2)
Other cancer	0.98 (0.64 to 1.49)	-0.9 (-18.6 to 16.9)
Endocrine system diseases	2.39 (1.70 to 3.38)	33.7 (13.8 to 53.7)
Diabetes mellitus	2.44 (1.66 to 3.59)	27.2 (9.4 to 45.0)
Other endocrine	2.23 (1.04 to 4.79)	6.6 (-2.5 to 15.7)
Blood and blood forming organs	1.45 (0.34 to 6.22)	1.3 (-4.9 to 7.6)
Mental disorders	3.78 (2.67 to 5.35)	42.6 (22.4 to 62.9)
Nervous system diseases	2.24 (1.52 to 3.29)	25.2 (7.7 to 42.8)
Circulatory system diseases	1.61 (1.42 to 1.83)	153.4 (101.8 to 204.9)
Ischaemic heart disease	1.80 (1.52 to 2.13)	105.3 (65.2 to 145.4)
Heart failure	1.41 (0.88 to 2.26)	6.4 (-3.9 to 16.7)
Cerebrovascular disease	1.25 (0.94 to 1.67)	14.5 (-5.9 to 34.8)
Other circulatory diseases	1.57 (1.15 to 2.14)	27.2 (4.1 to 50.3)
Respiratory system diseases	2.14 (1.67 to 2.75)	60.9 (32.3 to 89.5)
Pneumonia	2.16 (1.43 to 3.25)	21.2 (5.0 to 37.4)
Bronchitis, emphysema, and asthma	2.40 (1.70 to 3.40)	36.1 (14.5 to 57.8)
Other respiratory system diseases	1.39 (0.66 to 2.91)	3.6 (-5.9 to 13.0)
Digestive system diseases	2.92 (2.11 to 4.04)	51.4 (25.9 to 76.9)
Cirrhosis of liver	5.63 (3.31 to 9.56)	28.7 (10.1 to 47.4)
Other digestive system diseases	2.10 (1.41 to 3.14)	22.7 (5.3 to 40.0)
Genitourinary system diseases	1.43 (0.79 to 2.58)	5.1 (-5.0 to 15.3)
Musculoskeletal system diseases	1.63 (0.72 to 3.65)	3.2 (-3.5 to 10.0)
Ill defined conditions	2.09 (0.96 to 4.55)	8.5 (-4.2 to 21.2)
External causes	3.68 (2.74 to 4.95)	75.6 (44.7 to 106.4)
Suicide	5.59 (3.24 to 9.64)	26.3 (8.8 to 43.9)
Falls	1.65 (0.89 to 3.08)	6.0 (-3.4 to 15.4)
Other external causes	4.24 (2.80 to 6.42)	43.3 (19.7 to 66.8)
Other and unknown§	0.99 (0.23 to 4.33)	0.0 (-4.9 to 4.8)
Smoking related	2.03 (1.63 to 2.54)	87.7 (49.7 to 125.7)
Alcohol related	8.20 (5.03 to 13.38)	36.5 (16.0 to 57.0)
Drug related	9.17 (5.54 to 15.18)	32.3 (13.8 to 50.9)
Amenable to medical intervention (<75 years)	1.82 (1.37 to 2.43)	54.5 (19.0 to 85.6)

*Rate ratios and rate differences based on age standardised mortality rates (per 100 000 person years at risk). †Shelters, rooming houses, and hotels include homeless shelters and hostels, missions, YWCA/YMCAs, rooming and lodging houses, hotels, motels, and tourist homes.

‡Reference population (person years at risk) for age standardisation taken from total cohort age distribution (5 year age groupings).

§Includes deaths from complications of pregnancy (n=10), diseases of skin (n=122), congenital anomalies (n=152), perinatal related causes (n=2), unknown (213 deaths ascertained from tax filer data only).

Limitations

Our study has certain limitations, most of which should result in underestimation of the excess mortality risks associated with homelessness and marginal housing. Firstly, and most importantly, only people who were enumerated by the census and linked to tax filer data

could be part of the study cohort. The 1991 census failed to enumerate 3.4% of the Canadian population; missed individuals were more likely to be young, mobile, have low incomes, and be of Aboriginal ancestry.²⁹ Relatively low linkage rates of 26-41% among residents of shelters, rooming houses, and hotels presumably reflect the fact that many such individuals would not have filed a tax return or remained for long at the same address. We speculate that mortality might have been higher among those who could not be linked to a tax filer record; if so, our data would underestimate the true mortality rate among people living in shelters, rooming houses, and hotels. Nonetheless, it was reassuring that the socioeconomic characteristics of the homeless and marginally housed men and women whom we were able to link to tax filer data and follow for mortality were similar to the characteristics of all homeless and marginally housed individuals who were enumerated by the census. Secondly, we did not include homeless people sleeping rough on the street because they were not enumerated by the 1991 census. Previous studies have shown that these individuals have extremely high mortality rates, even higher than those of shelter residents,³⁰ and in Canada they are more likely to be of Aboriginal origin.^{31 32} Thirdly, small sized rooming and lodging houses operating without a licence might have been misclassified by the census as private rather than collective dwellings, so their residents would not have been included in any of our marginal housing categories. Fourthly,

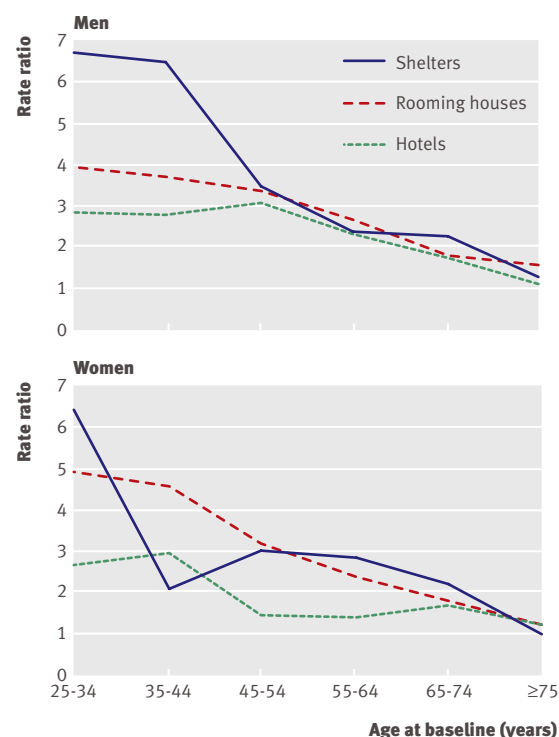


Fig 4 | Mortality rate ratios for men and women living in shelters, rooming houses, and hotels compared with entire cohort

WHAT IS ALREADY KNOWN ON THIS TOPIC

Previous research on mortality among people living in housing situations consistent with severe disadvantage has focused primarily on homeless people, usually in a single city

There is a high level of excess mortality among the homeless compared with the general population

WHAT THIS STUDY ADDS

Living in shelters, rooming houses, and hotels is a marker for much higher mortality than would have been expected on the basis of low income alone

Even in a country with universal medical insurance, mortality from medically amenable causes of death is higher in both relative and absolute terms

men and women whose usual place of residence was a hotel, motel, or tourist home mainly included people living in low cost accommodation that serves disadvantaged populations but also included a small number of people with much higher incomes who choose to live in hotels that provide amenities for long term residents. The presence of the latter group would be expected to slightly decrease the level of observed mortality within this category of housing. Fifthly, the socioeconomic and housing situation of cohort members was determined only at baseline, and no information was available on transitions into or out of different categories of housing or socioeconomic situations during the follow-up period. Finally, for the sake of simplicity, we determined mortality rates by income fifth using everyone in the study cohort. If people living in shelters, rooming houses, and hotels were to be excluded in calculations of mortality rates in the poorest income fifth, the mortality differences between these two groups (as shown in figs 1, 2, and 3) would be even greater. The magnitude of this effect, however, would be slight, as people living in shelters, rooming houses, and hotels account for less than 2% of the poorest income fifth.

Conclusion

In conclusion, this large national cohort study shows that homeless and marginally housed people living in shelters, rooming houses, and hotels have much higher mortality and shorter life expectancy than could be expected on the basis of low income alone. Mortality from medically amenable causes of death was higher in both relative and absolute terms. These findings emphasise the importance of considering housing situation as a marker of socioeconomic disadvantage. Further work should evaluate interventions to improve the health of homeless and marginally housed individuals, including interventions that improve housing affordability and quality.

Contributors: RW and MT conceived the study and conducted the analyses after revisions suggested by the other authors. SWH and RW drafted the manuscript with input from the other coauthors. All authors contributed in critically revising the article for important intellectual content, and approved the version submitted for publication. All authors had full access to the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. SWH and RW are guarantors.

Funding: The Canadian census mortality follow-up study was funded by the Canadian Population Health Initiative, part of the Canadian Institute for Health Information. The Centre for Research on Inner City Health gratefully acknowledges the support of the Ontario Ministry of Health and Long-Term Care. JRD was supported by a Canadian Institutes of Health Research and Public Health Agency of Canada Chair in Applied Public Health. The authors' work was independent of the funders. The views expressed in this article are those of the authors and do not necessarily reflect the views of the above-named organizations or of the institutions with which they are affiliated.

Competing interests: None declared.

Ethical approval: The Canadian census mortality follow-up study, of which this study is a part, was approved by the Statistics Canada Policy Committee and the research ethics committee of the University of Toronto.

Data sharing: No additional available.

- Davey Smith G, ed. *Health inequalities: lifecourse approaches*. Policy Press, 2003.
- Lantz PM, House JS, Lepkowski JM, Williams DR, Mero RP, Chen J. Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *JAMA* 1998;279:1703-8.
- Hwang SW. Homelessness and health. *CMAJ* 2001;164:229-33.
- Hwang SW, Martin RE, Tolomiczenko GS, Hulchanski JD. The relationship between housing conditions and health status of rooming house residents in Toronto. *Can J Public Health* 2003;94:436-40.
- Canadian Mortgage Housing Corporation. Research highlight: profile of rooming house residents. 2006. www.cmhc-schl.gc.ca/odpub/pdf/65235.pdf.
- Hibbs JR, Benner L, Klugman L, Spencer R, Macchini I, Mellinger A, et al. Mortality in a cohort of homeless adults in Philadelphia. *N Engl J Med* 1994;331:304-9.
- Hwang SW, Orav EJ, O'Connell JJ, Lebow JM, Brennan TA. Causes of death in homeless adults in Boston. *Ann Intern Med* 1997;126:625-8.
- Barrow SM, Herman DB, Córdova P, Struening EL. Mortality among homeless shelter residents in New York City. *Am J Public Health* 1999;89:529-34.
- Nordentoft M, Wandall-Holm N. 10 year follow up study of mortality among users of hostels for homeless people in Copenhagen. *BMJ* 2003;327:81.
- Beijer U, Andréasson A, Agren G, Fugelstad A. Mortality, mental disorders and addiction: a 5-year follow-up of 82 homeless men in Stockholm. *Nord J Psychiatry* 2007;61:363-8.
- Hwang SW. Mortality among men using homeless shelters in Toronto, Ontario. *JAMA* 2000;283:2152-7.
- Cheung AM, Hwang SW. Risk of death among homeless women: a cohort study and review of the literature. *CMAJ* 2004;170:1243-7.
- Roy E, Haley N, Leclerc P, Sochanski B, Boudreau JF, Boivin JF. Mortality in a cohort of street youth in Montreal. *JAMA* 2004;292:569-74.
- Riley ED, Bangsberg DR, Guzman D, Perry S, Moss AR. Antiretroviral therapy, hepatitis C virus, and AIDS mortality among San Francisco's homeless and marginally housed. *J Acquir Immune Defic Syndr* 2005;38:191-5.
- Babidge NC, Buhrich N, Butler T. Mortality among homeless people with schizophrenia in Sydney, Australia: a 10-year follow-up. *Acta Psychiatr Scand* 2001;103:105-10.
- Kaspro WJ, Rosenheck R. Mortality among homeless and nonhomeless mentally ill veterans. *J Nerv Ment Dis* 2000;188:141-7.
- Wilkins R, Tjepkema M, Mustard C, Choinière R. The Canadian census mortality follow-up study, 1991 through 2001. *Health Rep* 2008;19:25-43.
- Fair M. Generalized record linkage system—Statistics Canada's record linkage software. *Austrian J Stat* 2004;33:37-53.
- Fair ME, Carpenter M, Aylwin H. *Occupational and environmental health research projects: a descriptive catalogue 1978 to 2005*. Statistics Canada; 2006.
- Mackenbach JP, Stirbu I, Roskam AJ, Schaap MM, Menvielle G, Leinsalu M, et al. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med* 2008;358:2468-81.
- Office of National Statistics. Deaths related to drug poisoning: England and Wales, 1999-2003. *Health Stat Q* 2005;Spring:52-9.
- Carrière KC, Roos L. A method of comparison for standardized rates of low-incidence events. *Med Care* 1997;35:57-69.
- Chiang CL. *The life table and its applications*. Robert E Krieger, 1984.
- Bourbeau R, Légaré J, Émond V. *New birth cohort life tables for Canada and Quebec, 1801-1991*. Statistics Canada, 1997.
- Nagpur D. *Longevity and historical life tables 1921-1981 (abridged). Canada and the provinces*. Supply and Services Canada, 1986.

- 26 Shaw M, Dorling D, Brimblecombe N. Life chances in Britain by housing wealth and for the homeless and vulnerably housed. *Environ Plan A* 1999;31:2239-48.
- 27 Tsemberis S, Eisenberg RF. Pathways to housing: supported housing for street-dwelling homeless individuals with psychiatric disabilities. *Psychiatr Serv* 2000;51:487-93.
- 28 Hwang SW, Tolomiczenko G, Kouyoumdjian FG, Garner RE. Interventions to improve the health of the homeless: a systematic review. *Am J Prev Med* 2005;29:311-9.
- 29 Statistics Canada. *Coverage*. Minister of Industry, Science and Technology, 1994.
- 30 Shaw M, Dorling D. Mortality among street youth in the UK. *Lancet* 1998;352:743.
- 31 Golden A, Currie WH, Greaves E, Latimer EJ. Report of the Mayor's Homelessness Action Task Force. Taking responsibility for homelessness: an action plan for Toronto. 1999. www.toronto.ca/pdf/homeless_action.pdf.
- 32 Homelessness Count Committee. A count of homeless persons in Edmonton. 2000. http://intraspec.ca/Edmonton_homeless_sept00.pdf.

Accepted: 8 June 2009