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# Five-Year Standardised Mortality Ratios in a Cohort of Homeless People

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# Five-Year Standardised Mortality Ratios in a Cohort of Homeless People

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**ABSTRACT**

OBJECTIVE To calculate Standardised Mortality Ratio's (SMRs) for a cohort of homeless people in the Dublin region over a five-year period and to examine leading causes of death.

SETTING Homeless Services reporting deaths from homeless persons in their care across the Dublin Homeless Region.

METHODS Death data among people who experience homelessness was acquired from the Dublin Region Homeless Executive (2011-2015), and validated from both death certificates and records from the Dublin Coroner's Office.

PARTICIPANTS Two hundred and nine deaths were recorded, of these two hundred and one were verified (156 males, 77.6%). Deaths that could not be verified by certificate or coroners record were excluded from the study.

RESULTS SMRs were 3 to 10 times higher in homeless men and 6 to 10 times higher in homeless women compared to the general population. Drug and alcohol-related deaths were the leading cause of death, accounting for 38.4% of deaths in homeless individuals. These were followed by circulatory (20%) and respiratory causes (13%).

CONCLUSION Mortality rates amongst homeless persons are exceptionally high. Services and programmes, particularly housing and those targeting overdose and alcoholism, are urgently needed to prevent premature mortality in this vulnerable population.

Strengths and limitations of this study

- This study presents Standardised Mortality Ratios (SMRs) for homeless people. To date, there have been limited studies producing SMRs for homeless populations, particularly in the UK and Ireland.
- The study provides evidence of disparity in mortality among homeless people compared with the general population.
- The high percentage of potentially avoidable deaths among homeless people from overdose presents an opportunity for the development of possible preventative strategies.
- A number of the reported deaths provided to authors were unverifiable. One reason was that some individuals in question were using an alias, a not uncommon practice with homeless populations.
- Record keeping varied significantly between agencies, and several discrepancies existed between agency records and deaths reported to the DRHE.

## INTRODUCTION

Homelessness is a major public health concern for service providers and policymakers, [1, 2] as well as for homeless individuals and their families. The longer a person is homeless, the more likely it is that they will suffer from a medical condition and chronically homeless individuals are far more likely to experience greater rates of chronic disease, and mental health issues [3-5].

Moreover, homelessness is associated with an increased risk of infections such as tuberculosis and human immunodeficiency virus [HIV] disease [6]. Among the homeless, access to health care is often suboptimal [7, 8]. Homeless persons also experience severe poverty and often come from disadvantaged minorities, factors that are independently associated with poor health [8]. Thus, suggestions that mortality among homeless populations is much higher than in the general population is not surprising. According to a special Census report, one-third of the homeless population in Ireland reported having fair, bad or very bad general health; the corresponding figure for the general population was 10% [9]. Moreover, 42% of homeless individuals had a disability, a stark contrast to the percentage of 13% reported in the general population.

Addiction is frequently a contributory reason for, or a result of, homelessness [10]. Indeed, homeless persons experience excessive rates of addiction compared to the general population [5, 11, 12].

Studies of mortality amongst homeless populations, mainly in the United States [13], Canada [14] and Europe [15-17] carried out over the past 20 years have found that mortality rates among the homeless were 3 to 13 times higher than rates in the general population. While the causes of deaths vary widely, the leading causes included cancers, cardiovascular diseases, accidents, intoxication, and suicides. While these are similar to causes of death in the general population, they occur at very different rates. For example, despite the low prevalence of head and neck cancer in the general population is extremely low, however homeless people disproportionately suffer and die from head and neck cancers [18, 19]. Similarly, homicide and intoxication are among the leading causes of death in homeless populations [13, 20]. As homeless people age the causes of death change. In a recent study Baggett and colleagues examined changes in causes of death amongst homeless individuals over a 15-year period in the US. The authors found homicide was the leading cause of death among men who were 18 to 24 years of age. Acquired immunodeficiency syndrome was the major cause of death among those who were 25 to 44 years of age; heart disease and cancer were the leading causes of death in persons who were 45 to 64 years of age [13].

Despite the persistence of homelessness in Ireland [21-23] and internationally [24-28] the past decade has yielded few studies on mortality among the homeless, and information on causes of death in this

population is sparse. The majority of studies have been conducted in the US and Canada. Fewer have been carried out in Europe. Of the available studies, some calculated Standardised Mortality Ratios, more calculated direct age-standardised rates and others relied on Crude Mortality Rates or were limited to specific populations, i.e. males only or substance users. Of the available studies, the data are quite dated and often lack information about the exact cause of death [29]. There is a consensus within the literature that homeless deaths are significantly underestimated [29, 30]. Several studies identified the need to understand homeless mortality better, particularly the leading causes of death, in order to manage this issue and to implement effective strategies to decrease the number of homeless deaths [29, 30].

It is suggested by the European Monitoring Centre for Drugs and Drug Addiction [31] that Ireland is quite progressive when compared to European counterparts when it comes to reporting drug-related deaths [31] and the specific substances implicated in these deaths.
The aims of the current study are twofold; [i] to calculate mortality amongst the homeless population in Dublin [ii] to describe the leading causes of deaths amongst this population.

## METHODS

The study is a retrospective record study of homeless deaths between 2011 and 2015. The principal objective was to evaluate mortality in the homeless population of Dublin, Ireland. In Dublin the Dublin Region Homeless Executive (DRHE), a shared service operating under the aegis of Dublin City Council as the lead statutory authority in the Dublin Region, is responsible for the co-ordination of responses to homelessness. The DRHE provides a range of supports and services to the Dublin Joint Homeless Consultative Forum and Management Group. It has specific responsibilities for the operational coordination of the Homeless Action Plan, regional service provision, the disbursement of Section 10 funding[1] for homeless services and in commissioning new service provision. The DRHE commissioned this study. Data gathering was challenging because data in this population is often incomplete, and many individuals use an alias rather than legal name.

### Patient Involvement

Neither patients nor the public participated in this study

### Homeless population

Data on homeless population were provided by the DRHE. The DRHE introduced a new method of counting homeless people, the Pathway Accommodation and Support System [PASS], in 2011. The PASS system is a live shared client database with bed management and support planning functions.

[1] Section 10 of the Housing Act, 1988 enables local authorities to provide funding to voluntary bodies for the provision of emergency accommodation and long term housing for people who are homeless.

PASS provides live information about homeless presentations and bed occupancy within the Dublin area and has been rolled out nationally to all regions. The introduction of the PASS system has led to greater efficiency and an improved approach to collecting essential data on both presentation and service utilisation in the homeless services. PASS data is used to generate the national monthly, and quarterly figures reported and published by the Department of Housing, Planning, Community and Local Government so that there is a single agreed methodology to enumerating the homeless population in Ireland [See supplemental table 1].

Homeless deaths

The DRHE records of death consisted mostly of death notifications recorded on a standardised form developed by DRHE that required service providers to notify the DRHE of all deaths in services. However, in some instances, homeless service providers did not utilize the form and simply reported deaths in an email or facsimile [See supplemental table 2]. A three-phase design was necessary to validate the death data in the homeless population.

*Phase 1 – Validation* consisted of validating the dataset based on the death notifications maintained by DRHE. Data from DRHE records [n=180] were used to extract name, date of birth, date of death and place of death. These data were the minimal data required to find and view a death certificate in the General Registrar's Office [GRO]. The GRO hold records of all births, deaths and marriages registered in Ireland. The purpose was two-fold; [i] validate the death and [ii] obtain a cause of death. The study also utilised the records at the Dublin City Coroner's office to validate deaths of cases with outstanding inquests. At the end of phase 172 of the 180 deaths were validated. Deaths that were not validated were not included in the study.

*Phase 2 – Audit* consisted of meeting with a number of key agencies that had reported deaths to DRHE during the study period. The main purpose of the audit was to crosscheck homeless agencies records against homeless death notifications. During site visits, it became apparent that agencies reported and maintained records of deaths of service users differently across the sector. Some agencies reported only the death of a service user who died in their service; others reported the death of a service user who died in another agency but who was also accessing their services at the time, while other agencies reported the death of a known homeless person. In the effort to compile as comprehensive a picture as possible, an audit of records was carried out. Participating agencies included in the study were requested to return a copy of the death records of service users who had died during the study period. In addition, it was decided that the research team would meet with two hospice services that were named as the place of death on a number of death notifications. These two services also took part in the audit.

*Phase 3 - Reconciliation* consisted of crosschecking the audit figures against the DRHE death notifications. As a result, n=54 deaths were further verified as having occurred between 2011 and 2015. These additional cases were validated as per phase 1: either in GRO or Coroners records, and included in the dataset.

General Population

We acquired age and gender census data for Dublin for the Census year 2011 from the Central Statistics Office [9]. In addition, we acquired the inter-censal estimates for 2012 to 2015 [See supplemental table 3]. Mortality data by age and gender for the years 2011 to 2015 inclusive was supplied by the CSO [See supplemental table 4].

Standardised Mortality Ratio [SMR]

Age-standardised mortality ratios were calculated for each calendar year overall, and for males and females separately. Where date of birth (age) was not known, it was distributed across the data in the same proportion as where the age was known. General population of Dublin was used as Standard population.

**RESULTS**

A total of 201 deaths of homeless people, which occurred between 2011 and 2015 were included in the current study [Table 1]. The median age at death was 42 years [males 44 years and females 36 years]. Age and gender distribution of the deaths in homeless people are given in supplemental table 1.

Table 1: Verified deaths in the homeless population in Dublin 2005-2015 by age and gender

| **Verified deaths 2011-2010** | | | | | | |
|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** | **Total** |
| **Male** | 13 | 26 | 26 | 37 | 54 | 156 |
| **Female** | 4 | 8 | 9 | 12 | 12 | 45 |
| **Total** | **17** | **34** | **35** | **49** | **66** | **201** |

1: please note age categories 45-64 and 65+ have been collapsed in the current table due to small numbers and thus, potentially, identifiable deaths.

The majority of homeless people died in hospital or in a homeless service. Just over 10% [n=22] of people died outdoors [Table 2].

Table 2: Place where homeless death occurred

| Place Deaths 2011-2015 | N | % |
|---|---|---|
| Hospital | 100 | 49.7 |
| Homeless Services | 60 | 29.7 |
| Outdoors | 22 | 10.9 |
| Hospice | 8 | 4.4 |
| Prison | 1 | 0.4 |
| Private residence | 10 | 4.9 |
| **Total** | 201 | 100 |

Standardised Mortality Ratios

SMRs for homeless men ranged from 3 to 10 [table 3], compared to Dublin males in the general population. For homeless women the SMRs ranged from 6 to 10. The highest ratio for females was in 2012, whereas 2015 was highest ratios for males.

Table 3: Standardised Mortality Ratios 2011-2015

| Year | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Observed* | Expected± | SMR | Observed | Expected | SMR |
| 2011 | 13 | 4.9 | 2.7 | 4 | 0.65 | 6.2 |
| 2012 | 26 | 5.8 | 4.5 | 8 | 0.8 | 10.0 |
| 2013 | 26 | 6.1 | 4.3 | 9 | 1.0 | 9.0 |
| 2014 | 37 | 6.4 | 5.8 | 12 | 1.3 | 9.2 |
| 2015 | 54 | 5.4 | 10.0 | 12 | 1.3 | 9.2 |

*Number of observed deaths in the homeless population
±Number of expected deaths (calculate expected number of deaths among homeless as: mortality rate in general pop multiplied by the number of homeless people per age group)

Cause of Death

Cause of death was confirmed for 195 cases (supplemental Table) and n=6 are awaiting inquests. The highest ratios for women occurred in 2012, whereas the highest ratios for men were 2015.

Drug and alcohol were amongst the leading cause of death for this cohort (Table 4) accounting for more than a third of all deaths [38.4%]. In addition, in a further 43 cases alcohol and drugs are implicated. Thus, in 58.7% (118/195) of all deaths drugs and or alcohol were implicated. Drugs, particularly opioids, were implicated in more than half of drug related cases.

| Drug and alcohol related deaths | Total |
|---|---|
| Drugs | 71 |
| Alcohol | 2 |
| Both Drugs and Alcohol | 2 |
| Total | 75 |
| Deaths were drugs was antecedent | 43 |
| Total | 118 |



**DISCUSSION**

We examined two hundred and one deaths that occurred among homeless people between 2011 and 2015. Mortality rates were much higher among homeless people compared to the general population: for men SMRs were between 3 and 10 times higher for homeless women the SMRs ranged from 6 to 10 times higher. The causes of death for homeless individuals are different from those of the general population: drug and alcohol related deaths accounted for more than a third 36% of deaths in homeless individuals.

The median age at death for homeless people in Dublin just 43 years old, with the average age at death for homeless women is even lower at 41, which is drastically different to the general population. The reported causes of deaths vary widely, with leading causes included cancers, cardiovascular diseases, accidents, intoxication, and suicides. While these are similar to causes of death in the current study they occur at very different rates. For example, despite the high prevalence of homicide in international literature, particularly in the US, was not so prevalent in the current study. Similarly, however, intoxication from drug and alcohol was the leading causes of death a finding that is also consistent with the current body of research [13, 20].

Drug and alcohol were particularly common causes of death amongst the homeless population, accounting for one third [36%] of these deaths. In Ireland diseases of the circulatory system was the leading cause of death in Ireland in 2015. More than 10% of people died outdoors, a low figure in comparison to figures reported in the international literature [24]. A subgroup of ageing homeless individuals emerged from the data, with 12 deaths occurring in people aged 65 or over.

Acquiring and validated mortality data is a complex task and data such as DOB and legal name is at times unknown, thus the validation of vast majority of reported deaths is a major strength of the study. The Audit cycle proved to be quite simple and effective. The findings highlighted several

discrepancies in reported deaths throughout the recording system. It highlighted the need for agencies reporting a death to the DRHE to improve current reporting practices. In addition, the PASS system emerged as highly effective in recording the daily activity of service users. In addition, it offers consistency regarding homeless status.

The current study data had a number of limitations. A small number of the deaths in the current study were unverifiable and excluded from the analysis. One plausible reason was that individuals in question were using an alias, a not uncommon practice amongst persons accessing homeless service. Record keeping varied significantly between agencies and some discrepancies existed between agency records and deaths reported to the DRHE.

Walsh et al, [2013] suggests that apart from the scale of homelessness in the capital, the Dublin homeless population does not differ substantially in demographics when compared to other counties in Ireland [32]. Thus, the current findings may be generalisable to the whole of Ireland. Moreover, the demographics as well as the causes of death indicate similarities between the current study and other international cohorts [5, 11, 12].

**CONCLUSION**

In conclusion, this study demonstrates dramatically higher mortality ratios among men and women who were homeless. Overdose from substance use was a critical factor in more than one-third of verified deaths included in the current study, with opioids being overrepresented. Homeless people are notably more likely to die by overdose than the general population. Public health initiatives such as Naloxone to prevent and reverse opioid drug overdose should be considered and expanded to reduce the number of overdose fatalities in this population. These findings should be taken into account when developing interventions to prevent mortality among homeless populations.

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**FOOTNOTES**

**Contributors** JI and JB developed and directed the study. JB and JI conceived and designed the survey questions. JI coordinated data collection and JI, BG and GS carried out data cleaning and cross validation. JI & LZ performed the statistical analyses. JI drafted the manuscript. JI, JB, LZ, BODH and GS contributed to the final draft of the paper.

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**Competing interests** None.

**Ethics approval** The study received ethical approval by Ethics Committee at the Faculty of Health Sciences, Trinity College Dublin

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**Data sharing statement** No additional data available.

**Table 1: Denominator data for Homeless Population 2011-2014 by age and gender**

| | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|
| **Gender** | Male | Female | Male | Female | Male | Female | Male | Female |
| **18-24** | 386 | 249 | 440 | 262 | 521 | 313 | 512 | 395 |
| **25-44** | 1488 | 476 | 1729 | 595 | 1959 | 747 | 2092 | 1027 |
| **45-64** | 461 | 77 | 522 | 105 | 643 | 150 | 694 | 200 |
| **65+** | 34 | 6 | 42 | 8 | 45 | 12 | 42 | 15 |
| **Missing data** | 1,232 | 369 | 875 | 286 | 153 | 62 | 1 | 4 |
| Total All Ages | **3601** | **1177** | **3608** | **1256** | **3321** | **1284** | **3341** | **1641** |

**Table 2: Numerator data deaths homeless population 2011-2014 by age and gender**

| **Gender** | **Age Group** | **2011** | **2012** | **2013** | **2014** | **2015** | **Total** |
|---|---|---|---|---|---|---|---|
| **Male** | 18-24 | 1 | 1 | 5 | 3 | 2 | 12 |
| | 25-44 | 7 | 9 | 10 | 14 | 26 | 66 |
| | 45-64 | 4 | 14 | 8 | 13 | 19 | 58 |
| | 65+ | 1 | 2 | 3 | 4 | 4 | 14 |
| **Missing data** | | 0 | 0 | 0 | 3 | 3 | 6 |
| | Male Total | 13 | 26 | 26 | 37 | 54 | 156 |
| **Female** | **Age Group** | **2011** | **2012** | **2013** | **2014** | | **Total** |
| | 18-24 | 0 | 0 | 1 | 0 | 0 | 1 |
| | 25-44 | 2 | 4 | 6 | 10 | 6 | 28 |
| | 45-64 | 1 | 3 | 0 | 1 | 3 | 8 |
| | 65+ | 1 | 1 | 2 | 1 | 0 | 5 |
| **Missing data** | | 0 | 0 | 0 | 0 | 3 | 3 |
| | Female Total | 4 | 8 | 9 | 12 | 12 | 45 |
| **Grand Total** | | **17** | **34** | **35** | **49** | **66** | 201 |

**Table 3: Denominator data for General Population 2011-2014 by age and gender**

| | 2011 | | 2012 | | 2013 | | 2014 | |
|---|---|---|---|---|---|---|---|---|
| **Age** | Male | Female | Male | Female | Male | Female | Male | Female |
| **18-24** | 63711 | 67234 | 54917 | 56078 | 50903 | 48749 | 48472 | 44755 |
| **25-44** | 218986 | 225914 | 215490 | 227467 | 216450 | 227647 | 171245 | 229773 |
| **45-64** | 130529 | 140161 | 131813 | 140808 | 133881 | 142285 | 183566 | 1442235 |
| **65+** | 59804 | 79472 | 61878 | 81308 | 64421 | 83548 | 66966 | 86149 |
| | 473,030 | 512,781 | 464,098 | 505,661 | 465,655 | 502,229 | 470,249 | 504,912 |

**Table 4: Numerator data deaths in General Population 2011-2014 by age and gender**

| Deaths in General Population County Dublin By Gender & Age Group 2005-2014 | | | | | |
|---|---|---|---|---|---|
| **Male** | **Age Group** | **2011** | **2012** | **2013** | **2014** |
| | 18-24 | 45 | 26 | 35 | 38 |
| | 25-44 | 246 | 262 | 196 | 189 |
| | 45-64 | 717 | 749 | 693 | 702 |
| | 65+ | 2555 | 2662 | 2597 | 2716 |
| **Male Total** | | 3563 | 3699 | 3521 | 3645 |
| **Female** | 18-24 | 12 | 10 | 12 | 10 |
| | 25-44 | 113 | 129 | 114 | 128 |
| | 45-64 | 495 | 487 | 490 | 450 |
| | 65+ | 3154 | 3178 | 3323 | 3244 |
| **Female Total** | | 3774 | 3804 | 3939 | 3832 |
| **Grand Total** | | **7337** | **7503** | **7460** | **7577** |

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**ABSTRACT**

OBJECTIVE To calculate Standardised Mortality Ratios (SMRs) for a cohort of homeless people in the Dublin region over a five-year period and to examine leading causes of death.

SETTING Homeless Services reporting deaths from homeless persons in their care across the Dublin Homeless Region.

METHODS Death data among people who experience homelessness was acquired from the Dublin Region Homeless Executive (2011-2015), and validated from both death certificates and records from the Dublin Coroner's Office.

PARTICIPANTS Two hundred and nine deaths were recorded; of these two hundred and one were verified (n=156 males, 77.6%). Deaths that could not be verified by certificate or coroners record were excluded from the study.

RESULTS SMRs were 3 to 10 times higher in homeless men and 6 to 10 times higher in homeless women compared to the general population. Drug and alcohol-related deaths were the leading cause of death, accounting for 38.4% of deaths in homeless individuals. These were followed by circulatory (20%) and respiratory causes (13%).

CONCLUSION Mortality rates amongst homeless persons are exceptionally high. Services and programmes, particularly housing and those targeting overdose and alcoholism, are urgently needed to prevent premature mortality in this vulnerable population.

Strengths and limitations of this study

- The first Irish study to examine Standardised Mortality Ratios in a homeless persons
- A key strength is the high volume of verified deaths.
- The study provides evidence of disparity in mortality among homeless people in Dublin compared with the general population
- A weakness is small number of the reported deaths provided to authors were unverifiable.
- The common weaknesses of a retrospective analysis on database information apply.

## INTRODUCTION

Homelessness is a major public health concern [1 2]. Excess mortality is associated with extensive social exclusion[3]. Studies in the United States suggest that one fifth of persons experiencing homelessness will go on to become chronically homeless[4]. The longer a person is homeless, the more likely it is that they will suffer from a medical condition, and chronically homeless individuals are far more likely to experience greater rates of chronic disease, and mental health issues [5-8,9]and addiction[10]. Indeed, homeless persons experience excessive rates of poor mental health and addiction compared to the general population [7 8 11 12]. Furthermore, Nielsen et al. (2011) note that dual diagnosis, specifically schizophrenic spectrum disorders coupled with addiction, is predictive of increased mortality among homeless people [8].

Moreover, homelessness is associated with an increased risk of infections such as tuberculosis and human immunodeficiency virus disease [13 14]. Among the homeless, access to health care is often suboptimal [15 16]. Nonetheless Fazel et al. (2014) emphasize the systematic as well as individual factors that perpetuate homelessness[4]. Homeless persons also experience severe poverty and often come from disadvantaged minorities, factors that are independently associated with poor health [16]. Thus, suggestions that mortality among homeless populations is much higher than in the general population is not surprising.

Studies of mortality amongst homeless populations, mainly in the United States [17], Canada [18] and Europe [19-21] carried out over the past 20 years have found that mortality rates among the homeless were 3 to 13 times higher than rates in the general population. While the causes of deaths vary widely, the leading causes included cancers, cardiovascular diseases, accidents, intoxication, and suicides. While these are similar to causes of death in the general population, they occur at very different rates. For example, despite the low prevalence of head and neck cancer in the general population is extremely low, however homeless people disproportionately suffer and die from head and neck cancers [22 23]. Similarly, homicide and intoxication are among the leading causes of death in homeless populations [17 24]. As homeless people age the causes of death change. In a recent study Baggett and colleagues examined changes in causes of death amongst homeless individuals over a 15-year period in the US [17]. The authors found homicide was the leading cause of death among men who were 18 to 24 years of age. Acquired immunodeficiency syndrome was the major cause of death among those who were 25 to 44 years of age; heart disease and cancer were the leading causes of death in persons who were 45 to 64 years of age [17].

Despite the persistence of homelessness in Ireland [25-27] the past decade has yielded no studies on mortality among the homeless, and information on causes of death in this population is sparse. Internationally the majority of studies have been conducted in the US and Canada. Fewer have been carried out in Europe. There is a consensus within the literature that homeless deaths are significantly underestimated [28 29]. Several studies identified the need to understand homeless mortality better, particularly the leading causes of death[8], in order to manage this issue and to implement effective strategies to decrease the number of homeless deaths [28 29].

The aims of the current study are twofold; [i] to calculate mortality amongst the homeless population in Dublin [ii] to describe the leading causes of deaths amongst this population.

## METHODS

The study is a retrospective record study of homeless deaths between 2011 and 2015. The Dublin Region Homeless Executive (DRHE) is a shared service for all four local authorities in the Dublin region. It operates under the aegis of Dublin City Council as the lead statutory authority in the region and is responsible for the implementation of regional action plans, plans mandated under the Housing (Miscellaneous Provisions) Act 2009. It co-ordinates responses to homelessness primarily though the provision of funding to 23 non-profit homeless service providers operating 102 services in Dublin, the assessment and placement of persons into these funded services by Local Authority staff and through sourcing and allocating tenancies for persons experiencing homelessness. In March 2018, almost 7,000 people were accommodated in the Dublin Region, representing over 70% of the national homeless population. The DRHE commissioned this study.

### Patient and Public Involvement

Neither patients nor the public participated in this study

The European Typology of Homelessness and Housing Exclusion (ETHOS) identifies four main categories of homelessness: roofless; houseless; insecure housing; inadequate housing (FEANTSA). The DRHE are responsible for all roofless persons and all houseless persons accommodated in emergency accommodation. The Ethos typology also includes domestic violence and immigrant accommodation under the houseless category but in an Irish context these services are funded under different government departmental funding streams. Consequently the PASS data is restricted to services funded under Section

10[1] of the Housing Act, 1988 which enables local authorities to provide funding to voluntary bodies for the provision of emergency accommodation and long term housing for people who are homeless.

Homeless population

Data on the homeless population were provided by the DRHE. The DRHE introduced a new method of counting homeless people, the Pathway Accommodation and Support System [PASS], in 2011. The PASS system is a live, shared client database with bed management and support planning functions. PASS provides live information about homeless presentations and bed occupancy within the Dublin area and has been rolled out nationally to all regions. The introduction of the PASS system has led to greater efficiency and an improved approach to collecting essential data on both presentation and service utilisation in the homeless services. PASS data is used to generate the national monthly, and quarterly figures reported and published by the Department of Housing, Planning, Community and Local Government so that there is a single agreed methodology to enumerating the homeless population in Ireland [See supplemental table 1].

Homeless deaths

The DRHE records of death consisted mostly of death notifications recorded on a standardised form developed by the DRHE that required service providers to notify the DRHE of all deaths in services. However, in some instances, homeless service providers did not utilize the form and simply reported deaths in an email or facsimile. A three-phase design was necessary to validate the death data in the homeless population.

*Phase 1 – Validation* consisted of validating the dataset based on the death notifications maintained by DRHE. Data from DRHE records [n=180] were used to extract name, date of birth, date of death and place of death. These data were the minimal data required to find and view a death certificate in the General Registrar's Office [GRO]. The GRO hold records of all births, deaths and marriages registered in Ireland. The purpose was two-fold; [i] validate the death and [ii] obtain a cause of death. The study also utilised the records at the Dublin City Coroner's office to validate deaths of cases with outstanding inquests. At the end of phase 1, 172 of the 180 deaths were validated. Deaths that were not validated were not included in the study.

[1] Section 10 of the Housing Act, 1988 enables local authorities to provide funding to voluntary bodies for the provision of emergency accommodation and long term housing for people who are homeless.

*Phase 2 – Audit* consisted of meeting with a number of key agencies that had reported deaths to the DRHE during the study period. The main purpose of the audit was to crosscheck homeless agencies records against homeless death notifications. During site visits, it became apparent that agencies reported and maintained records of deaths of service users differently across the sector. Some agencies reported only the death of a service user who died in their service; others reported the death of a service user who died in another agency but who was also accessing their services at the time, while other agencies reported the death of a known homeless person. In the effort to compile as comprehensive a picture as possible, an audit of records was carried out. Participating agencies included in the study were requested to return a copy of the death records of service users who had died during the study period. In addition, it was decided that the research team would meet with two hospice services that were named as the place of death on a number of death notifications. These two services also took part in the audit.

*Phase 3 - Reconciliation* consisted of crosschecking the audit figures against the DRHE death notifications. As a result, n=29 deaths were further verified as having occurred between 2011 and 2015. These additional cases were validated as per phase 1: either in GRO or Coroners records, and included in the dataset.

General Population

We acquired age and gender census data for Dublin for the Census year 2011 from the Central Statistics Office (CSO) [30]. In addition, we acquired the inter-censal estimates for 2012 to 2015 [See supplemental table 2]. Mortality data by age and gender for the years 2011 to 2015 inclusive was supplied by the CSO [See supplemental table 3].

Standardised Mortality Ratio [SMR]Standardised mortality ratios were calculated for each calendar year overall, and for males and females separately by using the indirect standardisation method. Where date of birth (age) of homeless persons was not known, it was distributed across the data in the same proportion as where the age was known. The general population of Dublin was used as reference population. Age-specific mortality rate was calculated for the General population of Dublin using the census data. This rate was used to calculate the expected number of deaths in the homeless population (by multiplication of the number of homeless people in each age group by the reference mortality rate for that age group), for each age group. Addition of deaths across all age groups gave us the total number of expected deaths in the homeless population. SMR was calculated as the ratio of observed to the expected number of deaths among homeless.

## RESULTS

A total of 201 deaths of homeless people, which occurred between 2011 and 2015, were included in the current study [Table 1]. The median age at death was 42 years [males 44 years and females 36 years].

Table 1: Verified deaths in the homeless population in Dublin 2011-2015 by age and gender

| Gender | Age Group | 2011 | 2012 | 2013 | 2014 | 2015 | Total |
|---|---|---|---|---|---|---|---|
| Male | 18-24 | 1 | 1 | 5 | 3 | 2 | 12 |
| | 25-44 | 7 | 9 | 10 | 14 | 26 | 66 |
| | 45-64 | 4 | 14 | 8 | 13 | 19 | 58 |
| | 65+[1] | 1 | 2 | 3 | 4 | 4 | 14 |
| Missing data | | 0 | 0 | 0 | 3 | 3 | 6 |
| | Male Total | 13 | 26 | 26 | 37 | 54 | 156 |
| Female | **Age Group** | **2011** | **2012** | **2013** | **2014** | | **Total** |
| | 18-24 | 0 | 0 | 1 | 0 | 0 | 1 |
| | 25-44 | 2 | 4 | 6 | 10 | 6 | 28 |
| | 45-64 | 1 | 3 | 0 | 1 | 3 | 8 |
| | 65+ | 1 | 1 | 2 | 1 | 0 | 5 |
| Missing data | | 0 | 0 | 0 | 0 | 3 | 3 |
| | Female Total | 4 | 8 | 9 | 12 | 12 | 45 |
| **Grand Total** | | **17** | **34** | **35** | **49** | **66** | **201** |

1: please note age categories 45-64 and 65+ have been collapsed in the current table due to small numbers and thus, potentially, identifiable deaths.

### Standardised Mortality Ratios

SMRs for homeless men ranged from 3 to 10 [table 2], compared to Dublin males in the general population. For homeless women the SMRs ranged from 6 to 10. The highest ratio for females was in 2012, whereas 2015 was highest ratios for males.

Table 2: Standardised Mortality Ratios 2011-2015

| **Year** | **Males** | | | **Females** | | | **Both Genders** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Observed * | Expected ± | SMR | Observed | Expected | SMR | Observed * | Expected ± | SMR |
| 2011 | 13 | 4.9 | 2.7 | 4 | 0.65 | 6.2 | 17 | 5.55 | 3.1 |
| 2012 | 26 | 5.8 | 4.5 | 8 | 0.8 | 10 | 34 | 6.6 | 5.2 |
| 2013 | 26 | 6.1 | 4.3 | 9 | 1 | 9 | 35 | 7.1 | 4.9 |
| 2014 | 37 | 6.4 | 5.8 | 12 | 1.3 | 9.2 | 49 | 7.7 | 6.4 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2015 | 54 | 5.4 | 10 | 12 | 1.3 | 9.2 | 66 | 6.7 | 9.9 |
| total | 156 | 28.6 | 5.5 | **45** | **5.05** | **8.9** | **201** | **33.65** | **6.0** |

*Number of observed deaths in the homeless population
±Number of expected deaths (calculate expected number of deaths among homeless as: mortality rate in general pop multiplied by the number of homeless people per age group)

The majority of homeless people died in hospital or in a homeless service. Just over 10% [n=22] of people died outdoors [Table 3].

Table 3: Place where homeless death occurred

| **Place of deaths 2011-2015** | **N** | **%** |
|---|---|---|
| Hospital | 100 | 49.7 |
| Homeless Services | 60 | 29.7 |
| Outdoors | 22 | 10.9 |
| Hospice | 8 | 4.4 |
| Prison | 1 | 0.4 |
| Private residence | 10 | 4.9 |
| **Total** | 201 | 100 |

Cause of Death

Cause of death was confirmed for 195 cases (See supplemental table 4) and n=6 are awaiting inquests. Drug and alcohol were amongst the leading cause of death for this cohort (Table 4) accounting for more than one third of all verified deaths [38.4%]. In addition, in a further 43, cases alcohol and drugs were implicated. Thus, in 58.7% (118/195) of all verified causes of death, drugs and/or alcohol were implicated. Moreover, drugs, particularly opioids, were implicated in more than half of drug related cases.

Table 4: Drug and alcohol related deaths 2011-2015

| Drug and alcohol related deaths | Total |
|---|---|
| Drugs | 71 |
| Alcohol | 2 |
| Both Drugs and Alcohol | 2 |
| Total | 75 |
| Deaths where drugs were antecedent | 43 |
| Total | 118 |

## DISCUSSION

We examined two hundred and one deaths that occurred among homeless people between 2011 and 2015. Mortality rates were much higher among homeless people compared to the general population: for men SMRs were between 3 and 10 times higher for homeless women the SMRs ranged from 6 to 10 times higher. These are however, in line with international findings [17 18]. Just over 10% of deaths occurred outdoors, a low figure in comparison to figures reported in the international literature [31].

The causes of death for homeless individuals are different from those of the general population: drug and alcohol related deaths accounted for more than one third of deaths in homeless individuals, a finding that is also consistent with the current body of research [17 24]. Moreover, opioids accounted for most of these deaths. The majority of drug related deaths in Ireland[32] and the UK[33 34] are from opioid overdose. The high percentage of potentially avoidable deaths among homeless people from opioid overdose presents an opportunity for the development of possible preventative strategies. For example, public health initiatives such as Naloxone to prevent and reverse opioid drug overdose should be considered and expanded to reduce the number of overdose fatalities in this population.

A number of studies in homeless populations have noted the emergence of an ageing population[4 35 36]. For example, in the US the median age of the homeless population at death is 50 years[4]. Similarly, Neilsen et al. (2011) in Denmark report a mean age of 50 at death. The median age at death for homeless people in Dublin was 43 years old, with the median age at death for homeless women even lower at 41. Furthermore, in the current study only 12 deaths in people 65 and over emerged from the data.

Acquiring and validating mortality data is a complex task and data such as date of birth and legal name is at times unknown. Thus, the validation of the vast majority of reported deaths is a major strength of the

study. The Audit cycle proved to be quite simple and effective. The findings highlighted several discrepancies in reported deaths throughout the recording system. It highlighted the need for agencies reporting a death to the DRHE to improve current reporting practices. In addition, the PASS system emerged as highly effective in recording the daily activity of service users. In addition, it offers consistency regarding homeless status.

Walsh et al, (2013) suggest that apart from the scale of homelessness in the capital, the Dublin homeless population does not differ substantially in demographics when compared to other counties in Ireland [37]. Thus, the current findings may be generalisable to the whole of Ireland. Similarly, the demographics as well as the causes of death indicate similarities between the current study and other international cohorts in terms of age, gender and SMRs[7 11 12].

The current study data had a number of limitations. A small number of the deaths in the current study were unverifiable and excluded from the analysis. Data gathering was challenging because data in this population is often incomplete, and many individuals utilising homeless services use an alias rather than legal name. Record keeping varied significantly between agencies and some discrepancies existed between agency records and deaths reported to the DRHE.

## CONCLUSION

In conclusion, this study demonstrates dramatically higher mortality ratios among men and women who were homeless. Overdose from substance use was a critical factor in more than one third of verified deaths included in the current study, with opioids being overrepresented. Homeless people are notably more likely to die by overdose than the general population. These findings should be taken into account when developing interventions to prevent mortality among homeless populations.

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## FOOTNOTES

**Contributors** JI and JB developed and directed the study. JB and JI conceived and designed the survey questions. JI coordinated data collection and JI, BG and AH carried out data cleaning and cross validation. JI & LZ performed the statistical analyses. JI drafted the manuscript. JI, JB, LZ, BODH and AH contributed to the final draft of the paper.

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**Competing interests** None.

**Ethics approval** The study received ethical approval by Ethics Committee at the Faculty of Health Sciences, Trinity College Dublin

**Provenance and peer review** Not commissioned externally peer reviewed

**Data sharing statement** No additional data available.

**Table 1: Denominator data for Homeless Population 2011-2014 by age and gender**

| | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| 18-24 | 386 | 249 | 440 | 262 | 521 | 313 | 512 | 395 | 456 | 480 |
| 25-44 | 1488 | 476 | 1729 | 595 | 1959 | 747 | 2092 | 1027 | 2121 | 1328 |
| 45-64 | 461 | 77 | 522 | 105 | 643 | 150 | 694 | 200 | 768 | 243 |
| 65+ | 34 | 6 | 42 | 8 | 45 | 12 | 42 | 15 | 53 | 22 |
| Missing data | 1,232 | 369 | 875 | 286 | 153 | 62 | | | 1 | 9 |
| **Total All Ages** | **3601** | **1177** | **3608** | **1256** | **3321** | **1284** | **3340** | **1637** | **3399** | **2082** |

**Table 2: Denominator data for General Population 2011-2015 by age and gender**

| | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| 18-24 | 63711 | 67234 | 54917 | 56078 | 50903 | 48749 | 48472 | 44755 | 47109 | 44691 |
| 25-44 | 218986 | 225914 | 215490 | 227467 | 216450 | 227647 | 171245 | 229773 | 224521 | 230448 |
| 45-64 | 130529 | 140161 | 131813 | 140808 | 133881 | 142285 | 183566 | 1442235 | 138373 | 148366 |
| 65+ | 59804 | 79472 | 61878 | 81308 | 64421 | 83548 | 66966 | 86149 | 69719 | 88336 |
| **Total All Ages** | 473,030 | 512,781 | 464,098 | 505,661 | 465,655 | 502,229 | 470,249 | 504,912 | 479722 | 511841 |

**Table 3: Numerator data deaths in General Population 2011-2015 by age and gender**

| **Deaths in General Population County Dublin By Gender & Age Group 2005-2015** | | | | | | |
|---|---|---|---|---|---|---|
| Gender | **Age Group** | **2011** | **2012** | **2013** | **2014** | **2015** |
| Male | 18-24 | 45 | 26 | 35 | 38 | 19 |
| | 25-44 | 246 | 262 | 196 | 189 | 172 |
| | 45-64 | 717 | 749 | 693 | 702 | 551 |
| | 65+ | 2555 | 2662 | 2597 | 2716 | 2429 |
| Male Total | | **3563** | **3699** | **3521** | **3645** | **3171** |
| Female | 18-24 | 12 | 10 | 12 | 10 | 5 |
| | 25-44 | 113 | 129 | 114 | 128 | 84 |
| | 45-64 | 495 | 487 | 490 | 450 | 398 |
| | 65+ | 3154 | 3178 | 3323 | 3244 | 3153 |
| Female Total | | **3774** | **3804** | **3939** | **3832** | **3640** |
| **Grand Total** | | **7337** | **7503** | **7460** | **7577** | **6811** |

**Table 4: Cause of death 2011-2015**

| CAUSE OF DEATH | 2011 | 2012 | 2013 | 2014 | 2015 | TOTAL |
|---|---|---|---|---|---|---|
| Drug and Alcohol[1] | 7 | 9 | 14 | 18 | 27 | 75 |
| Circulatory' | 1 | 7 | 6 | 11 | 5 | 30 |
| Respiratory | 2 | 5 | 6 | 7 | 6 | 26 |
| Gastrointestinal | 1 | 5 | 2 | 3 | 3 | 14 |
| Unnatural | 1 | 3 | 2 | 4 | 9 | 19 |
| Cancer | 2 | 1 | 2 | 3 | 2 | 10 |
| Other | 3 | 4 | 3 | 3 | 8 | 21 |
| Outstanding Inquest | 0 | 0 | 0 | 0 | 6 | 6 |
| **Total** | 17 | 34 | 35 | 49 | 66 | 201 |

[1] Drug and alcohol as a direct cause of death represent a minimum. Drug and alcohol figures in table 8 refer to 'disease or condition leading directly to death' in a further 60 cases (17.8%) deaths drug and alcohol was an 'antecedent or significant factor, which contributed to the death see table 9. In addition, some inquests were outstanding.

STROBE Statement—checklist of items that should be included in reports of observational studies

| | Item No | Recommendation |
|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract [P3] |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found |
| **Introduction** | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported [4-5] |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses [3 &5] |
| **Methods** | | |
| Study design | 4 | Present key elements of study design early in the paper [P5] |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection [N/A] |
| Participants | 6 | (*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up [P6]<br>*Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls [N/A]<br>*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants [N/A] |
| | | (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed<br>*Case-control study*—For matched studies, give matching criteria and the number of controls per case [N/A] |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable [5-6] |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group [5-6] |
| Bias | 9 | Describe any efforts to address potential sources of bias |
| Study size | 10 | Explain how the study size was arrived at [N/A] |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why [P7] |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding |
| | | (*b*) Describe any methods used to examine subgroups and interactions [P7] |
| | | (*c*) Explain how missing data were addressed [5-6] |
| | | (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed<br>*Case-control study*—If applicable, explain how matching of cases and controls was addressed [N/A]<br>*Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy [N/A] |
| | | (*e*) Describe any sensitivity analyses [N/A] |

Continued on next page

| | | |
|---|---|---|
| **Results** | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed |
| | | (b) Give reasons for non-participation at each stage [5-7] |
| | | (c) Consider use of a flow diagram [N/A] |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders |
| | | (b) Indicate number of participants with missing data for each variable of interest |
| | | (c) *Cohort study*—Summarise follow-up time (eg, average and total amount) |
| Outcome data | 15* | *Cohort study*—Report numbers of outcome events or summary measures over time |
| | | *Case-control study*—Report numbers in each exposure category, or summary measures of exposure |
| | | *Cross-sectional study*—Report numbers of outcome events or summary measures |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included [7-8] |
| | | (*b*) Report category boundaries when continuous variables were categorized [N/A] |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses [N/A] |
| **Discussion** | | |
| Key results | 18 | Summarise key results with reference to study objectives [P9] |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias [P10] |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence [P9-10] |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results [P10] |
| **Other information** | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based [N/A] |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.