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Multimorbidity in Homeless Hospital Patients

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Multimorbidity In Young Homeless Hospital Inpatients

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Abstract

Objectives: Homeless people lack a secure, stable place to live, and experience higher rates of serious illness than the housed population.

We sought to compare the age profile, use of unscheduled ED and inpatient care and the prevalence of multimorbidity between housed and homeless individuals in Dublin, Ireland.

Setting: A large university teaching hospital serving the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital and is also collected in the national Hospital In-Patient Enquiry (HIPE) system, a computerised health information system designed to capture demographic, administrative and clinical data on all inpatient discharges from publicly funded acute hospitals in Ireland.

Participants: We carried out an observational cross-sectional study using data on all ED visits (n=47,174) and all unscheduled admissions under the general medical take (n=7,031) in St James's Hospital in Dublin in 2015.

Primary and Secondary Outcome Measures: The address field of the hospital's electronic patient record was used to identify homeless patients. Data on demographic details, length of stay and diagnoses was extracted from the HIPE database.

Results: In comparison to housed individuals in the hospital catchment area, homeless individuals had higher rates of ED attendance (0.16 per person/annum vs 3.0 per person/annum respectively) and inpatient bed days (0.3 bed days per person/annum vs 4.4 bed days per person/annum. The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed patients was 61.20 (95% CI 60.72-61.68). The mean number of comorbidities in housed medical inpatients aged 64 or less was 4.2 (95% CI 4.1-4.3), compared to 5.8 (95% CI 5.4-6.1) in homeless medical inpatients.

Conclusion: Young multimorbid homeless patients represent a significant proportion of ED attendees and medical inpatients. This has significant implications for restructuring hospital care and provision of services in the community.

Strengths and Limitations

- Use of large hospital-wide dataset including all ED presentations and medical admissions
- Presentations to other hospitals not captured
- Co-morbidities captured by non-clinician coders
- Identification of homeless patients based on address recorded in patient electronic record

Introduction

Homeless people lack a secure, stable place to live. Homelessness includes those who are sleeping rough; those living in emergency accommodation such as a hostel, night shelter, in B&B accommodation; those living with family and friends, or in a squat. In November 2015 the Dublin Regional Homeless Executive reported 3,615 adults in emergency accommodation nationally and a minimum of 91 individuals sleeping rough in Dublin [1].

Homelessness represents the extreme end on a scale of deprivation. This deprivation results in markedly inequitable health outcomes: rough sleepers in the UK have an average age of death of 47 years [2]. Cross-sectional studies in Dublin demonstrate that rough sleepers experience higher rates of serious and multiple morbidity than the housed population, with an average of eight to nine concomitant medical conditions [3]. The most common health needs of rough sleepers relate to drug dependence, alcohol dependence or mental ill-health [4]. Many homeless people experience the tri-morbidity of physical ill-health, mental ill-health and drug or alcohol misuse. In Dublin, up to 70% of homeless individuals report having used illegal drugs with over half reporting injecting drugs [5]. Addictions to alcohol and injection drugs cause complications including cirrhosis, infection with hepatitis C and HIV [6] and bacterial infections such as absesses, thrombophlebitis, endocarditis and bacteraemia. Contact with other homeless individuals involves exposure to airborne infectious agents including tuberculosis [6].

Homelessness and tri-morbidity create barriers to accessing scheduled healthcare. Homeless individuals may have other needs which override health-promoting behaviours, including accessing scheduled healthcare. Homeless people are low users of primary care services [7], and often use the Emergency Department (ED) as their initial point of contact with healthcare. Internationally, homeless people have been reported to attend ED 3-5 times more frequently than housed individuals [8-11]. Rates of inpatient admissions of homeless persons have also been found to be higher [10 12 13] with longer lengths of stay and increased readmission rates [13 14].

Multimorbidity has been defined as the co-occurrence of more than one chronic condition in an individual over time. In housed populations increased co-morbidities and increased use of unscheduled health care (ED visits and inpatient admissions) are driven primarily by age [15-17]. It has been suggested that the homeless populations have increased levels of psychosocial stress, poor accommodation and poor nutrition, which may contribute to premature aging and frailty[18].

We sought to compare the age profile, use of unscheduled ED and inpatient care and the prevalence of multimorbidity between housed and homeless individuals in Dublin, Ireland.

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Methods

We carried out an observational cross-sectional study using data on all ED visits and all unscheduled admissions under the general medical take in St James's Hospital, Dublin, in 2015. St James's Hospital is a large university teaching hospital serving adults resident in the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital and is also collected in the national Hospital In-Patient Enquiry (HIPE) system, a computerised health information system designed to capture demographic, administrative and clinical data on all inpatient discharges from publicly funded acute hospitals in Ireland. Diagnoses recorded on the HIPE system are determined by trained coders on examination of patient records.

All Emergency Department (ED) attendances and unscheduled inpatient stays between the 1st of January and the 31st of December 2015 (inclusive) were extracted from hospital databases. Individuals were identified by a unique identifier (medical record number). Homeless addresses were defined as no fixed abode (NFA) or any homeless hostels recorded on the Dublin Regional Homeless Authority Case Management website. The address field was also manually screened to ensure that any misspellings etc. were identified. Length of stay was extracted from the HIPE database. Outcomes of ED attendances were extracted from the hospital patient record. Diagnoses were extracted from the HIPE database.

Patients admitted under any medical specialty participating in the general medical take rota or under Infectious Diseases were defined as medical inpatients. This did not include patients admitted under Geriatrics, Neurology, Nephrology, Oncology, Haematology, Psychiatry or any surgical specialty. Age was defined as the age of the patient on the date of discharge from hospital. Patients without recorded address were excluded.

To assess the sensitivity of identifying homeless patients based on the address field in the EPR, patients who were referred to the Social Work Department for advice on homelessness were screened to see whether homelessness could be identified from the address field on the hospital electronic patient record.

The catchment population of the hospital was obtained from previous publications [19]. The homeless population of the catchment area was estimated by the Dublin Regional Homeless Executive.

Data was analysed using SPSS. Mann-Whitney tests were used to compare differences in age and length of stay between housed and homeless patients. Spearman's rank correlation co-efficient was used to assess the association between age and LOS and age and multimorbidity in housed and homeless patients.

Ethical approval was granted by the Joint Hospital Research Ethics Committee.

Results

The catchment population of St James's Hospital, Dublin is reported as 270,000. The homeless population of the catchment area was estimated as 1,000 individuals, resulting in a prevalence of homelessness of 0.4% of the population of the catchment area.

250 addresses (including no fixed abode and numerous homeless hostels as well as multiple spelling variants of the homeless hostels) were identified as homeless addresses and individuals giving these addresses as their current address were defined as homeless.

100 homeless patients were identified from referrals to hospital social workers for advice on homelessness. 72% of these had an address on their electronic patient record that had been identified as homeless.

5 ED attendances and 12 inpatient admissions had no address recorded.

ED attendances

Homeless individuals accounted for a disproportionally high number of ED attendances per proportion of the catchment population. The rates of attendance per year were increased in homeless individuals and they accounted for increasing proportions of attenders with frequent (>4/year) or very frequent (>12/year) attendances to the ED (Table 1).

Homeless ED attenders were predominantly male, and the median age was 6 years younger than that of housed ED attenders.

Table 1: Demographics of ED attenders

	Housed	**Homeless**
Catchment area	270,000	1,000 (0.4%)
ED attendances (% of total attendances)	44,208 (93.7%)	2,966 (6.3%)
Individuals	30,865	909
Female	48.5%	21.6%
Attendances/individual **Median (range) [95% CI]**	1.4 (1-109) [1.4-1.4]	2 (1-88) [2.9-3.6]
ED attendances per catchment population (95%CI)	0.16/person/annum	3.0/person/annum

Individuals with >=4 presentations per year	592 (90.7% of individuals with >= 4 presentations per year, 0.2% of housed catchment population)	57 (9.3% of individuals with >= 4 presentations per year, 6% of homeless catchment population)
Individuals with >=12 presentations per year	48 (59% of individuals with >= 12 presentations per year, 0.02% of housed catchment population)	34 (41% of individuals with >= 12 presentations per year, 3% of homeless catchment population)

Homeless ED attenders were much more likely to leave the ED without being assessed or against medical advice (Table 2). Rates of admission to the hospital in those who remained for assessment and management were similar between housed and homeless attenders.

Table 2: Outcomes of ED attendances

	Housed	**Homeless**
Left before seen/against medical advice	6,870 (15.5%)	1,207 (40.7%)
Deceased	111 (0.3%)	1 (0.1%)
Discharged	24,374 (55%)	1221 (41.2%)
Admitted to SJH	12749 (28.8%)	537 (17.2%)

Patient presenting complaints were recorded at triage. These were then ranked in order of frequency in housed and homeless presenters (Table 3). Presentations related to drug and alcohol use and mental health were more common in homeless ED attenders.

Table 3: ED Presenting Complaints

	Housed	**Homeless**
1	Limb problems (8464, 19.1%)	Limb problems (383, 12.9%)
2	Abdominal pain (4250, 9.6%)	Overdose and poisoning (223, 7.6%)

3	Chest pain (3315, 7.5%)	Apparently drunk (196, 6.6%)
4	Unwell adult (2818, 6.4%)	Unwell adult (184, 6.2%)
5	Shortness of breath (2655, 6%)	Head injury (165, 5.6%)
6	Head injury (1843, 4.2%)	Mental illness (143, 4.8%)
7	Back pain (1503, 3.4%)	Collapsed adult (133, 4.5%)
8	Collapsed adult (1396, 3.2%)	Abdominal pain (112, 3.8%)
9	Headache (1199, 2.7%)	Shortness of breath (86, 2.9%)
10	Facial problems (870 2.0%)	Chest pain (85, 2.9%)

Acute Medical Admissions

Homeless individuals represented a high proportion of inpatient admissions which was disproportionate to the prevalence of homelessness in the catchment area. In contrast to housed medical inpatients, the majority of homeless medical inpatients were male. Although there was no significant difference in the median length of stay (LOS), the median number of admissions was higher in homeless individuals. The median number of bed days/individual per year was significantly higher in homeless people: 7 (0-369) compared to 5 (0-726) in housed individuals. This difference was statistically significant (p=0.001, Mann-Whitney). The number of bed days per person living in the catchment area was over ten times higher for homeless people than housed

Table 4: Demographics of Unscheduled Medical Admissions

Medical Admissions	**Housed**	**Homeless**
Inpatient Admissions	6572 (93.4%)	459 (6.5%)
Individuals	4853	261
Bed-days	80,629 (93.5%)	4,435 (6.5%)
Bed-days per catchment population	0.3 bed days/person/annum	4.4 bed days/person/annum
ITU bed-days	6573	443 (6.3%)

	0.03 bed days/person/annum	0.4 bed days/person/annum
Mean LOS (range) [95% CI]	12.2 (0-726) [11.5-12.96]	9.41 (0-369) [7.2-11.6]
Female	3306 (51.3%)	103 (23.3%)
Mean admissions	1.37 (1-11) [1.34-1.39]	1.79 (1-7) [1.62-1.96]
Individuals >4 admissions/year	178 (2.7%)	30 (11.5%)

The 10 most frequent primary diagnoses for housed and homeless medical inpatients were determined (Table 5). Acute respiratory diagnoses were frequent in both populations. Diagnoses associated with injecting drug use (abscesses, venous thrombo-embolic disease) and Hepatitis C and/or alcohol use (hepatic failure, haematemesis) were more common in homeless inpatients. Cardiovascular disease (congestive heart failure and atrial fibrillation) were less common in homeless inpatients. Seizures were also more common in homeless patients, which may result from the increased rate of traumatic brain injury and substance use in this population.

Table 5: Primary Diagnoses in Unscheduled Medical Admissions

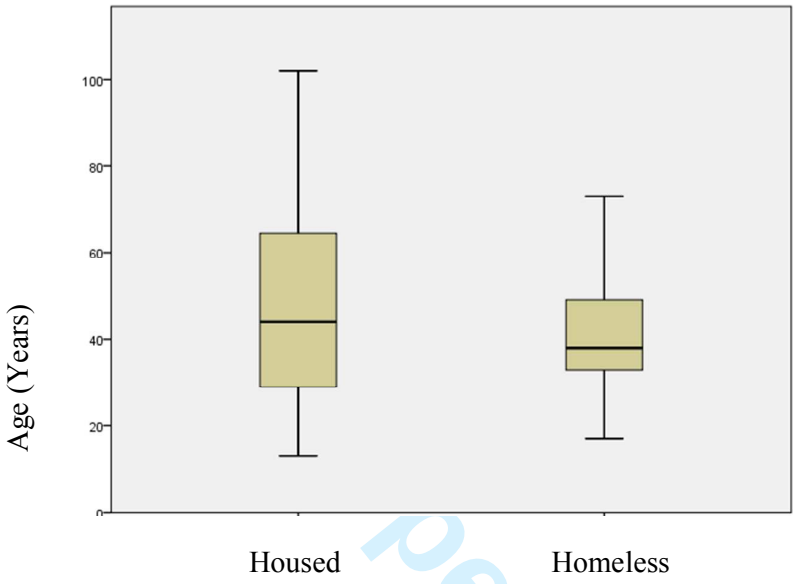
	Housed (n=6572)	**Homeless (n=459)**
1	Acute exacerbation of COPD/asthma 397 (6.0%)	Pneumonia/bronchitis 54 (11.8%)
2	Pneumonia/bronchitis 393 (6.0%)	Seizures 39 (8.5%)
3	Syncope and collapse 268 (4.1%)	Syncope and collapse 26 (5.7%)
4	UTI/Pyelonephritis 265 (4.0%)	Acute exacerbation of COPD/asthma 24 (5.3%)
5	Congestive heart failure	Abscess

	196 (3.0%)	23 (5.0%)
6	Cellulitis 152 (2.3%)	Cellulitis 22 (4.8%)
7	Headache 149 (2.3%)	VTE 16 (3.5%)
8	Atrial fibrillation 134 (2.0%)	Haematemesis 15 (3.27%)
9	Seizures 133 (2.0%)	Hepatic failure 10 (2.18%)
10	Chest pain 115 (1.7%)	Alcohol withdrawal 10 (2.18%)

Homeless ED attenders and medical inpatients are younger than their housed counterparts

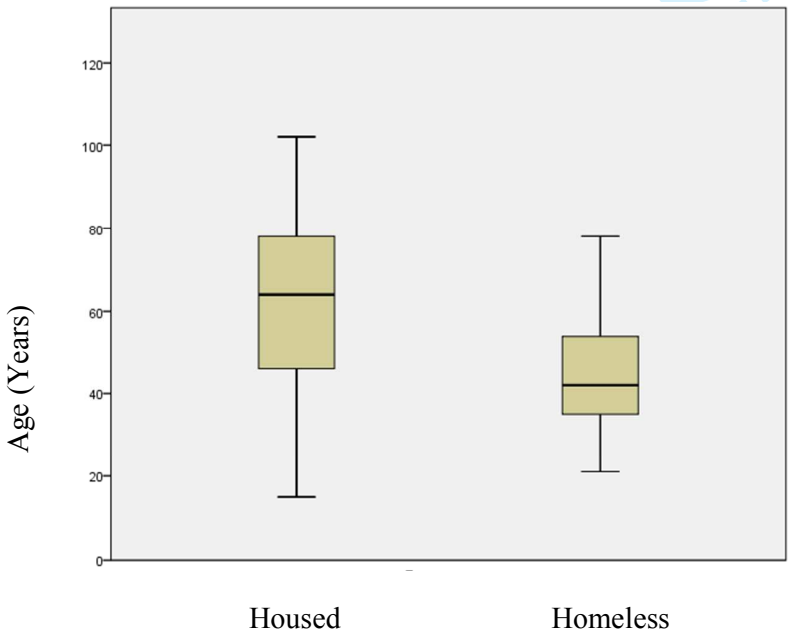
The mean age of homeless ED attendees was 39 (17-76) [95% CI 37.2-40.8], whereas that of housed ED attendees was 45 (16-102) [95% CI 42.1-47.9] (Figure 1). The difference in distribution of age was statistically significant (Mann-Whitney, p=0.000).

Figure 1: Age of housed and homeless ED attenders



The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed patients was 61.20 (95% CI 60.72-61.68). The distribution of age was significantly different between the two groups (p=0.000, Mann-Whitney) (Figure 2).

Figure 2: Age of unscheduled medical admissions



Bed days in patients aged 64 or younger accounted for 33.8% (27,274/80,633) of bed days generated by all housed medical admissions, versus 88.3% (3689/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square).

Use of unscheduled healthcare is age-related in housed, but not homeless people

Increasing age was strongly correlated with LOS in housed medical inpatients, whereas this was not the case in homeless medical inpatient (Table 7).

Table 7: Age is correlated with LOS in housed, but not homeless, medical inpatients.

	Housed	**Homeless**
Spearman correlation between age and LOS (95% confidence interval)	0.257 (0.223-0.292)	-0.034 (-0.222-0.155)
Significance	<0.005	0.12

Multimorbidity is independent of age in homeless individuals

In housed individuals, increasing age was strongly associated with increasing multimorbidity. This association was absent in homeless individuals, indeed increasing age was associated with a small decrease in multimorbidity in homeless patients (Table 8). The median number of diagnoses in housed medical inpatients aged 64 or less was 3, whereas the median number of diagnoses in homeless inpatients aged 64 or less was 5. Common co-morbidities are listed in order of frequency in Table 9.

Table 8: Increasing age is correlated with multimorbidity in housed, but not homeless, medical inpatients

	Housed	**Homeless**
Spearman correlation between age and number of diagnoses (95% confidence interval)	0.11 (0.11-0.11)	-0.012 (-0.015- -0.009)
Significance	<0.005	<0.005

Table 9: Common co-morbidities in housed vs homeless medical inpatients (present in n% of individuals)

	Housed	Homeless
1	Hypertension (16%)	Opiate dependence (33%)
2	Atrial fibrillation (8%)	Chronic HCV (31%)
3	Ischaemic heart disease (5%)	Alcohol dependence (29%)
4	Alcohol dependence (5%)	Epilepsy/seizures (15%)
5	T2DM (5%)	HIV (12%)
6	COPD/asthma (5%)	COPD/asthma (10%)
7	Chronic HCV (4%)	Cirrhosis (8%)
8	Opiate dependence (4%)	Recurrent depressive disorder (7%)
9	UTI (4%)	Vascular disease (5%)
10	AKI (4%)	Hypertension (4%)

Discussion

Homelessness is a state of extreme socioeconomic deprivation, and is associated with increased use of unscheduled hospital care (ED visits and admissions). In Dublin, homeless individuals are almost 10-fold more likely to present to ED or to have an unscheduled medical admission than housed individuals. These findings are similar to those reported from the US, Canada and the UK[3 9 20-25]. We demonstrate a striking difference in the age profile of homeless patients compared to housed patients. The median age of homeless medical inpatients was 20 years younger than that of housed patients. Most bed days generated by homeless patients were in patients less than 65 year of age, which was in contrast to the housed population. Earlier mortality in homeless people may account for their relative under-representation in older in-patients.

Cardiovascular presentations (congestive heart failure, atrial fibrillation and chest pain) were less common in homeless than in housed patients, whereas diseases related to alcohol and drug use (abscesses, hepatic failure and haematemesis) were more common in homeless patients. Both groups presented frequently with syncope, pneumonia and exacerbation of COPD/asthma. These presentations are common in elderly housed populations, but are seen in homeless patients at a significantly younger age.

Ageing can be thought of as a trajectory, with some individuals progressing rapidly towards multiple disease states whereas others progress much more slowly [26]. In housed populations, ageing has been reported to be strongly associated with increasing rates of multimorbidity and unscheduled medical admissions [27]. We found a similar association in housed patients in Dublin. However, we found that homeless patients demonstrated age-independent multimorbidity and use of unscheduled healthcare. The most frequent co-morbidities in housed individuals were cardiovascular (hypertension, atrial fibrillation and ischaemic heart disease); whereas comorbidity related to addiction was frequent in homeless individuals (hepatitis C, HIV, cirrhosis). Dependence on alcohol and opiates was a frequent comorbidity in housed and homeless individuals.

Socioeconomic determinants are powerful determinants of the rates of ageing [26 28 29], with lower socioeconomic status (SES) associated with more rapid ageing and multimorbidity [30]. Multiple mechanisms have been proposed to account for this phenomenon. Homelessness represents a state of extreme socio-economic deprivation, and is associated with increased prevalence of behaviours associated with morbidity (smoking, alcohol and drug use) but also with increased psychological stress potentially resulting in inflammation, immunopareisis and increased biological ageing [31-33]. These exogenous and endogenous factors appear to be so strongly associated with multimorbidity that the association between ageing and multimorbidity seen in housed hospital patients is overcome.

This study is the first to report multimorbidity in hospitalised homeless patients. Limitations of this study include that presentations to other hospitals were not captured, and that co-morbidities were captured by non-clinician coders. An additional limitation of the study was that identification of homeless patients was based on the address recorded on the patient

electronic record, with an estimated under-reporting rate of 30%. Strengths of the study include the large number of patients included, and the ability to focus analysis on medical inpatient admissions (thereby excluding psychiatric inpatient admissions).

Conclusion:

We demonstrate that young multi-morbid homeless patients represent a significant proportion of ED attendees and medical inpatients. Earlier mortality in homeless people may account for their relative under-representation in older in-patients. Geriatricians typically provide such care for older patients, but an equivalent approach is lacking for younger multi-morbid patients. These findings have significant implications for restructuring hospital care and provision of services in the community to encompass patients who require co-ordinated, cohesive care for multiple physical and mental illnesses as well as numerous social and financial issues.

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Competing interest statement - All authors have completed the Unified Competing Interest form and declare: support from the Health Research Board, Ireland (HRB) and the Health Services Executive, Ireland (HSE) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

The lead author, Dr Clíona Ní Cheallaigh, affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

The study was approved by the Joint Research Ethics Committee of St James's Hospital and the Adelaide and Meath Hospital.

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Author Contributions:
CNC: Study design, data collection, data analysis, writing of manuscript
SC: Data collection
JB, JK, CB, RAK, DB: Editing of manuscript
FOR, AOC: Literature search, data collection, editing of manuscript
RS: Statistical advice

Extra data is available by emailing nicheacm@tcd.ie.

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

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

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	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
,Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,9
		(b) Indicate number of participants with missing data for each variable of interest	6
		(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 x	*6-*
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	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*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	
Discussion			
Key results x	18	Summarise key results with reference to study objectives	
Limitations x	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation x	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability x	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding x	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	

*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.

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Multimorbidity In Young Homeless Hospital Inpatients

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AOC, FOR: Co-Director
DB: Clinical Senior Lecturer
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Abstract

Objectives: Homeless people lack a secure, stable place to live, and experience higher rates of serious illness than the housed population. We hypothesised that homeless people experience multimorbidity at a young age, and that this results in use of unscheduled acute healthcare.

We sought to compare the use of unscheduled ED and inpatient care and the the age profile and prevalence of multimorbidity between housed and homeless hospital patients in a high-income European setting in Dublin, Ireland.

Setting: A large university teaching hospital serving the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital.

Participants: We carried out an observational cross-sectional study using data on all ED visits (n=47,174) and all unscheduled admissions under the general medical take (n=7,031) in 2015.

Primary and Secondary Outcome Measures: The address field of the hospital's electronic patient record was used to identify patients living in emergency accommodation or rough sleeping (hereafter referred to as homeless). Data on demographic details, length of stay and diagnoses was extracted.

Results: In comparison to housed individuals in the hospital catchment area, homeless individuals had higher rates of ED attendance (0.16 per person/annum vs 3.0 per person/annum respectively) and inpatient bed days (0.3 bed days per person/annum vs 4.4 bed days per person/annum. The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed patients was 61.20 (95% CI 60.72-61.68). The mean number of comorbidities in housed medical inpatients aged 64 or less was 4.2 (95% CI 4.1-4.3), compared to 5.8 (95% CI 5.4-6.1) in homeless medical inpatients.

Conclusion: Young multimorbid homeless patients represent a significant proportion of ED attendees and medical inpatients. This has significant implications for restructuring hospital care and provision of services in the community.

Strengths and Limitations

- Use of large hospital-wide dataset including all ED presentations and medical admissions
- Co-morbidities identified from health records, rather than self-reported
- Presentations to other hospitals not captured
- Identification of homeless patients based on self-reported address at time of presentation to hospital as either no fixed abode (NFA) or emergency accommodation, individuals giving an address of family or friends not identified as homeless
- Absence of data on the duration and nature of homelessness

Introduction

Homeless people lack a secure, stable place to live. There are a variety of definitions of homelessness[1]: the European Typology of Homelessness and Housing Exclusion (ETHOS) defines a person as roofless or homeless if they have a deficit in at least two of : no dwelling, no legal title to a place for exclusive possession, and no private and safe space for social relations[2]. This definition of homelessness includes those who are sleeping rough (i.e. those sleeping in the open air); those living in emergency accommodation such as a hostel, night shelter or B&B accommodation; those living with family and friends, or in a squat. Homelessness may be chronic (lasting more than one year), intermittent or short-term/crisis-related[3] In November 2015 the Dublin Regional Homeless Executive (DRHE) reported 3,615 adults in emergency accommodation and a minimum of 91 individuals sleeping rough in Dublin [4]. Eighty percent of adults in emergency accommodation or rough sleeping in Dublin in January 2016 were 44 years old or younger [4 5], this contrasts with the ageing homeless population reported in the US [6].

Homelessness represents the extreme end on a scale of socio-economic deprivation.Lower socioeconomic status is associated with a younger onset of chronic disease and multimorbidity and a reduced life expectancy[7] : Multimorbidity has been defined as the co-occurrence of more than one chronic condition in an individual over time. In housed populations increased co-morbidities and increased use of unscheduled health care (ED visits and inpatient admissions) are driven primarily by age [8-10].

Cross-sectional studies in Dublin demonstrate that rough sleepers experience higher rates of serious and multiple morbidity than the housed population, with an average of eight to nine self-reported concomitant medical conditions [11]. This is in agreement with increased prevalence of self-reported chronic diseases seen in newly homeless individuals in the US[12].. Many homeless people experience the simultaneous tri-morbidity of physical ill-health, mental ill-health and drug or alcohol misuse. In Dublin, homeless is strongly associated with drug use: up to 70% of homeless individuals report having used illegal drugs with over half reporting injecting drugs [13]. Addictions to alcohol and injection drugs can cause chronic diseases including cirrhosis, infection with hepatitis C and HIV [14] and bacterial infections such as absesses, thrombophlebitis, endocarditis and bacteraemia.. It has been suggested that the homeless populations have increased levels of psychosocial stress, poor accommodation and poor nutrition, which may contribute to premature aging [15]. Studies from the US and Canada have reported earlier onset of frailty and other geriatric syndromes usually seen in older adults[16-18].

In addition, homelessness and tri-morbidity create barriers to accessing scheduled healthcare. Homeless individuals may have other needs which override health-promoting behaviours, including accessing scheduled healthcare. Homeless people are low users of primary care services [19], and often use the Emergency Department (ED) as their initial point of contact with healthcare. Internationally, homeless people have been reported to attend ED 3-5 times more frequently than housed individuals [20-23]. Rates of inpatient admissions of homeless

persons have also been found to be higher [22 24 25] with longer lengths of stay and increased readmission rates [25 26].

We hypothesised that, in Dublin, young homeless individuals experience multimorbidity and require a disproportionate amount of unscheduled healthcare. We sought to compare the age profile, use of unscheduled ED and inpatient care, and the prevalence of multimorbidity between housed and homeless individuals in Dublin, Ireland.

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Methods

We carried out an observational cross-sectional study using data on all ED visits and all unscheduled admissions under the general medical take (internal medicine) in St James's Hospital, Dublin, in 2015. St James's Hospital is a large university teaching hospital serving adults resident in the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital and is also collected in the national Hospital In-Patient Enquiry (HIPE) system, a computerised health information system designed to capture demographic, administrative and clinical data on all inpatient discharges from publicly funded acute hospitals in Ireland. Diagnoses recorded on the HIPE system are determined by trained coders on examination of patient records.

All Emergency Department (ED) attendances and unscheduled inpatient stays between the 1st of January and the 31st of December 2015 (inclusive) were extracted from hospital databases. Individuals were identified by a unique identifier (medical record number). Addresses were extracted from the patient record. Addresses are obtained from patients by trained receptionists upon registration in the ED, and are checked at each admission. Homeless addresses were defined as no fixed abode (NFA) or any emergency accommodation (homeless hostels) recorded on the Dublin Regional Homeless Authority Case Management website. The address field was also manually screened to ensure that all hostels were identified and any misspellings etc. were identified. In addition, any addresses with more than 2 patients presenting from the same address within the calendar year were manually screened to identify potential homeless hostels. Length of stay was extracted from the HIPE database. Outcomes of ED attendances were extracted from the hospital patient record. Diagnoses were extracted from the HIPE database.

Patients admitted under any medical specialty participating in the general medical take (internal medicine acute admissions) rota or under Infectious Diseases were defined as medical inpatients. This did not include patients admitted under Geriatrics, Neurology, Nephrology, Oncology, Haematology, Psychiatry or any surgical specialty. Geriatrics, Neurology, Nephrology, Oncology and Haematology were excluded because they do not participate in the unselected internal medical take. Age was defined as the age of the patient on the date of discharge from hospital. Patients without recorded address were excluded.

To assess the sensitivity of identifying homeless patients based on the address field in the EPR, patients who were referred to the Social Work Department for advice on homelessness were screened to see whether homelessness could be identified from the address field on the hospital electronic patient record.

The catchment population of the hospital was obtained from previous publications [27]. The homeless population of Dublin was taken from data collected by the Dublin Regional Homeless Executive[5], and the proportion of those falling within the catchment area of the hospital was estimated by consensus by the authors and by the head of research in the Dublin Regional Homeless Executive.

Data was analysed using SPSS. Mann-Whitney tests were used to compare differences in age and length of stay between housed and homeless patients. Chi-squared was used to compare categorical data between housed and homeless patients. Spearman's rank correlation co-efficient was used to assess the association between age and LOS and age and multimorbidity in housed and homeless patients.

Ethical approval was granted by the Joint Hospital Research Ethics Committee.

Results

The catchment population of St James's Hospital, Dublin is reported as 270,000. The homeless population sleeping rough or in emergency accommodation (hereafter referred to as homeless) of the catchment area was estimated as 1,000 individuals, resulting in a prevalence of homelessness of 0.4% of the population of the catchment area.

250 addresses (including no fixed abode and numerous homeless hostels as well as multiple spelling variants of the homeless hostels) were identified as homeless addresses and individuals giving these addresses as their current address were defined as homeless.

100 homeless patients were identified from referrals to hospital social workers for advice on homelessness. 72% of these had an address on their electronic patient record that had been identified as homeless.

5 ED attendances and 12 inpatient admissions had no address recorded.

ED attendances

Homeless individuals accounted for a disproportionally high number of ED attendances per proportion of the catchment population. 909 (91%) homeless adults out of an estimated 1000 homeless adults in the catchment area presented to the ED over this time period compared to 30,865 (11.4%) of 270,000 housed individuals in the catchment area. The rates of attendance per year were increased in homeless individuals and they accounted for increasing proportions of attenders with >4/year or >12/year attendances to the ED (Table 1).

Homeless ED attenders were predominantly male, and the median age was 6 years younger than that of housed ED attenders.

Table 1: Demographics of ED attenders

	Housed	**Homeless**	
Catchment area	270,000	1,000 (0.4%)	
ED attendances (% of total attendances)	44,208 (93.7%)	2,966 (6.3%)	<0.5
Individuals	30,865	909	<0.5
Female	48.5%	21.6%	<0.5
ED attendances per capita of catchment population (95%CI)	0.16/person/annum	3.0/person/annum	
Individuals with >=4 presentations per year	592 (90.7%))	57 (9.3%)	<0.5
Individuals with >=12 presentations per year	48 (59%)	34 (41%)	<0.5

Homeless ED attenders were much more likely to leave the ED without being assessed or against medical advice (Table 2). Rates of admission to the hospital in those who remained

for assessment and management were similar between housed and homeless attenders (31% of homeless vs 35% of housed.

Table 2: Outcomes of ED attendances

	Housed	Homeless	p-value
Left before seen/against medical advice	6,870 (15.5%)	1,207 (40.7%)	<0.05
Assessed	37,234 (84.5%)	1,759 (59.3%)	<0.05
Deceased	111 (0.3%)	1 (0.1%)	<0.05
Discharged	24,374 (65% of those assessed)	1,221 (69% of those assessed)	<0.05
Admitted	12,749 (35% of those assessed)	537 (31% of those assessed)	<0.05

Patient presenting complaints were recorded at triage. These were then ranked in order of frequency in housed and homeless presenters (Table 3). Presentations related to drug and alcohol use and mental health were more common in homeless ED attenders.

Table 3: ED Presenting Complaints

	Housed	Homeless
1	Limb problems (8464, 19.1%)	Limb problems (383, 12.9%)
2	Abdominal pain (4250, 9.6%)	Overdose and poisoning (223, 7.6%)
3	Chest pain (3315, 7.5%)	Apparently drunk (196, 6.6%)
4	Unwell adult (2818, 6.4%)	Unwell adult (184, 6.2%)
5	Shortness of breath (2655, 6%)	Head injury (165, 5.6%)

6	Head injury (1843, 4.2%)	Mental illness (143, 4.8%)
	Back pain (1503, 3.4%)	Collapsed adult (133, 4.5%)
8	Collapsed adult (1396, 3.2%)	Abdominal pain (112, 3.8%)
9	Headache (1199, 2.7%)	Shortness of breath (86, 2.9%)
10	Facial problems (870 2.0%)	Chest pain (85, 2.9%)
Other	15,782 (35.7%)	1, 257 (42.4%)

Acute Medical Admissions

Homeless individuals represented a high proportion of inpatient admissions which was disproportionate to the prevalence of homelessness in the catchment area (Table 4). In contrast to housed medical inpatients, the majority of homeless medical inpatients were male. The mean length of stay (LOS) was higher in housed individuals. In individuals under the age of 65, there was no statistically significant difference in mean LOS was longer in homeless individuals (8.21 in housed, 9.62 in homeless, p=0.33). The mean number of readmissions per individuals was higher in homeless individuals. The number of bed days per person living in the catchment area was over ten times higher for homeless people than housed

Table 4: Demographics of Unscheduled Medical Admissions

Medical Admissions	**Housed**	**Homeless**	**p-value**
Inpatient Admissions	6572 (93.4%)	459 (6.5%)	
Individuals	4853	261	
Bed-days	80,629 (93.5%)	4,435 (6.5%)	
Bed-days per capita of catchment population	0.3 bed days/person/annum	4.4 bed days/person/annum	
ITU (intensive care unit) bed-days per capita of catchment population	6573 0.03 bed days/person/annum	443 (6.3%) 0.4 bed days/person/annum	
Mean LOS (range)	12.2 (0-726) [11.5-	9.41 (0-369) [7.2-11.6]	<0.05

[95% CI]	12.96]		
Female	3306 (51.3%)	103 (23.3%)	<0.05
Mean admissions	1.87 (1-11) [1.84-1.91]	2.79 [2.62-2.96]	<0.05
Individuals >4 admissions/year	178 (2.7%)	30 (11.5%)	<0.05

The 10 most frequent primary diagnoses for housed and homeless medical inpatients were determined (Table 5). Acute respiratory diagnoses were frequent in both populations. Diagnoses associated with injecting drug use (abscesses, venous thrombo-embolic disease) and Hepatitis C and/or alcohol use (hepatic failure, haematemesis) were more common in homeless inpatients. Cardiovascular disease (congestive heart failure and atrial fibrillation) were less common in homeless inpatients. Seizures were also more common in homeless patients, which may result from the increased rate of traumatic brain injury and substance use in this population.

Table 5: Primary Diagnoses in Unscheduled Medical Admissions

	Housed (n=6572)	**Homeless (n=459)**
1	Acute exacerbation of COPD/asthma 397 (6.0%)	Pneumonia/bronchitis 54 (11.8%)
2	Pneumonia/bronchitis 393 (6.0%)	Seizures 39 (8.5%)
3	Syncope and collapse 268 (4.1%)	Syncope and collapse 26 (5.7%)
4	UTI/Pyelonephritis 265 (4.0%)	Acute exacerbation of COPD/asthma 24 (5.3%)
5	Congestive heart failure 196 (3.0%)	Abscess 23 (5.0%)

6	Cellulitis 152 (2.3%)	Cellulitis 22 (4.8%)
7	Headache 149 (2.3%)	VTE 16 (3.5%)
8	Atrial fibrillation 134 (2.0%)	Haematemesis 15 (3.27%)
9	Seizures 133 (2.0%)	Hepatic failure 10 (2.18%)
10	Chest pain 115 (1.7%)	Alcohol withdrawal 10 (2.18%)

Homeless ED attenders and medical inpatients are younger than their housed counterparts

The mean age of homeless ED attendees was 39 (17-76) [95% CI 37.2-40.8], whereas that of housed ED attendees was 45 (16-102) [95% CI 42.1-47.9] (Figure 1). The difference in distribution of age was statistically significant (Mann-Whitney, p=0.000).

Figure 1: Age of housed and homeless ED attenders

The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed medical inpatients was 61.20 (95% CI 60.72-61.68). The distribution of age was significantly different between the two groups (p=0.000, Mann-Whitney) (Figure 2).

Figure 2: Age of unscheduled medical admissions

Bed days in patients aged 64 or younger accounted for 33.8% (27,274/80,633) of bed days generated by all housed medical admissions, versus 88.3% (3689/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square).

Use of unscheduled healthcare is age-related in housed, but not homeless people

Increasing age was strongly correlated with LOS in housed medical inpatients, whereas this was not the case in homeless medical inpatient (Table 6).

Table 6: Age is correlated with LOS in housed, but not homeless, medical inpatients.

	Housed	Homeless
Spearman correlation between age and LOS (95% confidence interval)	0.257 (0.223-0.292)	-0.034 (-0.222-0.155)
Significance	<0.005	0.12

Multimorbidity is independent of age in homeless individuals

In housed individuals, increasing age was strongly associated with increasing multimorbidity. This association was absent in homeless individuals, indeed increasing age was associated with a small decrease in multimorbidity in homeless patients (Table 7). The median number of diagnoses in housed medical inpatients aged 64 or less was 3, whereas the median number of diagnoses in homeless inpatients aged 64 or less was 5. Common co-morbidities are listed in order of frequency in Table 8.

Table 7: Increasing age is correlated with multimorbidity in housed, but not homeless, medical inpatients

	Housed	Homeless
Spearman correlation between per additional year of age and number of diagnoses (95% confidence interval)	0.11 (0.11-0.11)	-0.012 (-0.015- -0.009)
Significance	<0.005	<0.005

Table 8: Common co-morbidities in housed vs homeless medical inpatients (present in n% of individuals)

	Housed	Homeless
1	Hypertension (16%)	Opiate dependence (33%)
2	Atrial fibrillation (8%)	Chronic HCV (31%)
3	Ischaemic heart disease (5%)	Alcohol dependence (29%)
4	Alcohol dependence (5%)	Epilepsy/seizures (15%)
5	T2DM (5%)	HIV (12%)
6	COPD/asthma (5%)	COPD/asthma (10%)
7	Chronic HCV (4%)	Cirrhosis (8%)
8	Opiate dependence (4%)	Recurrent depressive disorder (7%)
9	UTI (4%)	Vascular disease (5%)
10	AKI (4%)	Hypertension (4%)

Discussion

Homelessness is a state of extreme socioeconomic deprivation, and is associated with increased morbidity and increased use of unscheduled hospital care (ED visits and admissions). It is important to note a number of key demographic differences between homeless individuals in the US and those high-income European countries such as Ireland. Homeless populations in the US include a high proportion of veterans and of ethnic minorities, unlike those in Europe. Access to free primary and secondary healthcare also differs between these settings, with free primary and secondary healthcare provided to those in the lowest one-third income bracket in Ireland and universal healthcare available in the UK. However, in Dublin, homeless individuals are almost 10-fold more likely to present to ED or to have an unscheduled medical admission than housed individuals. These findings are similar to those reported from the US, Canada and the UK[11 16 21 28-32].

In our study, homeless patients were much more likely to leave the ED without being seen (41% vs 16% in housed patients). Patients who leave the ED without being seen have been

reported to represent the failure of an emergency care delivery system to meet its goals[33].These rates are similar to those reported by Svoboda et al in Toronto[34] and higher than those reported from London[35]. Anecdotally, some of the homeless individuals who leave without being seen may have simply been seeking shelter for the night in the ED waiting room, with others requiring medical attention leaving due to withdrawal from alcohol and/or opiates and ADHD-related difficulties with waiting.

Homeless individuals accounted for a grossly disproportionate amount of inpatient bed days relative to their proportion of the catchment population. Cardiovascular presentations (congestive heart failure, atrial fibrillation and chest pain) were less common in homeless than in housed patients, whereas diseases related to alcohol and drug use (abscesses, hepatic failure and haematemesis) were more common in homeless patients. Both groups presented frequently with syncope, pneumonia and exacerbation of COPD/asthma. These presentations are common in elderly housed populations, but are seen in homeless patients at a significantly younger age.

We demonstrate a striking difference in the age profile of homeless patients compared to housed patients. The median age of homeless medical inpatients was 20 years younger than that of housed patients. Most bed days generated by homeless patients were in patients less than 65 year of age, which was in contrast to the housed population. Of note, we excluded admissions to the Geriatric service, which consist solely of housed individuals over 70 years of age. Earlier mortality in homeless people may account for their relative under-representation in older in-patients. Work by Kushel et al on homeless veterans in the US also reported a younger median age in homeless hospital patients with a 5-16 year difference in median age between homeless and housed veterans presenting with medical conditions[16].

Ageing can be thought of as a trajectory, with some individuals progressing rapidly towards multiple disease states whereas others progress much more slowly [36]. In housed populations, ageing has been reported to be strongly associated with increasing rates of multimorbidity, frailty, unscheduled medical admissions and length of stay[37]. We found a similar pattern in housed patients in Dublin. However, we found that homeless patients demonstrated age-independent multimorbidity and use of unscheduled healthcare. Even young homeless patients demonstrated strikingly high rates of multimorbidity (6 conditions per individual in those under 65 years of age). Studies from the US have reported increased multi-morbidity and usage of unscheduled healthcare by homeless individuals as they age[16 18 26 38 39], with some studies reporting increased prevalence of functional impairment, frailty, depression, visual impairment and urinary incontinence in older homeless individuals. The high prevalence of age-independent multi-morbidity in young homeless adults had not been previously reported.

Socioeconomic determinants are powerful determinants of the rates of ageing [36 40 41], with lower socioeconomic status (SES) associated with more rapid ageing and multimorbidity [7]. Multiple mechanisms have been proposed to account for this phenomenon. Homelessness represents a state of extreme socio-economic deprivation, and is associated with increased

prevalence of behaviours associated with morbidity (smoking, alcohol and drug use) but also with increased psychological stress potentially resulting in inflammation, immunopareisis and increased biological ageing [42-44].

This study is the first to report multimorbidity resulting in hospital admissions for medical diagnoses in young homeless individuals. Limitations of this study include that presentations to other hospitals were not captured, and that co-morbidities were captured by non-clinician coders. An additional limitation of the study was that identification of homeless patients was based on the address recorded on the patient electronic record, with an estimated under-reporting rate of 30% and an inability to identify those who gave the address of a family member or friend. Estimates of the proportion of the homeless population of Dublin within the catchment area of the hospital are crude, and there is a significant degree of mobility of homeless people within the city. However, the differences in usage of acute unscheduled care are so dramatic that even an underestimation of the homeless population by 100% in our study would result in a homeless population in the catchment area of only 2,000 individuals, and the dramatic increase in use of unscheduled healthcare in homeless individuals compared to housed individuals would remain. Strengths of the study include the large number of patients included and the ability to focus analysis on medical inpatient admissions (thereby excluding psychiatric inpatient admissions).

Conclusion:

We demonstrate that young homeless individuals experience age-independent multimorbidity and represent a significant proportion of ED attendees and medical inpatients. Earlier mortality in homeless people may account for their relative under-representation in older in-patients. Geriatricians typically provide scare for multimorbid older patients, but an equivalent approach is lacking for younger multimorbid patients. These findings have significant implications for restructuring hospital care and provision of services in the community to encompass patients who require co-ordinated, cohesive care for multiple chronic physical and mental illnesses as well as numerous social and financial issues. [45]

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The lead author, Dr Clíona Ní Cheallaigh, affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

The study was approved by the Joint Research Ethics Committee of St James's Hospital and the Adelaide and Meath Hospital.

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Author Contributions:
CNC: Study design, data collection, data analysis, writing of manuscript
SC, JC: Data collection
JS, JB, JK, CB, RAK, DB: Editing of manuscript
FOR, AOC: Literature search, data collection, editing of manuscript
RS: Statistical advice

Extra data is available by emailing nicheacm@tcd.ie.

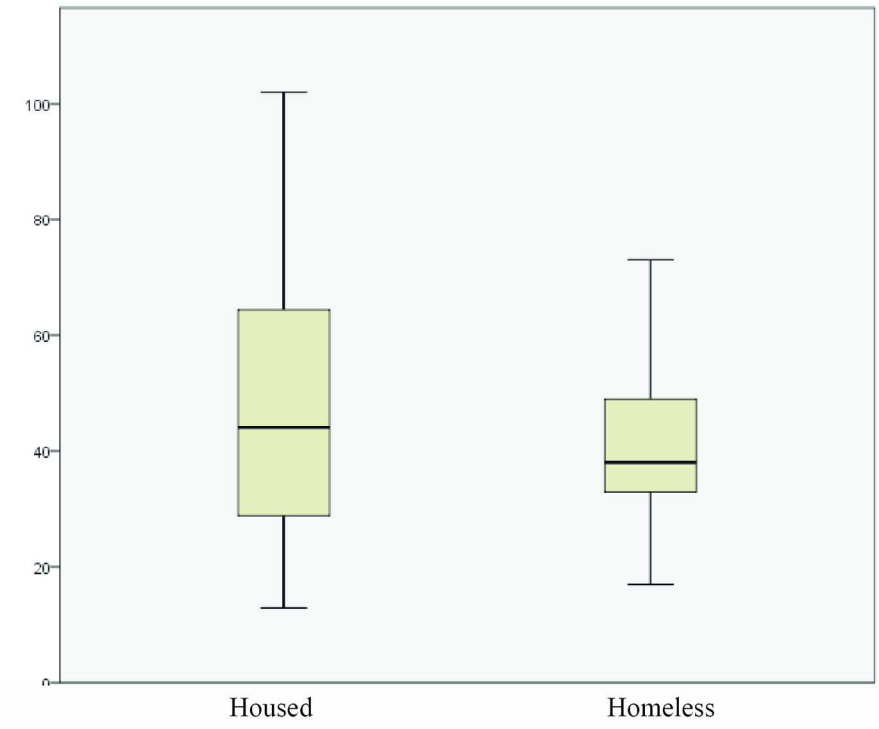

Figure 1

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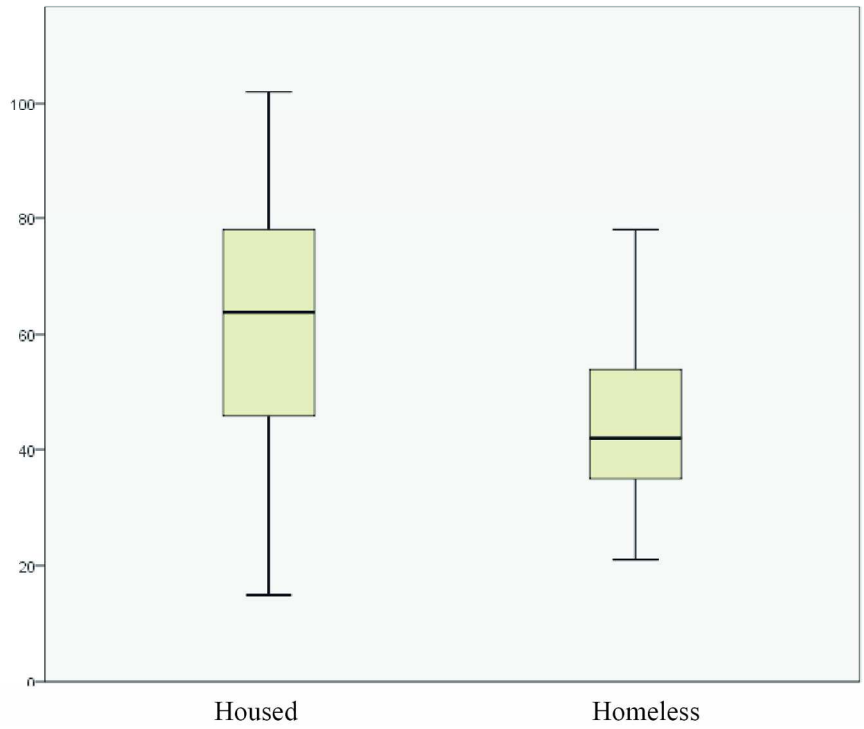

Figure 2

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

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

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	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
,Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,9
		(b) Indicate number of participants with missing data for each variable of interest	6
		(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 x	*6-*
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	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*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	
Discussion			
Key results x	18	Summarise key results with reference to study objectives	
Limitations x	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation x	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability x	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding x	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	

*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.

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Usage of Unscheduled Hospital Care by Homeless Individuals in Dublin, Ireland

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Usage of Unscheduled Hospital Care by Homeless Individuals in Dublin, Ireland

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Abstract

Objectives: Homeless people lack a secure, stable place to live, and experience higher rates of serious illness than the housed population. Studies, mainly from the US, have reported increased use of unscheduled health care by homeless individuals.

We sought to compare the use of unscheduled ED and inpatient care between housed and homeless hospital patients in a high-income European setting in Dublin, Ireland.

Setting: A large university teaching hospital serving the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital.

Participants: We carried out an observational cross-sectional study using data on all ED visits (n=47,174) and all unscheduled admissions under the general medical take (n=7,031) in 2015.

Primary and Secondary Outcome Measures: The address field of the hospital's electronic patient record was used to identify patients living in emergency accommodation or rough sleeping (hereafter referred to as homeless). Data on demographic details, length of stay and diagnoses was extracted.

Results: In comparison to housed individuals in the hospital catchment area, homeless individuals had higher rates of ED attendance (0.16 attendances per person/annum vs 3.0 attendances per person/annum respectively) and inpatient bed days (0.3 bed days per person/annum vs 4.4 bed days per person/annum. The rate of leaving ED before assessment was higher in homeless individuals (40% of ED attendances vs 15% of ED attendances in housed individuals). The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed patients was 61.20 (95% CI 60.72-61.68). Homeless patients were more likely to terminate an inpatient admission against medical advice (15% of admissions vs 2% of admissions in homeless individuals).

Conclusion: Homeless patients represent a significant proportion of ED attendees and medical inpatients. In contrast to housed patients, the bulk of usage of unscheduled care by homeless people occurs in individuals aged 25-65.

Strengths and Limitations

- Use of large hospital-wide dataset including all ED presentations and medical admissions
- Presentations to other hospitals not captured
- Identification of homeless patients based on self-reported address at time of presentation to hospital as either no fixed abode (NFA) or emergency accommodation, individuals giving an address of family or friends not identified as homeless
- Absence of data on the duration and nature of homelessness

Introduction

Homeless people lack a secure, stable place to live. There are a variety of definitions of homelessness[1]: the European Typology of Homelessness and Housing Exclusion (ETHOS) defines a person as roofless or homeless if they have a deficit in at least two of : no dwelling, no legal title to a place for exclusive possession, and no private and safe space for social relations[2]. This definition of homelessness includes those who are sleeping rough (i.e. those sleeping in the open air); those living in emergency accommodation such as a hostel, night shelter or B&B accommodation; those living with family and friends, or in a squat. Homelessness may be chronic (lasting more than one year), intermittent or short-term/crisis-related[3]. In November 2015 the Dublin Regional Homeless Executive (DRHE) reported 3,615 adults in emergency accommodation and a minimum of 91 individuals sleeping rough in Dublin [4].

Homelessness is associated with ill-health. Many homeless people have multiple simultaneous chronic conditions, termed multimorbidity [5]. The simultaneous tri-morbidity of physical ill-health, mental ill-health and drug or alcohol misuse is highly prevalent in homeless people[6]. Diseases related to alcohol and/or drug addiction including cirrhosis, infective endocarditis, abscesses, venous ulcers, infection with hepatitis C and HIV are more prevalent in homeless than housed people [7]. In addition, studies from the US and Canada have reported earlier onset in homeless people of frailty and other geriatric syndromes usually seen in older adults [8-10].

Homeless people have been reported to use relatively little primary care [11], and often use the Emergency Department (ED) as their initial point of contact with healthcare. Internationally, homeless people have been reported to attend ED 3-5 times more frequently than housed individuals [12-15]. Rates of inpatient admissions of homeless persons have also been found to be higher [14 16 17] with longer lengths of stay and increased readmission rates [17 18].

We sought to compare the age profile and use of unscheduled ED and inpatient care between housed and homeless individuals in Dublin, Ireland.

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Methods

Study Setting

We carried out an observational cross-sectional study using data on all ED visits and all unscheduled admissions under the general medical take (internal medicine) in St James's Hospital, Dublin, in 2015. St James's Hospital is a large university teaching hospital serving adults resident in the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital and is also collected in the national Hospital In-Patient Enquiry (HIPE) system, a computerised health information system designed to

capture demographic, administrative and clinical data on all inpatient discharges from publicly funded acute hospitals in Ireland. Diagnoses recorded on the HIPE system are determined by trained coders on examination of patient records.

Data Extraction

All Emergency Department (ED) attendances and unscheduled inpatient stays between the 1st of January and the 31st of December 2015 (inclusive) were extracted from hospital databases. Individuals were identified by a unique identifier (medical record number). Length of stay and outcomes of ED attendances and inpatient admissions were extracted from the hospital patient record.

Patients admitted under any medical specialty participating in the general medical take (internal medicine acute admissions) rota or under Infectious Diseases were defined as medical inpatients. This did not include patients admitted under Geriatrics, Neurology, Nephrology, Oncology, Haematology, Psychiatry or any surgical specialty. Geriatrics, Neurology, Nephrology, Oncology and Haematology were excluded because they do not participate in the unselected internal medical take. Age was defined as the age of the patient on the date of discharge from hospital. Patients without recorded address were excluded.

Operational Definition of Homelessness

Homeless individuals were defined as those with recorded addresses of no fixed abode (NFA) or any emergency accommodation (homeless hostels). Addresses were extracted from the patient record. Addresses are obtained from patients by trained receptionists upon registration in the ED, and are checked at each admission. The names and/or street addresses of homeless hostels were obtained from the Dublin Regional Homeless Authority Case Management website. The address field in the patient record was manually screened to identify addresses corresponding to homeless hostels. In addition, any addresses with more than 2 patients presenting from the same address within the calendar year were scrutinised to identify potential homeless hostels.

To assess the sensitivity of identifying homeless patients based on the address field in the EPR, patients who were referred to the Social Work Department for advice on homelessness were checked against those identified as homeless using the previous method.

Operational Definition of Housed and Homeless Population of Catchment Area

The catchment population of the hospital was obtained from previous publications [19]. The homeless population of Dublin was taken from data collected by the Dublin Regional Homeless Executive[20], and the proportion of those falling within the catchment area of the hospital was estimated by consensus by the authors and by the head of research in the Dublin Regional Homeless Executive.

Data Analysis

Data was analysed using SPSS. Mann-Whitney tests were used to compare differences in age and length of stay between housed and homeless patients. Chi-squared was used to compare categorical data between housed and homeless patients. Spearman's rank correlation co-efficient was used to assess the association between age and LOS in housed and homeless patients.

Ethical approval was granted by the Joint Hospital Research Ethics Committee.

Results

The catchment population of St James's Hospital, Dublin is reported as 270,000. The homeless population sleeping rough or in emergency accommodation (hereafter referred to as homeless) of the catchment area was estimated as 1,000 individuals, resulting in a prevalence of homelessness of 0.4% of the population of the catchment area.

250 address fields (including no fixed abode (NFA) and numerous homeless hostels as well as multiple spelling variants of the homeless hostels) were identified as homeless addresses and individuals giving these addresses as their current address were defined as homeless.

100 homeless patients were identified from referrals to hospital social workers for advice on homelessness. 72% of these had an address on their electronic patient record that had been identified as homeless.

5 ED attendances and 12 inpatient admissions had no address recorded.

ED Attendances

The demographics of all ED attenders are described in Table 1.

Table 1: Demographics of ED attenders

Number of individuals	31775
Female	15157 (47.7%)
Age (median and range)	44 (13-102)
Age (female, median and range)	45 (13-102)
Age (male, median and range)	43 (13-99)
Age <25	3386 (15.4%)
Age 25-44	7349 (33.6%)

Age 45-64	5205 (23.7%)
Age 65-74	4542 (20.8%)
Age >75	1392 (6.4%)

Table 2: Demographics of Housed and Homeless ED attenders

	Housed	**Homeless**	
ED attendances (% of total attendances)	44,208 (93.7%)	2,966 (6.3%)	<0.5
Individuals	30,865	909	<0.5
Female	14, 969 (48.5%)	196 (21.6%)	<0.5
ED attendances per capita of catchment population (95%CI)	0.16/person/annum	3.0/person/annum	
Individuals with >=4 presentations per year	592 (90.7%)	57 (9.3%)	<0.5
Individuals with >=12 presentations per year	48 (59%)	34 (41%)	<0.5

Homeless individuals accounted for a disproportionally high number of ED attendances per proportion of the catchment population. 909 (91%) homeless adults out of an estimated 1000 homeless adults in the catchment area presented to the ED over this time period compared to 30,865 (11.4%) of 270,000 housed individuals in the catchment area. The rates of attendance per year were increased in homeless individuals and they accounted for increasing

proportions of attenders with >4/year or >12/year attendances to the ED. Homeless ED attenders were predominantly male. (Table 2).

Homeless ED attenders are younger than their housed counterparts

The mean age of homeless ED attendees was 39 (17-76) [95% CI 37.2-40.8], whereas that of housed ED attendees was 45 (16-102) [95% CI 42.1-47.9] (Figure 1). The difference in distribution of age was statistically significant (Mann-Whitney, p=0.000).

Figure 1: Age of housed and homeless ED attenders

Table 3: Outcomes of ED attendances

	Housed	Homeless	p-value
Left before seen/against medical advice	6,870 (15.5%)	1,207 (40.7%)	<0.05
Assessed	37,234 (84.5%)	1,759 (59.3%)	<0.05
Deceased	111 (0.3%)	1 (0.1%)	<0.05
Discharged	24,374 (65% of those assessed)	1,221 (69% of those assessed)	<0.05
Admitted	12,749 (35% of those assessed)	537 (31% of those assessed)	<0.05

Homeless ED attenders were much more likely to leave the ED without being assessed or against medical advice (Table 3). Rates of admission to the hospital in those who remained for assessment and management were similar between housed and homeless.

Patient presenting complaints were recorded at triage. These were then ranked in order of frequency in housed and homeless presenters (Table 4). Presentations related to drug and alcohol use and mental health were more common in homeless ED attenders.

Table 4: ED Presenting Complaints

	Housed	Homeless

1	Limb problems (8464, 19.1%)	Limb problems (383, 12.9%)
2	Abdominal pain (4250, 9.6%)	Overdose and poisoning (223, 7.6%)
3	Chest pain (3315, 7.5%)	Apparently drunk (196, 6.6%)
4	Unwell adult (2818, 6.4%)	Unwell adult (184, 6.2%)
5	Shortness of breath (2655, 6%)	Head injury (165, 5.6%)
6	Head injury (1843, 4.2%)	Mental illness (143, 4.8%)
	Back pain (1503, 3.4%)	Collapsed adult (133, 4.5%)
8	Collapsed adult (1396, 3.2%)	Abdominal pain (112, 3.8%)
9	Headache (1199, 2.7%)	Shortness of breath (86, 2.9%)
10	Facial problems (870 2.0%)	Chest pain (85, 2.9%)
Other	15,782 (35.7%)	1, 257 (42.4%)

Acute Medical Admissions

5104 individuals had unscheduled general medical admissions in 2015 (Table 5). Seventy-five percent of admissions were in individuals aged over 45. Homeless individuals demonstrated a greater than ten-fold increase in usage of unscheduled general medical inpatient bed-days per capita of the catchment area compared to housed individuals. (Table 6). In contrast to housed medical inpatients, the majority of homeless medical inpatients were male.

Table 5: Demographics of Unscheduled Medical Admissions

	N
Individuals	5104
Female	2551 (50%)
Age (median, range)	62 (15-102)

Age (female, median and range)	65 (16-102)
Age (male, median and range)	60 (15-99)
Age <25	282 (4%)
Age 25-44	1507 (21.5%)
Age 45-64	1944 (27.7%)
Age 65-84	2444 (34.8%)
Age >85	805 (11.5%)

Table 6: Characteristics of Housed and Homeless Unscheduled Medical Admissions

Medical Admissions	**Housed**	**Homeless**	**p-value**
Inpatient Admissions	6572 (93.4%)	459 (6.5%)	
Individuals	4853	261	
Bed-days	80,629 (93.5%)	4,435 (6.5%)	
Bed-days per capita of catchment population	0.3 bed days/person/annum	4.4 bed days/person/annum	
ITU (intensive care unit) bed-days per capita of catchment population	6573 0.03 bed days/person/annum	443 (6.3%) 0.4 bed days/person/annum	
Mean LOS (range) [95% CI]	12.2 (0-726) [11.5-12.96]	9.41 (0-369) [7.2-11.6]	<0.05
Female	3306 (51.3%)	103 (23.3%)	<0.05
Mean admissions	1.87 (1-11) [1.84-1.91]	2.79 [2.62-2.96]	<0.05
Individuals >4 admissions/year	178	30 (11.5%)	<0.05

The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed medical inpatients was 61.20 (95% CI 60.72-61.68) (Figure 2). The distribution of age was significantly different between the two groups (p=0.000, Mann-Whitney) (Figure 3).

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Figure 2: Age of unscheduled medical admissions

Figure 3: Bed days by age group

Bed days in patients aged 64 or younger accounted for 33.8% (27,274/80,633) of bed days generated by all housed medical admissions, versus 88.3% (3689/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square). Bed days in patients aged 44 or younger accounted for 10.8%% (8734/80,633) of bed days generated by all housed medical admissions, versus 49.1% (2050/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square) (Figure 3).

Use of unscheduled healthcare is age-related in housed, but not homeless people

Increasing age was strongly correlated with LOS in housed medical inpatients, whereas this was not the case in homeless medical inpatient (Table 7).

Table 7: Age is correlated with LOS in housed, but not homeless, medical inpatients.

	Housed	**Homeless**
Spearman correlation between age and LOS (95% confidence interval)	0.257 (0.223-0.292)	-0.034 (-0.222-0.155)
Significance	<0.005	0.12

The 10 most frequent primary diagnoses for housed and homeless medical inpatients were determined (Table 8). Acute respiratory diagnoses were frequent in both populations. Diagnoses associated with injecting drug use (abscesses, venous thrombo-embolic disease) and hepatitis C and/or alcohol use (hepatic failure, haematemesis) were more common in homeless inpatients. Cardiovascular disease (congestive heart failure and atrial fibrillation) were less common in homeless inpatients.

Table 8: Primary Diagnoses in Unscheduled Medical Admissions

	Housed (n=6572)	**Homeless (n=459)**

1	Acute exacerbation of COPD/asthma 397 (6.0%)	Pneumonia/bronchitis 54 (11.8%)
2	Pneumonia/bronchitis 393 (6.0%)	Seizures 39 (8.5%)
3	Syncope and collapse 268 (4.1%)	Syncope and collapse 26 (5.7%)
4	UTI/Pyelonephritis 265 (4.0%)	Acute exacerbation of COPD/asthma 24 (5.3%)
5	Congestive heart failure 196 (3.0%)	Abscess 23 (5.0%)
6	Cellulitis 152 (2.3%)	Cellulitis 22 (4.8%)
7	Headache 149 (2.3%)	VTE 16 (3.5%)
8	Atrial fibrillation 134 (2.0%)	Haematemesis 15 (3.27%)
9	Seizures 133 (2.0%)	Hepatic failure 10 (2.18%)
10	Chest pain 115 (1.7%)	Alcohol withdrawal 10 (2.18%)

Table 9: Outcome of Admission

	Housed	**Homeless**	**P**

All unscheduled medical admissions	6572	459	
Self-discharge	125 (1.9%)	67 (14.6%)	
Deceased	151 (2.3%)	6 (1.3%)	
Discharged to home/homelessness	6157 (93.7%)	386 (84%)	
Discharge to long-term care	138 (2.1%)	0 (0%)	

A higher proportion of homeless inpatients self-discharged against medical advice (Table 9).

Discussion

Homelessness is a state of extreme socioeconomic deprivation, and is associated with increased morbidity and increased use of unscheduled hospital care (ED visits and admissions). We found that, in Dublin, homeless individuals have a 20-fold increased use of ED and over 10-fold increased use of unscheduled medical inpatient bed da than housed individuals. These findings are similar, although the relative increase is higher in Ireland, to those reported from the US, Canada and the UK [8 13 21-26]

It is important to note a number of key demographic differences between homeless individuals in the US and those in high-income European countries such as Ireland. Homeless populations in the US include a high proportion of veterans and of ethnic minorities. and those in Australia and Canada include a high proportion of individuals reporting themselves as Aboriginal/First Nation[5]. Homeless people in Dublin are predominantly white Irish, with 4% reporting themselves as Irish Traveller [6]. Very few Irish people are combat veterans. Eighty percent of adults in emergency accommodation or rough sleeping in Dublin in January 2016 were 44 years old or younger [4 20], this contrasts with the ageing homeless population reported in the US [27]. In Dublin, homelessness is strongly associated with drug use: up to 70% of homeless individuals report having used illegal drugs with over half reporting injecting drugs [6]. Free primary and secondary healthcare is available to those in the lowest one-third income bracket in Ireland.

In our study, homeless patients were much more likely to leave the ED without being seen (41% vs 16% in housed patients). Patients who leave the ED without being seen have been reported to represent the failure of an emergency care delivery system to meet its goals[28].These rates are similar to those reported by Svoboda et al in Toronto[29] and higher than

those reported from London[30]. Anecdotally, some of the homeless individuals who leave without being seen may have simply been seeking shelter for the night in the ED waiting room, with others requiring medical attention leaving due to withdrawal from alcohol and/or opiates and ADHD-related difficulties with waiting. Homeless medical inpatients were also much more likely to self-discharge against medical advice.

Homeless individuals accounted for a grossly disproportionate amount of inpatient bed days relative to their proportion of the catchment population. Cardiovascular presentations (congestive heart failure, atrial fibrillation and chest pain) were less common in homeless than in housed patients, whereas diseases related to alcohol and drug use (abscesses, hepatic failure and haematemesis) were more common in homeless patients. Seizures were also more common in homeless patients, which may result from the increased rate of traumatic brain injury and substance use in this population. Both groups presented frequently with syncope, pneumonia and exacerbation of COPD/asthma. These presentations are common in elderly housed populations, but are seen in homeless patients at a significantly younger age.

We demonstrate a striking difference in the age profile of homeless patients compared to housed patients. The median age of homeless medical inpatients was 20 years younger than that of housed patients. Most bed days generated by homeless patients were in patients less than 65 year of age, which was in contrast to the housed population. Of note, we excluded admissions to the Geriatric service, which consist solely of housed individuals over 70 years of age. Work by Kushel et al on homeless veterans in the US also reported a younger median age in homeless hospital patients with a five to 16 year difference in median age between homeless and housed veterans presenting with medical conditions [8]. Earlier mortality in homeless people may account for their relative under-representation in older in-patients.

Limitations of this study include that presentations to other hospitals were not captured, and that diagnoses were captured by non-clinician coders. An additional limitation of the study was that identification of homeless patients was based on the address recorded on the patient electronic record, with an estimated under-reporting rate of 30% and an inability to identify those who gave the address of a family member or friend. Estimates of the proportion of the homeless population of Dublin within the catchment area of the hospital are crude, and there is a significant degree of mobility of homeless people within the city. However, the differences in usage of acute unscheduled care are so dramatic that even an underestimation of the homeless population by 100% in our study would result in a homeless population in the catchment area of only 2,000 individuals, and the dramatic increase in use of unscheduled healthcare in homeless individuals compared to housed individuals would remain. Strengths of the study include the large number of patients included and the ability to focus analysis on medical inpatient admissions (thereby excluding psychiatric inpatient admissions).

Conclusion:

We demonstrate that homeless individuals account for a significantly increased amount of ED attendances and medical inpatient bed day. In contrast to housed patients, the bulk of usage of

unscheduled care by homeless people occurs in individuals aged 25-65. Earlier mortality in homeless people may account for their relative under-representation in older in-patients.

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The lead author, Dr Clíona Ní Cheallaigh, affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

The study was approved by the Joint Research Ethics Committee of St James's Hospital and the Adelaide and Meath Hospital.

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Author Contributions:
CNC: Study design, data collection, data analysis, writing of manuscript
SC, JC: Data collection
JS, JB, JK, CB, RAK, DB: Editing of manuscript
FOR, AOC: Literature search, data collection, editing of manuscript
RS: Statistical advice

Extra data is available by emailing nicheacm@tcd.ie.

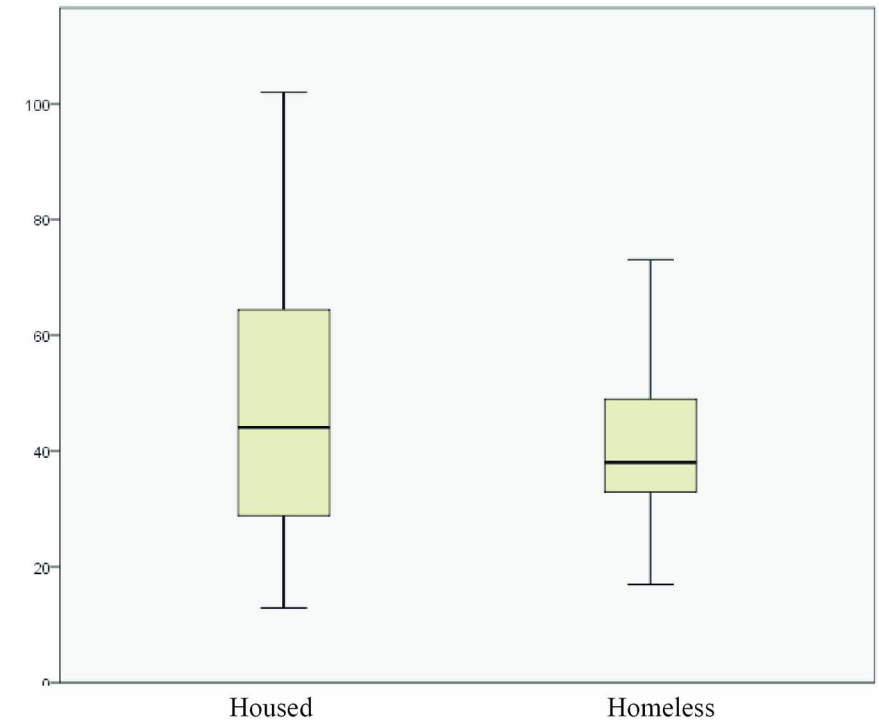

Figure 1

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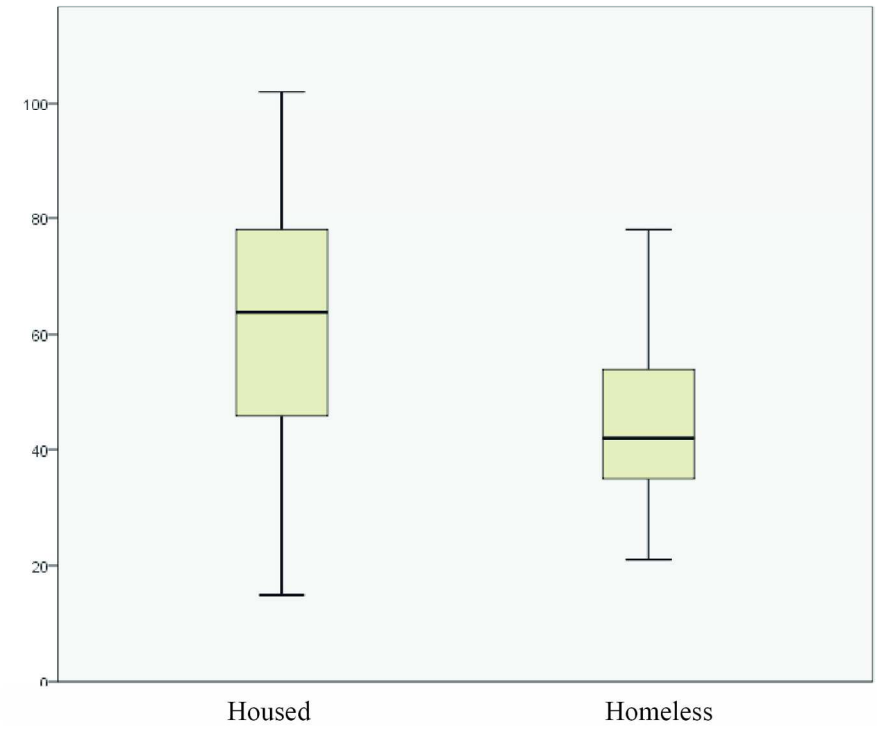

Figure 2

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

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

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	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
,Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,9
		(b) Indicate number of participants with missing data for each variable of interest	6
		(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 x	6-11
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	6-12
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*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	
Discussion			
Key results x	18	Summarise key results with reference to study objectives	13-14
Limitations x	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation x	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability x	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			**16**
Funding x	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	

*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.

BMJ Open

Usage of Unscheduled Hospital Care by Homeless Individuals in Dublin, Ireland: A Cross-Sectional Study

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Usage of Unscheduled Hospital Care by Homeless Individuals in Dublin, Ireland: A Cross-Sectional Study

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Abstract

Objectives: Homeless people lack a secure, stable place to live, and experience higher rates of serious illness than the housed population. Studies, mainly from the US, have reported increased use of unscheduled health care by homeless individuals.

We sought to compare the use of unscheduled ED and inpatient care between housed and homeless hospital patients in a high-income European setting in Dublin, Ireland.

Setting: A large university teaching hospital serving the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital.

Participants: We carried out an observational cross-sectional study using data on all ED visits (n=47,174) and all unscheduled admissions under the general medical take (n=7,031) in 2015.

Primary and Secondary Outcome Measures: The address field of the hospital's electronic patient record was used to identify patients living in emergency accommodation or rough sleeping (hereafter referred to as homeless). Data on demographic details, length of stay and diagnoses were extracted.

Results: In comparison to housed individuals in the hospital catchment area, homeless individuals had higher rates of ED attendance (0.16 attendances per person/annum vs 3.0 attendances per person/annum respectively) and inpatient bed days (0.3 bed days per person/annum vs 4.4 bed days per person/annum. The rate of leaving ED before assessment was higher in homeless individuals (40% of ED attendances vs 15% of ED attendances in housed individuals). The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed patients was 61.20 (95% CI 60.72-61.68). Homeless patients were more likely to terminate an inpatient admission against medical advice (15% of admissions vs 2% of admissions in homeless individuals).

Conclusion: Homeless patients represent a significant proportion of ED attendees and medical inpatients. In contrast to housed patients, the bulk of usage of unscheduled care by homeless people occurs in individuals aged 25-65.

Strengths and Limitations

- Use of large hospital-wide dataset including all ED presentations and medical admissions
- Presentations to other hospitals not captured
- Identification of homeless patients based on self-reported address at time of presentation to hospital as either no fixed abode (NFA) or emergency accommodation, individuals giving an address of family or friends not identified as homeless
- Absence of data on the duration and nature of homelessness

Introduction

Homeless people lack a secure, stable place to live. There are a variety of definitions of homelessness[1]: the European Typology of Homelessness and Housing Exclusion (ETHOS) defines a person as roofless or homeless if they have a deficit in at least two of : no dwelling, no legal title to a place for exclusive possession, and no private and safe space for social relations[2]. This definition of homelessness includes those who are sleeping rough (i.e. those sleeping in the open air); those living in emergency accommodation such as a hostel, night shelter or B&B accommodation; those living with family and friends, or in a squat. Homelessness may be chronic (lasting more than one year), intermittent or short-term/crisis-related[3]. In November 2015 the Dublin Regional Homeless Executive (DRHE) reported 3,615 adults in emergency accommodation and a minimum of 91 individuals sleeping rough in Dublin [4].

Homelessness is associated with ill-health. Many homeless people have multiple simultaneous chronic conditions, termed multimorbidity [5]. The simultaneous tri-morbidity of physical ill-health, mental ill-health and drug or alcohol misuse is highly prevalent in homeless people[6]. Diseases related to alcohol and/or drug addiction including cirrhosis, infective endocarditis, abscesses, venous ulcers, infection with hepatitis C and HIV are more prevalent in homeless than housed people [7]. In addition, studies from the US and Canada have reported earlier onset in homeless people of frailty and other geriatric syndromes usually seen in older adults [8-10].

Homeless people have been reported to use relatively little primary care [11], and often use the Emergency Department (ED) as their initial point of contact with healthcare. Internationally, homeless people have been reported to attend ED 3-5 times more frequently than housed individuals [12-15]. Rates of inpatient admissions of homeless persons have also been found to be higher [14 16 17] with longer lengths of stay and increased readmission rates [17 18].

We sought to compare the age profile and use of unscheduled ED and inpatient care between housed and homeless individuals in Dublin, Ireland.

.

Methods

Study Setting

We carried out an observational cross-sectional study using data on all ED visits and all unscheduled admissions under the general medical take (internal medicine) in St James's Hospital, Dublin, in 2015. St James's Hospital is a large university teaching hospital serving adults resident in the south inner city in Dublin, Ireland. Patient data is collected on an electronic patient record within the hospital and is also collected in the national Hospital In-Patient Enquiry (HIPE) system, a computerised health information system designed to

capture demographic, administrative and clinical data on all inpatient discharges from publicly funded acute hospitals in Ireland. Diagnoses recorded on the HIPE system are determined by trained coders on examination of patient records.

Data Extraction

All Emergency Department (ED) attendances and unscheduled inpatient stays between the 1st of January and the 31st of December 2015 (inclusive) were extracted from hospital databases. Individuals were identified by a unique identifier (medical record number). Length of stay and outcomes of ED attendances and inpatient admissions were extracted from the hospital patient record.

Patients admitted under any medical specialty participating in the general medical take (internal medicine acute admissions) rota or under Infectious Diseases were defined as medical inpatients. This did not include patients admitted under Geriatrics, Neurology, Nephrology, Oncology, Haematology, Psychiatry or any surgical specialty. Geriatrics, Neurology, Nephrology, Oncology and Haematology were excluded because they do not participate in the unselected internal medical take. Age was defined as the age of the patient on the date of discharge from hospital. Patients without recorded address were excluded.

Operational Definition of Homelessness

Homeless individuals were defined as those with recorded addresses of no fixed abode (NFA) or any emergency accommodation (homeless hostels). Addresses were extracted from the patient record. Addresses are obtained from patients by trained receptionists upon registration in the ED, and are checked at each admission. The names and/or street addresses of homeless hostels were obtained from the Dublin Regional Homeless Authority Case Management website. The address field in the patient record was manually screened to identify addresses corresponding to homeless hostels. In addition, any addresses with more than 2 patients presenting from the same address within the calendar year were scrutinised to identify potential homeless hostels.

To assess the sensitivity of identifying homeless patients based on the address field in the EPR, patients who were referred to the Social Work Department for advice on homelessness were checked against those identified as homeless using the previous method.

Operational Definition of Housed and Homeless Population of Catchment Area

The catchment population of the hospital was obtained from previous publications [19]. The homeless population of Dublin was taken from data collected by the Dublin Regional Homeless Executive[20], and the proportion of those falling within the catchment area of the hospital was estimated by consensus by the authors and by the head of research in the Dublin Regional Homeless Executive.

Data Analysis

Data were analysed using SPSS. Mann-Whitney tests were used to compare differences in age and length of stay between housed and homeless patients. Chi-squared was used to compare categorical data between housed and homeless patients. Spearman's rank correlation co-efficient was used to assess the association between age and LOS in housed and homeless patients.

Results

The catchment population of St James's Hospital, Dublin is reported as 270,000. The homeless population sleeping rough or in emergency accommodation (hereafter referred to as homeless) of the catchment area was estimated as 1,000 individuals, resulting in a prevalence of homelessness of 0.4% of the population of the catchment area.

250 address fields (including no fixed abode (NFA) and numerous homeless hostels as well as multiple spelling variants of the homeless hostels) were identified as homeless addresses and individuals giving these addresses as their current address were defined as homeless.

100 homeless patients were identified from referrals to hospital social workers for advice on homelessness. 72% of these had an address on their electronic patient record that had been identified as homeless.

5 ED attendances and 12 inpatient admissions had no address recorded.

ED Attendances

The demographics of all ED attenders are described in Table 1.

Table 1: Demographics of ED attenders

Number of individuals	31775
Female	15157 (47.7%)
Age (median and range)	44 (13-102)
Age (female, median and range)	45 (13-102)
Age (male, median and range)	43 (13-99)
Age <25	3386 (15.4%)
Age 25-44	7349 (33.6%)
Age 45-64	5205 (23.7%)
Age 65-74	4542 (20.8%)

Age >75	1392 (6.4%)

Table 2: Demographics of Housed and Homeless ED attenders

	Housed	Homeless	
ED attendances (% of total attendances)	44,208 (93.7%)	2,966 (6.3%)	<0.5
Individuals	30,865	909	<0.5
Female	14, 969 (48.5%)	196 (21.6%)	<0.5
ED attendances per capita of catchment population (95%CI)	0.16/person/annum	3.0/person/annum	
Individuals with >=4 presentations per year	592 (90.7%)	57 (9.3%)	<0.5
Individuals with >=12 presentations per year	48 (59%)	34 (41%)	<0.5

Homeless individuals accounted for a disproportionally high number of ED attendances per proportion of the catchment population. 909 (91%) homeless adults out of an estimated 1000 homeless adults in the catchment area presented to the ED over this time period compared to 30,865 (11.4%) of 270,000 housed individuals in the catchment area. The rates of attendance per year were increased in homeless individuals and they accounted for increasing proportions of attenders with >4/year or >12/year attendances to the ED. Homeless ED attenders were predominantly male. (Table 2).

Homeless ED attenders are younger than their housed counterparts

The mean age of homeless ED attendees was 39 (17-76) [95% CI 37.2-40.8], whereas that of housed ED attendees was 45 (16-102) [95% CI 42.1-47.9] (Figure 1). The difference in distribution of age was statistically significant (Mann-Whitney, p=0.000).

Figure 1: Age of housed and homeless ED attenders

Table 3: Outcomes of ED attendances

	Housed (n=44,208)	Homeless (n=2,966)	p-value
Left before seen/against medical advice	6,870 (15.5%)	1,207 (40.7%)	<0.05
Assessed	37,234 (84.5%)	1,759 (59.3%)	<0.05
Deceased	111 (0.3%)	1 (0.1%)	<0.05
Discharged	24,374 (65% of those assessed)	1,221 (69% of those assessed)	<0.05
Admitted	12,749 (35% of those assessed)	537 (31% of those assessed)	<0.05

Homeless ED attenders were much more likely to leave the ED without being assessed or against medical advice (Table 3). Rates of admission to the hospital in those who remained for assessment and management were similar between housed and homeless.

Patient presenting complaints were recorded at triage. These were then ranked in order of frequency in housed and homeless presenters (Table 4). Presentations related to drug and alcohol use and mental health were more common in homeless ED attenders.

Table 4: ED Presenting Complaints

	Housed	Homeless
1	Limb problems (8464, 19.1%)	Limb problems (383, 12.9%)
2	Abdominal pain (4250, 9.6%)	Overdose and poisoning (223, 7.6%)

3	Chest pain (3315, 7.5%)	Apparently drunk (196, 6.6%)
4	Unwell adult (2818, 6.4%)	Unwell adult (184, 6.2%)
5	Shortness of breath (2655, 6%)	Head injury (165, 5.6%)
6	Head injury (1843, 4.2%)	Mental illness (143, 4.8%)
	Back pain (1503, 3.4%)	Collapsed adult (133, 4.5%)
8	Collapsed adult (1396, 3.2%)	Abdominal pain (112, 3.8%)
9	Headache (1199, 2.7%)	Shortness of breath (86, 2.9%)
10	Facial problems (870 2.0%)	Chest pain (85, 2.9%)
Other	15,782 (35.7%)	1, 257 (42.4%)

Acute Medical Admissions

5104 individuals had unscheduled general medical admissions in 2015 (Table 5). Seventy-five percent of admissions were in individuals aged over 45. Homeless individuals demonstrated a greater than ten-fold increase in usage of unscheduled general medical inpatient bed-days per capita of the catchment area compared to housed individuals. (Table 6). In contrast to housed medical inpatients, the majority of homeless medical inpatients were male.

Table 5: Demographics of Unscheduled Medical Admissions

	N
Individuals	5104
Female	2551 (50%)
Age (median, range)	62 (15-102)
Age (female, median and range)	65 (16-102)
Age (male, median and range)	60 (15-99)
Age <25	282 (4%)
Age 25-44	1507 (21.5%)

Age 45-64	1944 (27.7%)
Age 65-84	2444 (34.8%)
Age >85	805 (11.5%)

Table 6: Characteristics of Housed and Homeless Unscheduled Medical Admissions

Medical Admissions	**Housed**	**Homeless**	**p-value**
Inpatient Admissions	6572 (93.4%)	459 (6.5%)	
Individuals	4853	261	
Bed-days	80,629 (93.5%)	4,435 (6.5%)	
Bed-days per capita of catchment population	0.3 bed days/person/annum	4.4 bed days/person/annum	
ITU (intensive care unit) bed-days per capita of catchment population	6573 0.03 bed days/person/annum	443 (6.3%) 0.4 bed days/person/annum	
Mean LOS (range) [95% CI]	12.2 (0-726) [11.5-12.96]	9.41 (0-369) [7.2-11.6]	<0.05
Female	3306 (51.3%)	103 (23.3%)	<0.05
Mean admissions	1.87 (1-11) [1.84-1.91]	2.79 [2.62-2.96]	<0.05
Individuals >4 admissions/year	178	30 (11.5%)	<0.05

The mean age of homeless medical inpatients was 44.19 (95% CI 42.98-45.40), whereas that of housed medical inpatients was 61.20 (95% CI 60.72-61.68) (Figure 2). The distribution of age was significantly different between the two groups (p=0.000, Mann-Whitney) (Figure 3).

Figure 2: Age of unscheduled medical admissions

Figure 3: Bed days by age group

Bed days in patients aged 64 or younger accounted for 33.8% (27,274/80,633) of bed days generated by all housed medical admissions, versus 88.3% (3689/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square). Bed days in patients aged 44 or younger accounted for 10.8%% (8734/80,633) of bed days generated by all housed medical admissions, versus 49.1% (2050/4176) of bed days generated by all homeless medical admissions. This difference was statistically significant (p=0.000, chi-square) (Figure 3).

Use of unscheduled healthcare is age-related in housed, but not homeless people

Increasing age was strongly correlated with LOS in housed medical inpatients (Spearman correlation 0.257 (0.233-0.292, p<0.005), whereas this was not the case in homeless medical inpatient (Spearman correlation -0.034 (-0.222-0.155, p= 0.12)).

The 10 most frequent primary diagnoses for housed and homeless medical inpatients were determined (Table 7). Acute respiratory diagnoses were frequent in both populations. Diagnoses associated with injecting drug use (abscesses, venous thrombo-embolic disease) and hepatitis C and/or alcohol use (hepatic failure, haematemesis) were more common in homeless inpatients. Cardiovascular disease (congestive heart failure and atrial fibrillation) were less common in homeless inpatients.

Table 7: Primary Diagnoses in Unscheduled Medical Admissions

	Housed (n=6572)	**Homeless (n=459)**
1	Acute exacerbation of COPD/asthma 397 (6.0%)	Pneumonia/bronchitis 54 (11.8%)
2	Pneumonia/bronchitis 393 (6.0%)	Seizures 39 (8.5%)
3	Syncope and collapse 268 (4.1%)	Syncope and collapse 26 (5.7%)
4	UTI/Pyelonephritis 265 (4.0%)	Acute exacerbation of COPD/asthma 24 (5.3%)

5	Congestive heart failure 196 (3.0%)	Abscess 23 (5.0%)
6	Cellulitis 152 (2.3%)	Cellulitis 22 (4.8%)
7	Headache 149 (2.3%)	VTE 16 (3.5%)
8	Atrial fibrillation 134 (2.0%)	Haematemesis 15 (3.27%)
9	Seizures 133 (2.0%)	Hepatic failure 10 (2.18%)
10	Chest pain 115 (1.7%)	Alcohol withdrawal 10 (2.18%)

Table 8: Outcome of Admission

	Housed	**Homeless**	**P**
All unscheduled medical admissions	6572	459	
Self-discharge	125 (1.9%)	67 (14.6%)	
Deceased	151 (2.3%)	6 (1.3%)	
Discharged to home/homelessness	6157 (93.7%)	386 (84%)	
Discharge to long-term care	138 (2.1%)	0 (0%)	

A higher proportion of homeless inpatients self-discharged against medical advice (Table 8).

Discussion

Homelessness is a state of extreme socioeconomic deprivation, and is associated with increased morbidity and increased use of unscheduled hospital care (ED visits and admissions). We found that, in Dublin, homeless individuals have a 20-fold increased use of ED and over 10-fold increased use of unscheduled medical inpatient bed da than housed individuals. These findings are similar, although the relative increase is higher in Ireland, to those reported from the US, Canada and the UK [8 13 21-26]

It is important to note a number of key demographic differences between homeless individuals in the US and those in high-income European countries such as Ireland. Homeless populations in the US include a high proportion of veterans and of ethnic minorities. and those in Australia and Canada include a high proportion of individuals reporting themselves as Aboriginal/First Nation[5]. Homeless people in Dublin are predominantly white Irish, with 4% reporting themselves as Irish Traveller [6]. Very few Irish people are combat veterans. Eighty percent of adults in emergency accommodation or rough sleeping in Dublin in January 2016 were 44 years old or younger [4 20], this contrasts with the ageing homeless population reported in the US [27]. In Dublin, homelessness is strongly associated with drug use: up to 70% of homeless individuals report having used illegal drugs with over half reporting injecting drugs [6]. Free primary and secondary healthcare is available to those in the lowest one-third income bracket in Ireland.

In our study, homeless patients were much more likely to leave the ED without being seen (41% vs 16% in housed patients). Patients who leave the ED without being seen have been reported to represent the failure of an emergency care delivery system to meet its goals[28].These rates are similar to those reported by Svoboda et al in Toronto[29] and higher than those reported from London[30]. Anecdotally, some of the homeless individuals who leave without being seen may have simply been seeking shelter for the night in the ED waiting room, with others requiring medical attention leaving due to withdrawal from alcohol and/or opiates and ADHD-related difficulties with waiting. Homeless medical inpatients were also much more likely to self-discharge against medical advice.

Homeless individuals accounted for a grossly disproportionate amount of inpatient bed days relative to their proportion of the catchment population. Cardiovascular presentations (congestive heart failure, atrial fibrillation and chest pain) were less common in homeless than in housed patients, whereas diseases related to alcohol and drug use (abscesses, hepatic failure and haematemesis) were more common in homeless patients. Seizures were also more common in homeless patients, which may result from the increased rate of traumatic brain injury and substance use in this population. Both groups presented frequently with syncope, pneumonia and exacerbation of COPD/asthma. These presentations are common in elderly housed populations, but are seen in homeless patients at a significantly younger age.

We demonstrate a striking difference in the age profile of homeless patients compared to housed patients. The median age of homeless medical inpatients was 20 years younger than that of housed patients. Most bed days generated by homeless patients were in patients less than 65 year of age, which contrasted with the housed population. Of note, we excluded unscheduled and elective admissions to the Geriatric service, which consist solely of housed individuals over 70 years of age. Work by Kushel et al on homeless veterans in the US also reported a younger median age in homeless hospital patients with a five to 16-year difference in median age between homeless and housed veterans presenting with medical conditions [8]. Earlier mortality in homeless people may account for their relative under-representation in older in-patients.

Limitations of this study include that presentations to other hospitals were not captured, and that diagnoses were captured by non-clinician coders. An additional limitation of the study was that identification of homeless patients was based on the address recorded on the patient electronic record, with an estimated under-reporting rate of 30% and an inability to identify those who gave the address of a family member or friend. Estimates of the proportion of the homeless population of Dublin within the catchment area of the hospital are crude, and there is a significant degree of mobility of homeless people within the city. However, the differences in usage of acute unscheduled care are so dramatic that even an underestimation of the homeless population by 100% in our study would result in a homeless population in the catchment area of only 2,000 individuals, and the dramatic increase in use of unscheduled healthcare in homeless individuals compared to housed individuals would remain. Strengths of the study include the large number of patients included and the ability to focus analysis on medical inpatient admissions (thereby excluding psychiatric inpatient admissions).

Conclusion:

Homelessness is associated with ill-health and dramatic decreases in life-expectancy. In this study, we demonstrate that homelessness is also associated with a dramatic increase in the per capita use of costly unscheduled acute healthcare. A failure to address the structural causes of homelessness results in increased costs to society through increased use of healthcare, in addition to social care and opportunity costs. . In contrast to housed patients, the bulk of usage of unscheduled care by homeless people occurs in individuals aged 25-65. Earlier mortality in homeless people may account for their relative under-representation in older in-patients**.** Primary and ambulatory care for homeless people, if aiming to prevent costly inpatient admissions, will need to cater a significantly younger population than services for housed individuals.

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Competing interest statement - All authors have completed the Unified Competing Interest form and declare: support from the Health Research Board, Ireland (HRB) and the Health Services Executive, Ireland (HSE) for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

The lead author, Dr Clíona Ní Cheallaigh, affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

The study was approved by the Joint Research Ethics Committee of St James's Hospital and the Adelaide and Meath Hospital.

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Author Contributions:
CNC: Study design, data collection, data analysis, writing of manuscript
SC, JC: Data collection
JS, JB, JK, CB, RAK, DB: Editing of manuscript
FOR, AOC: Literature search, data collection, editing of manuscript
RS: Statistical advice

Extra data is available by emailing nicheacm@tcd.ie.

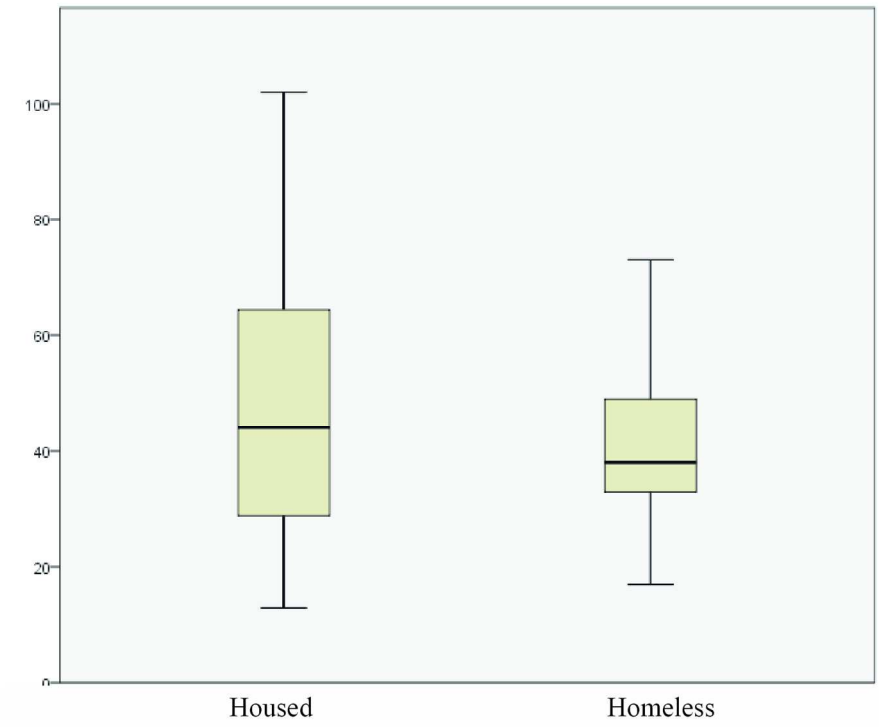

Figure 1

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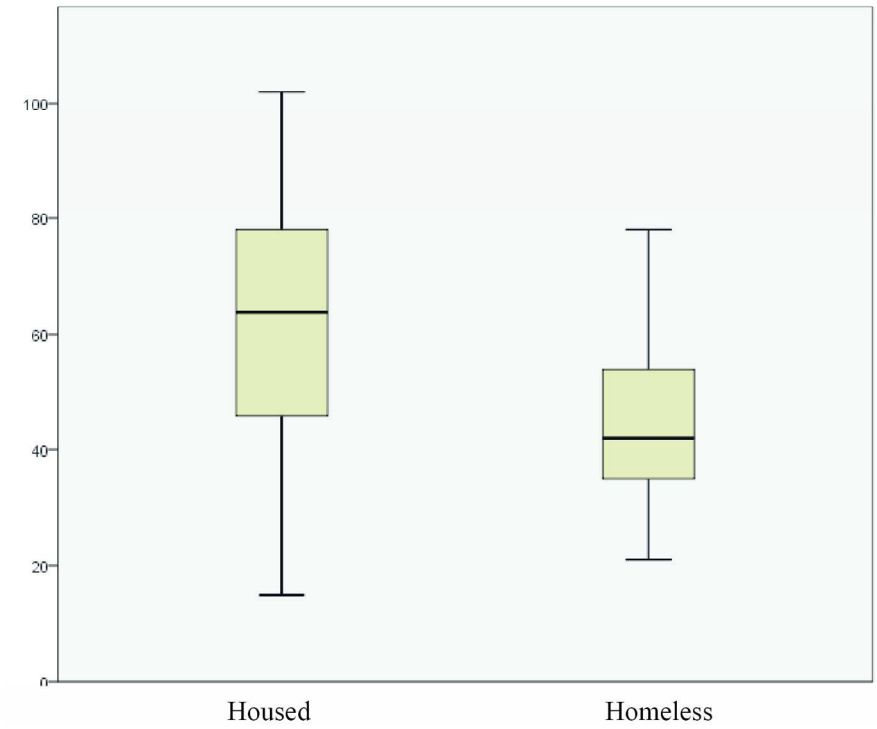

Figure 2

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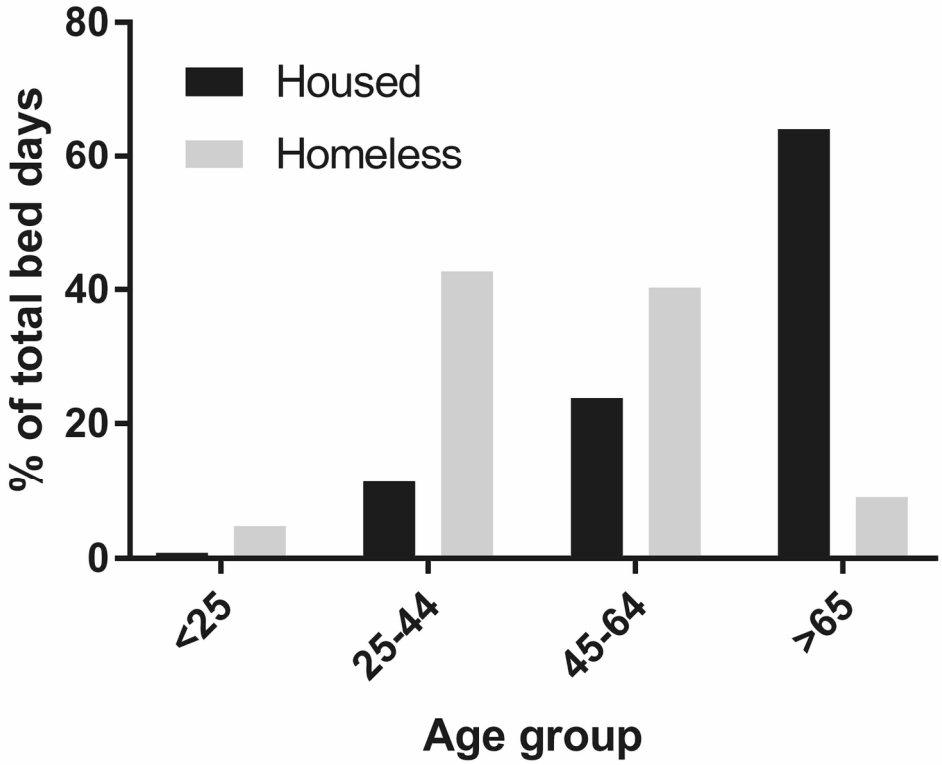

Figure 3

80x68mm (600 x 600 DPI)

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

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

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	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
,Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6,9
		(b) Indicate number of participants with missing data for each variable of interest	6
		(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 x	6-11
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	6-12
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*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	
Discussion			
Key results x	18	Summarise key results with reference to study objectives	13-14
Limitations x	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation x	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability x	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			**16**
Funding x	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	

*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.