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Statistics and Research Agency
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um Staitistící agus Taighde

Drug-related Deaths in Northern Ireland: Socio-Demographic Analyses

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Introduction

Northern Ireland has seen a considerable rise in drug-related deaths (DRDs) in the last two decades despite increased awareness of the harmful consequences of drug misuse. According to the latest official statistics[1], registrations of DRDs in Northern Ireland reached a record high of 189 deaths in 2018. Drug misuse is an important, yet inadequately understood, public health problem in Northern Ireland that can have tragic consequences for families and communities and creates a wider societal cost in terms of premature mortality. There is continued demand (a) for support services to help individuals who are at risk of harm from both illegal and prescription drugs, and (b) on the police/criminal justice system in terms of enforcing relevant legislation[2,3].

The aim of this research is to advance understanding of drug-related deaths in Northern Ireland, over and above regularly published official statistics. The key objectives are:

- to examine recent trends in drug-related mortality;
- to ascertain the socio-demographic profile of drug-related mortality; and
- to determine the associations of socio-demographic, health and area characteristics with drug-related mortality in the Northern Ireland population.

The study aims to inform the development and evaluation of current and future public health policies and interventions, including preventive strategies in response to drug-related harm. Information on methods and definitions is included in Section 2 and Annex 2.

Section 1 contextualises the issue using the National Statistics on DRDs produced by the Northern Ireland Statistics & Research Agency (NISRA)[1]. It examines trends in mortality rates and assesses how mortality is distributed by age, sex, area and by recorded drug substances. Section 2 uses a linked research dataset, the Northern Ireland Mortality Study[4] (NIMS), to examine how socio-demographic, health and area factors influence drug-related mortality.

Key Findings

- The Age Standardised Rate for drug-related deaths (DRDs) for persons aged 10-64 years was 13.7 (per 100,000) in 2018 compared to 2.6 (per 100,000) in 2001.
- Over the last 15 years, the greatest increases in DRDs occurred in males aged 25-44.
- In 2018, over 73% of DRDs involved two or more substances.
- A high proportion of DRDs (61% in 2018) involve opioids (including heroin/morphine and tramadol) and benzodiazepines (51% in 2018) and this has increased over time. However, a considerable proportion of DRDs in 2017 (29%) and 2018 (31%) involved pregabalin/gabapentin.
- There is a notable geographic variation with higher mortality rates in Belfast (14.2 per 100,000) compared to other Local Government Districts. In Greater Belfast, there is a two-fold greater risk of DRD in the most deprived areas compared to the least deprived areas.
- Drug deaths are observed across a range of socio-economic groups, however, after taking account of other factors, those most at-risk are younger age groups, males, those living alone, those with lower educational attainment and the economically inactive.
- After examining area deprivation, socio-demographic and health factors, there is an excess risk (21%) of DRD in Greater Belfast compared to the rest of Northern Ireland.
- Drug misuse is strongly linked with co-occurring mental health problems and long term illness.

1

Mortality Trends and Breakdowns Drug-related Deaths in Northern Ireland[A]

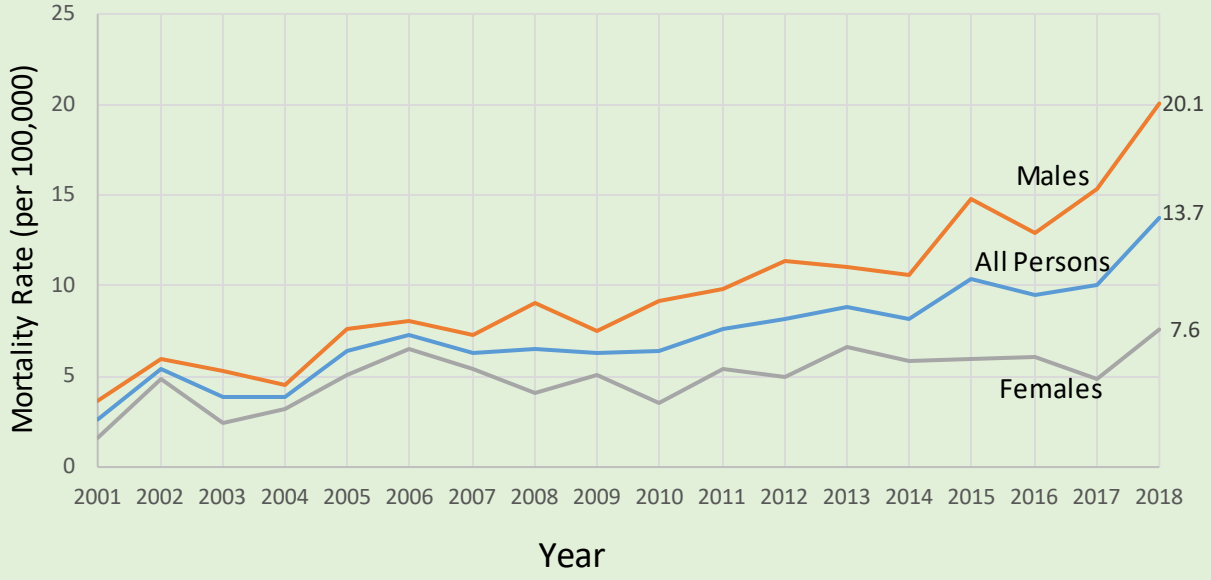
According to official statistics[1] there has been a general upward trend in the number of drug-related deaths (DRDs) in Northern Ireland. Figure 1 shows European Age-Standardised Rates[5] (EASR) for drug-related mortality in Northern Ireland, by sex, for each year 2001-2018, for persons aged 10-64 years. A lower cut-off age of 10 years was chosen, as the risk of starting to use drugs is largely found in adolescence and young adult years. Males accounted for 70.4% of the drug-related deaths in 2018. Over the last two decades, increases in death rates have occurred for both sexes but have been more marked in males.

EASRs for DRDs registered in Northern Ireland (per 100,000 population) for ages 10-64 years were:

- 13.7 in 2018 for Northern Ireland overall, compared with 2.6 in 2001;
- 20.1 in 2018 for males, compared to 3.7 in 2001; and
- 7.6 in 2018 for females, compared to 1.6 in 2001.

In 2018, DRDs accounted for 22.6% of all male deaths under the age of 45 and 12.1% of all deaths of females under the age of 45 (not shown).

Figure 1: Age-standardised Mortality Rates for Drug-related Deaths 2001-2018 (10-64 years)



Age standardization is a method to control for different age distributions among populations or over time. The EASR is the rate that would have been found if the population of Northern Ireland had the same age composition (proportion of total population in each five year age class) as a hypothetical European population, known as the European Standard Population (ESP)[5].

[A] Official deaths data published by NISRA are counted on the basis of the calendar year in which the death is registered rather than the year of occurrence.

A UK Comparison of Drug Related Deaths

Scotland has had the highest drug-related mortality rate in the UK since the time series began in 2001, while relatively similar rates have been observed in England, Wales and Northern Ireland over the last two decades (Figure 2). It is noteworthy that there is considerable geographic variation within countries, e.g. higher mortality rates are observed in the North of England compared to the South[6].

Figure 2: Age-standardised Mortality Rates for Drug-related Deaths 2001-2018 (10-64 years)

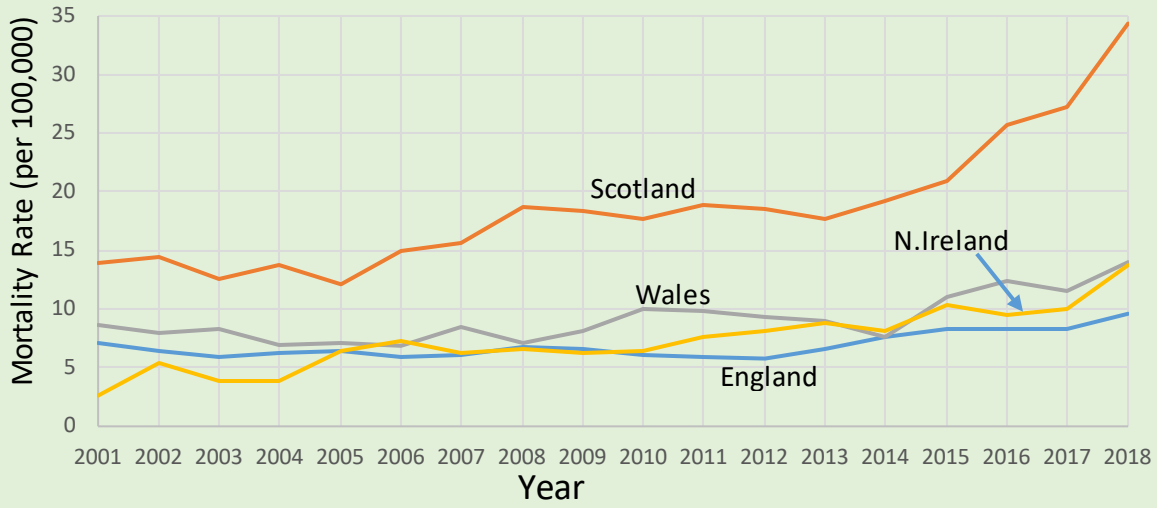
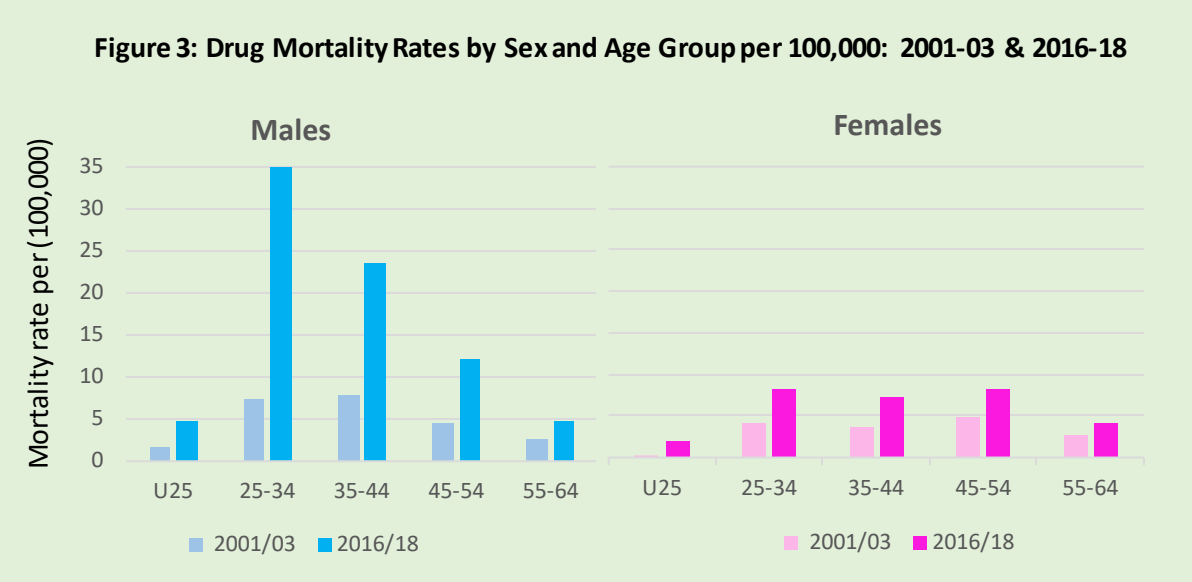


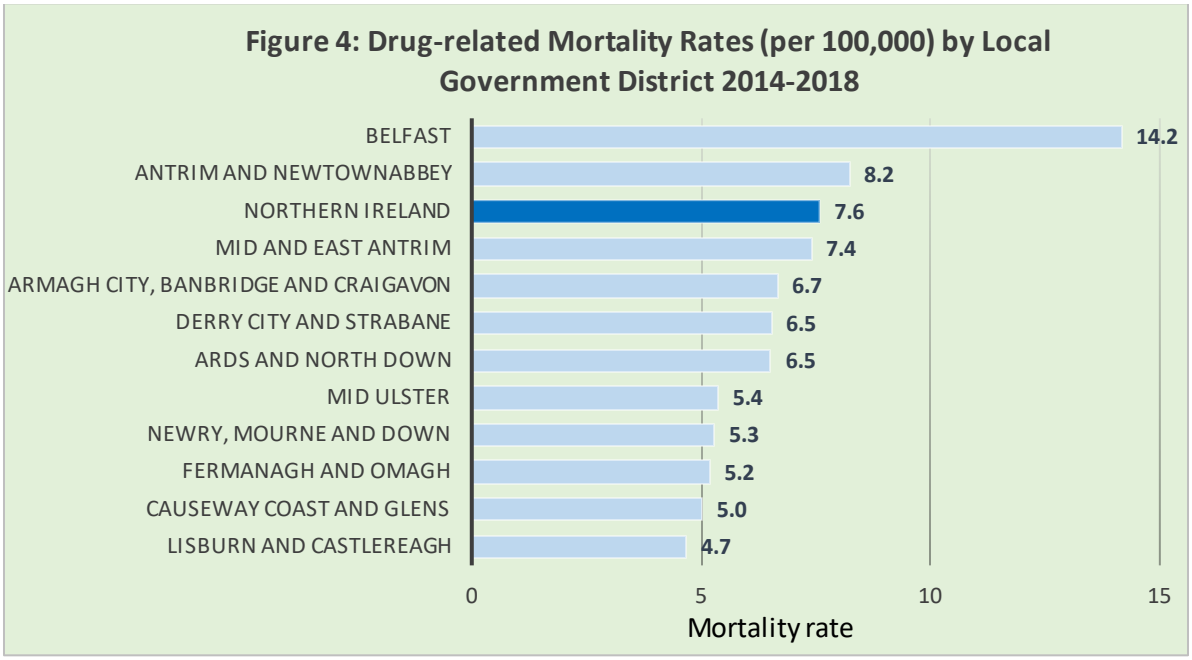
Figure 3 compares age-specific rates by age group for 2001-03[B] and 2016-18. For males, increases in mortality rates were observed between the two periods for all age groups. Nearly a five-fold increase was observed among 25-34 year olds males to become the group with the highest rate in Northern Ireland (35.0 deaths per 100,000 in 2016-18). For females, increases in mortality rates were also observed for all age groups and in 2016-18 the highest rates were observed in both the 25-34 and 45-54 age groups (8.3 deaths per 100,000).

[B] For some sex specific age-groups, the number of deaths is too small to report a rate with reliability; therefore, rates are based on three years of registrations data rather than single registration years.



Geographical Variation

There are notable regional differences in drug-related mortality rates within Northern Ireland (Figure 4), with Belfast Local Government District[7] recording the highest rate of 14.2 (per 100,000), followed by Antrim and Newtownabbey LGD at 8.2 (per 100,000). Lisburn and Castlereagh LGD had the lowest drug-related mortality rate of 4.7 (per 100,000).



Drugs/ Drug Groups Mentioned on Death Certificate

There is an escalating problem of polydrug use, evidenced by a growing proportion of cases each year where multiple drugs are present in the body at the time of death (Figure 5). In 2018, the majority (73%) of DRDs involved the presence of two or more substances while the proportion of DRDs with three or more drugs present in the body at the time of death increased from 25% in 2008 to 50% and 51% in 2016 and 2018 respectively. In 2018, proportions of DRDs involving three or more drugs were the same for males and females (both 51% - not shown).

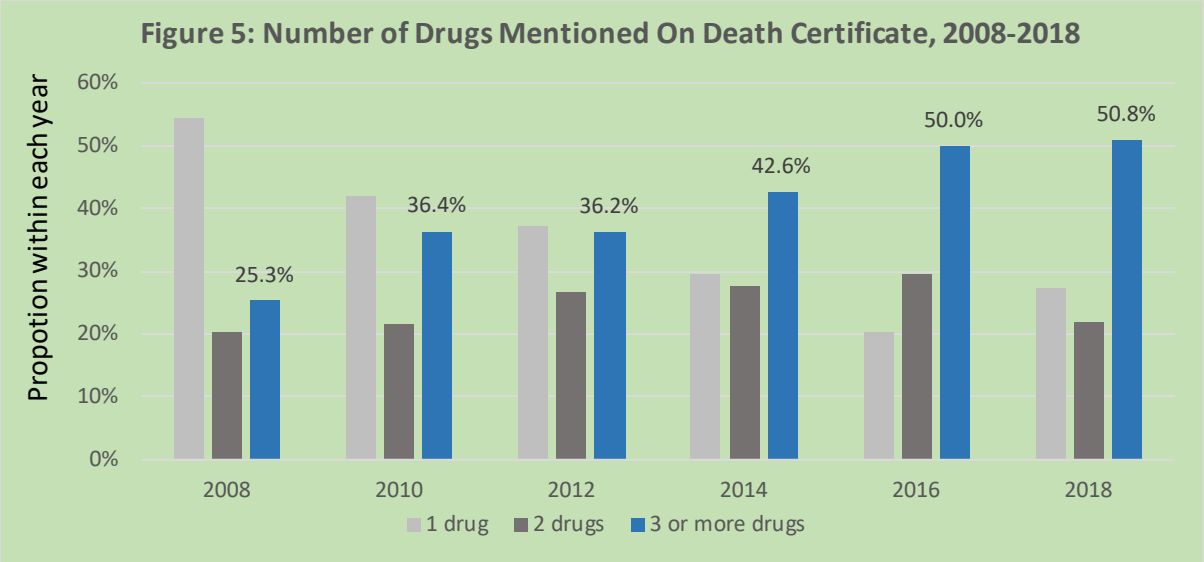
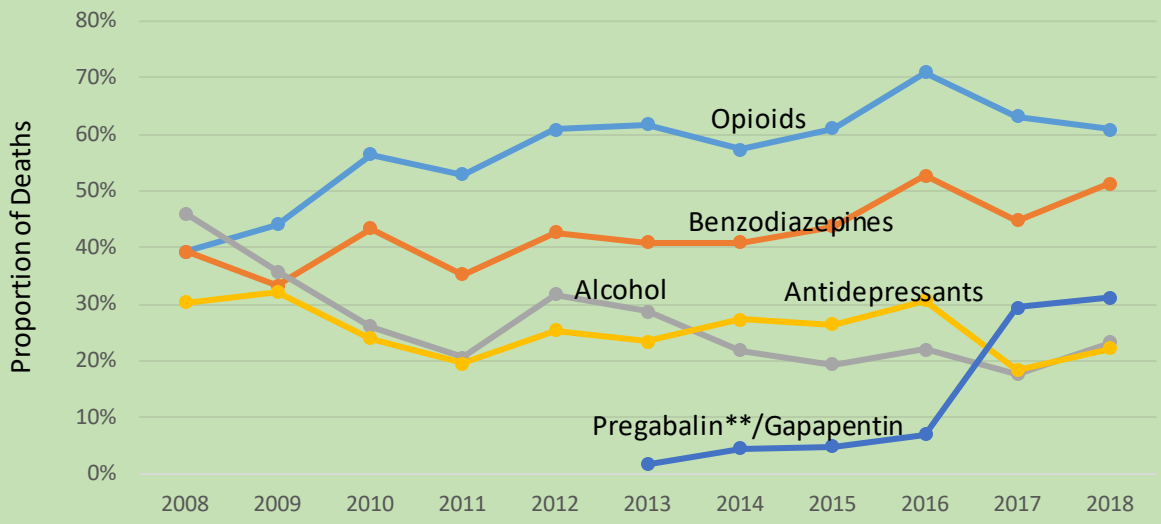


Figure 6 shows trends in specific drug groups mentioned on the death certificate. Between 2008 and 2018, there were marked increases in the proportion of DRDs mentioning opioids (39.3% → 60.8%) and benzodiazepines (39.3% → 51.3%). In 2018, the most commonly reported opioids mentioned[1] in DRDs were heroin/morphine (21.2%) and tramadol (14.3%).

Mention of alcohol in DRDs fell between 2008 (46.1%) and 2018 (23.3%). Over the same period the percentage of DRDs which involved antidepressants ranged between 18.4% and 32.1%. In recent years there has been a considerable increase in DRDs involving the pharmaceutical drugs pregabalin[C] and gabapentin: in 2018, pregabalin/gabapentin was present in 31.2% of DRDs.

[C] Anti-epileptic medication used in the treatment for epilepsy, anxiety and nerve pain.

Figure 6: Selected Drug Groups* Mentioned in DRDs, 2008-2018



*More than one drug group may be reported per death. Proportions are based on mentions of each grouping, and should not be added. ** Pregabalin was first identified in NI drug-related deaths recording in 2013.

This section has examined trends in DRDs in recent years and shows the variation in deaths by age, sex and by area. There is an established social gradient in health in Northern Ireland; lower socio-economic groups are more likely to experience poor health outcomes and die prematurely than those who are more advantaged[8]. Research quantifying the relationship between socio-economic status and drug-related mortality is much less prevalent and typically based on single socio-economic indicators (e.g. age, sex and area deprivation). However, little is known about the relationship between DRDs and other socio-economic parameters such as educational status, housing tenure and living arrangements, as these data are not typically collected in routine monitoring systems. This will be examined in Section 2.

2 Assessing Socio-demographic Associations of Drug-Related Mortality

The primary goal of this section is to determine the associations of socio-demographic, health and area characteristics with drug-related mortality in the Northern Ireland population. To achieve this goal, a research dataset linking the 2011 Census of Population to deaths registered between 2011 and 2017 (the Northern Ireland Mortality Study) was examined to provide further insight. Descriptive statistics of the research dataset are presented as well as modelling findings.

Design and Setting

Analyses were undertaken using the Northern Ireland Mortality Study (NIMS[4]), a large-scale research dataset linking 2011 Census data to subsequent registered deaths from March 2011 to December 2017. The Office for Research Ethics Committees Northern Ireland (ORECNI[9]) has ratified the usage of NIMS for approved research. The NIMS dataset was accessed in the NISRA safe setting and records were rendered anonymous for analyses purposes.

The study population comprised persons aged 10-64 years, enumerated in the Census on 27 March 2011, linked to deaths registered in Northern Ireland up until December 2017 (a follow-up period of 6.75 years). The selected age range was informed by the age distribution of DRDs. Individuals living in communal establishments, including homeless hostels, hospitals and prisons, were excluded due to missing information at the household level. The study population for analyses consisted of 1.09 million records, of which 533 had died of drug-related causes by the end of the study period. This represented 65% (533 out of 816[D]) of all DRDs that occurred during this period.

Study variables

The definition of DRD used in the NIMS-based analyses included all deaths that were directly (main cause of death was drug-related ~ 91%) and indirectly (contributory cause of death was drug-related ~9%) drug-related. This definition was chosen to capture the wider burden of drug usage on mortality. Codes from the International Classification of Diseases (10th Revision, ICD-10 codes), used in UK Official Statistics, was the basis of identifying drug-related deaths. Data on socio-demographic characteristics at baseline originated from Census 2011. Annex 2 provides further details on definitions and study variables.

Area Deprivation Quintile

An indicator based on the official Northern Ireland Multiple Deprivation Measure[10] (NIMDM 2010 – see Annex 2 for further detail) was included in the analyses as a measure of area disadvantage. The deprivation measure identifies seven separate domains of deprivation and an overall summary measure. The income domain was used to assign individuals to one

[D] Total DRDs occurring during the period received from NISRA Vital Statistics Unit – see Annex 3 for additional information

of five equal groups (or quintiles), ranging from most deprived to least deprived, based on their usual address of residence.

Descriptive Analyses

The study population for analyses comprised 1,089,205 individuals aged 10-64 years at the time of Census 2011. Within this group, 533 people were identified as having died from a DRD by December 2017. Data on socio-demographic, household and area factors of those who died of a DRD can provide useful insights into risk factors of drug-related mortality. Table 1 provides a descriptive summary of the individual, household and area level variables among the study population (NI population) at baseline compared with those who died from a DRD during the follow up period of the study. Using official mortality data, weighted proportions (Annex 3) were generated for DRDs to take account of under-representation of deaths for sex-specific age groups during the study period (April 2011 – December 2017). It found that:

- DRDs were over-represented for males (70.1% of DRDs were males compared with 48.8% of males in the NI population) and for persons aged 25-34 years (31.1% of DRDs compared with 20.7% of this age group in the NI population).

- People with no qualifications (44.3% of DRDs compared with 21.4% of the NI population) and the economically inactive (54.3% compared with 20.5% of the NI population) were more likely to die from drug related causes.

- Higher proportions of DRDs were evident in those that indicated a mental illness (39.7% versus 7.7%) and a limiting illness (52.2% versus 17.1%).

- In terms of household characteristics, there was a higher prevalence of DRDs compared to the NI population for those living alone (34.2% versus 10.6%), those in social rented accommodation (39.5% versus 12.8%) and for those that indicated no household access to a car (46.3% versus 13.8%).

- Higher proportions of DRDs were evident for those that lived in urban areas (82.3% versus 63.5%) for residents of Greater Belfast Local Government District (45.3% versus 33.8%) and for individuals living in the top 20% of deprived areas (39.1% versus 19.1%).

The socio-demographic characteristics of those who have died from a drug-related cause, for persons residing in Greater Belfast and in the rest of NI, were broadly similar (Annex 4). However, there was a notable difference for area deprivation. Over a half (51.0%) of all DRDs in Greater Belfast occurred for people residing in the top 20% of deprived areas compared with 28.4% of deaths in the rest of Northern Ireland. This is only partly due to a higher concentration of the most deprived areas in Greater Belfast (26.5%) compared to the rest of Northern Ireland (15.3%). However, it is worth noting that rural areas are larger and more diverse than urban areas; the main area deprivation measure (NIMDM) in Northern Ireland could be a better indicator of deprivation in urban areas than rural areas[11].

Table 1 Distribution of Socio-demographic and Health Determinants of the (i) Study Population and (ii) Among those who Died of a Drug-related Cause, Ages 10-64 Years

			(i) Study Population (%) *(n=1,089,205)*	*(ii) Weighted[E] DRDs (%)* *(n=533)*
Demographic	Sex	Male	48.8	70.1
		Female	51.2	29.9
	Age	10-24	18.4	14.0
		25-34	20.7	31.1
		35-44	21.8	26.4
		45-54	21.9	19.7
		55-64	17.2	8.8
	Religious Affiliation	Catholic	45.8	46.3
		Protestant	48.5	46.7
		Other/none/unknown	5.7	7.0
Individual level	Marital Status	Single	40.8	60.5
		Married	47.3	17.1
		Separated/divorced/widowed	11.9	22.4
	Educational Attainment	Degree level or higher	26.1	9.3
		School level or other (intermediate[F])	52.5	46.4
		No qualifications	21.4	44.3
	Economic Activity	Employed	64.0	30.9
		Unemployed	5.5	10.3
		Student	10.1	4.5
		Inactive	20.5	54.3
	Mental Health	No	92.3	60.3
		Yes	7.7	39.7
	Limiting Illness	No	82.9	47.8
		Yes	17.1	52.2
Household and Area Level	Living Arrangements	Living in couple	53.5	22.0
		Living alone	10.6	34.2
		Other[G]	35.9	43.9
	Housing Tenure	Owner occupied	73.2	41.2
		Private rental	14.1	19.3
		Social rental	12.8	39.5
	Number of Cars[H]	None	13.8	46.3
		1	33.5	35.0
		2 or more	52.8	18.8
	Local Government District[I]	Greater Belfast	33.8	45.3
		Rest of Northern Ireland	64.2	54.7
	Urban Residence[J]	Urban	63.5	82.3
		Rural	36.5	17.7
	Area Deprivation[K]	Quintile 1 (Most deprived)	19.1	39.1
		Quintile 2	20.1	24.0
		Quintile 3	20.5	16.5
		Quintile 4	21.1	12.9
		Quintile 5 (Least deprived)	19.2	7.5

[E] Weighted by age and sex to take account of under-representation of DRDs in the research dataset (Annex 3).
[F] School level qualification or other vocational qualification or apprenticeship.
[G] Includes for example, cohabiting individuals who are not part of a couple, for example siblings, unrelated individuals who may be friends/flatmates.
[H] A proxy for Income.
[I] Greater Belfast encompasses Belfast, Antrim & Newtownabbey and Lisburn & Castlereagh Local Government Districts[7].
[J] Based on official NISRA settlement report[12].
[K] Derived from the Multiple Deprivation Measure (NIMDM 2010[10]).

Assessing the impact of Individual, Household and Area Factors on Drug-related Deaths - Regression Analyses

Cox regression (proportional hazards regression) methods[13], a standard approach for analysing NIMS data, were used to estimate the risk of mortality from a drug-related cause. The main advantage of regression models is their ability to assess the effect of several variables on an outcome simultaneously. An initial analysis examined the impact of each individual predictor variable, adjusted for age and sex[L]. Weaker predictor variables (p>.05) were then removed and the model was rerun (Model 1).

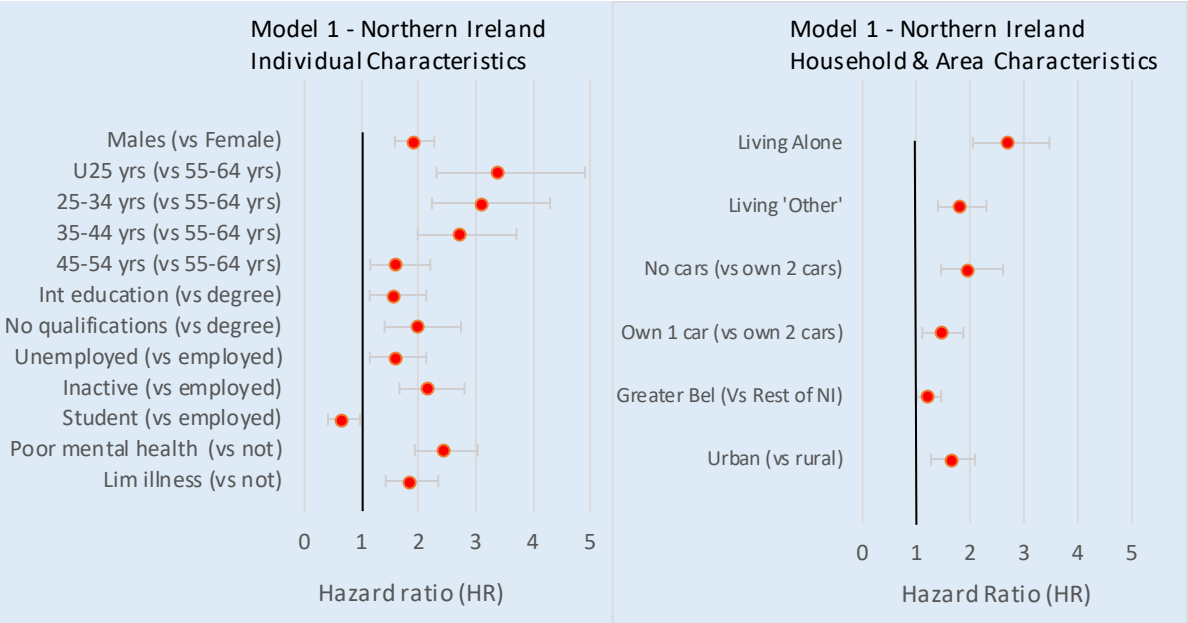
Results

Significant predictors from Model 1 are summarised in Figure 7 with full results presented in tabular form in Table 5 (Annex 5). For Northern Ireland overall, after adjusting for all predictor variables in the model:

- Males had nearly a two-fold greater likelihood of dying from a drug-related cause compared with females.
- The highest hazard ratios (HR) for DRDs were evident in the youngest age groups (HR: 3.4 times, 3.1 times and 2.7 times greater risk in under 25 years, 25-34 and 35-44 years respectively, all compared with the 55-64 age band).
- Compared with having a degree level education, there was a 60% increased risk of DRD for those with intermediate level education with two times greater risk (HR: 2.0) for those with no educational qualifications.
- Relative to being in employment, being economically inactive (HR: 2.2 times) and being unemployed (HR: 1.6 times) increased the likelihood of DRD and being a student reduced the likelihood of DRD by 37%.
- An indication of self-reported mental health (HR: 2.4 times) and of limiting illness (HR: 1.8 times) increased the likelihood of DRD.
- There was a two-fold (HR: 2.7) increased risk of DRD for those living alone (compared with living in a couple).
- Having no access to a car had a two-fold risk of DRD (compared with having two or more cars) while having access to one car had a 44% greater likelihood of DRD (compared with two or more cars).
- Urban residence (compared to rural residence) indicated a 60% greater likelihood of a DRD while residing in Greater Belfast (compared to residing outside of Greater Belfast) increased the likelihood of a DRD by 21%.

[L] Religious affiliation was not significant (P>0.5) in models adjusted for age and sex (not shown) and therefore omitted from subsequent analyses.

Figure 7 Cox Proportional Hazards (95% Confidence Intervals*) for Drug-related Mortality, Aged 10-64 Years, Fully Adjusted Hazard Ratios – All Northern Ireland Residents (Model 1)



Int Education – Intermediate Education. Lim illness = Limiting Illness
*Confidence Intervals that do not cross 1 are statistically significant

The hazard ratio (HR) is a likelihood ratio from the Cox proportional hazards modelling. The other categories of the variable are compared against the reference category to derive the hazard ratio(s). The reference category is typically selected as being the category with the lowest proportion of DRDs and will always have a HR of 1.

- A HR of 1 for the comparison group indicates no difference between the reference category and the comparison group.
- A HR of greater than 1 indicates that the comparison group is more likely to experience a drug-related death compared to the reference group.
- A HR of less than 1 indicates that the comparison group is less likely to experience a drug-related death compared to the reference group.
- Confidence intervals that do not cross 1 are statistically significant.

Variation in DRD by Area

Section 1 (Figure 4) demonstrated the variation in DRD rates across Local Government Districts. Results from Model 1 also indicated variation in DRDs by area with a higher likelihood of DRD evident in Greater Belfast. To explore this further, results from Model 1 informed a stepwise[14] modelling approach to incrementally assess the influence of individual, household and area factors on DRDs. Separate geography variables were analysed for (i) Greater Belfast Local Government Districts and for (ii) Belfast Local Government District.

For Greater Belfast, the unadjusted model (that is, no other factors are taken into account when looking at the relationship between area and likelihood of dying) indicated a 62% greater likelihood of a DRD compared to the rest of Northern Ireland (Table 2). Adjusting for age and sex had no impact on the likelihood of mortality. After adjusting for educational attainment, economic activity, living alone and household access to a car (a proxy for income) a 37% greater likelihood of a drug-related death in Greater Belfast was evident. After adjusting for all remaining area based and health indicators, residence in Greater Belfast had a 21% excess risk of DRD compared to residence in all other areas of Northern Ireland.

The area effect for Belfast Local Government District was similar; the unadjusted model indicated a 2-fold greater likelihood of a drug-related death. Again, adjusting for age and sex had no impact on the likelihood of mortality. After adjusting for educational attainment, economic activity, living alone and household access, a 32% greater likelihood of a drug-related death in Belfast was evident. After adjusting for all remaining area based and health factors, residence in Belfast had a 23% excess risk of DRD compared to living in all other areas of Northern Ireland.

Table 2 Cox Proportional Hazards (95% Confidence Intervals) for Drug-Related Mortality in Persons Aged 10-64 Years, Incremental Adjustment for Individual and Household Factors for (i) Greater Belfast LGD and (ii) Belfast LGD

	Unadjusted	+ Age + Sex	+ Educational attainment + Economic Activity	+ Living Alone + Household access to cars	+ Area deprivation +Urban[M] residence	+ Mental Health + limiting Illness
(i) Greater Belfast[N]	**1.62** (1.36, 1.92)	**1.62** (1.36, 1.92)	**1.66** (1.40, 1.97)	**1.37** (1.15, 1.63)	**1.23** (1.02, 1.48)	**1.21** (1.01, 1.46)
(ii) Belfast LGD	**2.00** (1.66, 2.40)	**2.00** (1.66, 2.40)	**1.75** (1.45, 2.10)	**1.32** (1.09, 1.59)	**1.24** (1.03, 1.54)	**1.23** (1.01, 1.50)

[M] Urban residence was not examined for part (ii) as the Belfast LGD area is predominately urban (95%).
[N] A geographical area encompassing Belfast, Antrim & Newtownabbey and Lisburn & Castlereagh Local Government Districts.

Assessing Variation in DRDs in Greater Belfast

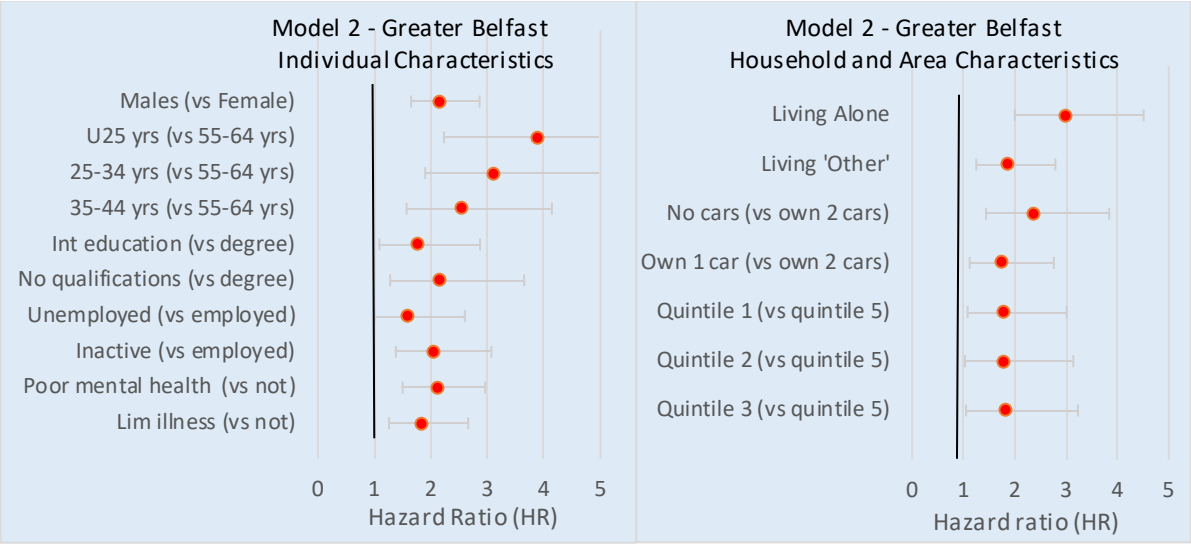
To further examine area based differences in DRDs, a separate model was run for residents in Greater Belfast (Model 2). The model provides an understanding of the extent to which the variation in drug deaths can be explained by differences in the individual, household and area level characteristics of people living in Greater Belfast.

(i) Model 2 - Greater Belfast

After adjusting for all predictor variables in the model, results for Greater Belfast were broadly similar to the Northern Ireland (NI) model (Figure 7), however, there were some differences:

- Compared to females, males had a greater likelihood of dying in Greater Belfast (HR: 2.2) compared to NI overall (HR: 1.9);
- Compared to persons aged 55-64 years, there was a greater likelihood of DRD in persons under 25 years in Greater Belfast (HR: 3.9) compared to NI overall (HR: 3.4);
- An indication of self-reported mental illness had a decreased likelihood of DRD in greater Belfast (HR: 2.1) compared to NI overall (HR: 2.4);
- Relative to living in a couple, living alone increased the likelihood of DRD in Greater Belfast (HR: 3.0) in comparison with NI overall (HR: 2.7);
- Having no access to a car (compared with having two or more cars) had a greater risk of DRD in Greater Belfast (HR: 2.4) compared to NI overall (HR: 2.0)[O]; and
- An area deprivation effect was observed for Greater Belfast with approximately an 80% greater risk of DRD evident in each of the three most deprived quintiles (compared with living in the least deprived quintile).

Figure 8 Cox Proportional Hazards (95% Confidence Intervals*) for Drug-related Mortality, Aged 10-64 Years, Fully Adjusted Hazard Ratios – Greater Belfast (Model 2)



Int Education – Intermediate Education. Lim illness = Limiting Illness
*Confidence Intervals that do not cross 1 are statistically significant

[O] Households in Greater Belfast, a predominately urban area, are less likely to need access to a car compared with those living in Northern Ireland overall.

A further model was run for residents in the 'Rest of Northern Ireland' (Model 3) (see Annex 6). Overall, results were similar to Greater Belfast, however, area deprivation was not a significant predictor of DRD in the 'Rest of NI model' when other predictor variables were examined. For the rest of NI however, there was evidence of urban-rural differences. Living in an urban area (compared to living in a rural area) increased the likelihood of DRD by 70%. Unlike the greater Belfast model, social renting (compared to owner occupancy) was a significant predictor for the rest of NI and had a 50% increased likelihood of a DRD.

Conclusion

Drug-related deaths (DRDs) in Northern Ireland have more than doubled in the last ten years, particularly for younger males, with almost a fifth of all deaths of males under the age of 45 being attributable to drug-related causes. The majority of drug deaths mentioned two or more substances and increases in recent years have been associated with increasing involvement of opioids and benzodiazepines. The proportion of deaths mentioning the pharmaceutical drugs, pregabalin and gabapentin has increased substantially in Northern Ireland in recent years. Figures published by the Office for National Statistics indicated that of all DRDs in England and Wales that mentioned pregabalin or gabapentin, 85% also included mention of an opioid-related drug[15].

The production of high level official statistics is vital to inform patterns and trends in DRDs. Research utilising linked administrative data provides additional insight to routinely published figures and can identify indicators of socio-economic disadvantage that are strongly associated with the risk of drug-related death. The findings of this study illustrate associations between socio-economic disadvantage and drug-related deaths at both the individual, household and area level. No single variable can be viewed as the best indicator for socio-economic status, however, these results have demonstrated large differences between subgroups across a range of socio-economic measures. After simultaneously examining a range of factors, individual level (e.g. low educational attainment and economic activity) and household level (e.g. living alone and no access to a car (a proxy for income)) factors were associated with excess risk of drug-related death.

DRD rates also varied by area and higher rates of DRD in Greater Belfast can be explained in part by increased risk of death due to the influence of area deprivation. However, our results demonstrate that there is a potential 'Belfast effect', where higher levels of drug-related mortality are evident beyond that explained by area deprivation, socio-economic disparities and health related factors. Higher rates of mortality have been shown in other UK cities, e.g. Glasgow[16], after taking into account differences in the main influences on poor health including poverty and deprivation. There may be a number of unmeasured factors, not included in our analyses that are important to DRDs including levels of drug availability and family related[17] risk factors.

Over two fifths (125 out of 307; 41% in 2018) of all suicides (including deaths of undetermined intent) in Northern Ireland are due to drug-related causes. We found that mental health and

limiting illness were strongly associated with DRD. However, the direction of the relationship is unclear, in particular for mental health, as drug usage can contribute to later onset of depressive symptoms while individuals with mental illness have a known increased risk of problematic substance misuse. In some cases, drugs are used as a method of overdose even if there is no history of drug misuse[18]. Other social factors including loneliness and poverty can also play a role in the interplay between mental illness and substance misuse[19].

Evidence-based prevention and intervention programmes are central to public health approaches to tackling drugs misuse in a co-ordinated and sustained fashion. Reducing the harmful consequences of substance misuse through prevention of harm has been central to the Northern Ireland New Strategic Direction for Alcohol and Drugs Phase 2[20], and the publication of a successor strategy is outlined as a priority for the NI Executive in the 'New Decade, New Approach' deal[21].

People experiencing socio-economic disadvantage often experience poorer health outcomes, and higher rates of preventable death. Reducing inequalities and addressing high levels of economic inactivity, poverty and social disadvantage are central to the Programme for Government in Northern Ireland[22] which sets out to achieve positive outcomes and life chances for the people of Northern Ireland.

Study Strengths and Limitations

This study has several **strengths:** It used high quality data from a large cohort study linked to deaths registrations, allowing a robust examination of sub-populations and geographical variability in relation to drug-related deaths in Northern Ireland. The study is longitudinal and based on the general population, therefore results reflect population level impact and social differentials in drug-related mortality. The analyses incorporates adolescents aged 10-16 years, a key demographic group in relation to exposure to risky behaviours and not typically captured in population level mortality studies. Area-based results can be used to direct harm reduction interventions towards areas or individuals at risk.

This study has a few **limitations:** Firstly, there were an insufficient number of deaths to undertake sex-based analyses below population level and the study did not take into account any changes in socio-economic and health related factors after Census 2011. In the UK it is standard procedure to include both 'self-harm' and 'events of undetermined intent' as suicide. This 'undetermined intent' element makes it difficult to distinguish clearly between DRDs that were intentional suicides and those that were accidental drug overdoses[23]. The coverage of drug-related deaths over the study period is 65% and individuals living in communal establishments including hospitals, homeless hostels and prisons were excluded. Study results are therefore likely to underestimate the role of socio-economic determinants as hard-to-reach groups may have been excluded. Planned future research will examine the risk of mortality in the offending population in Northern Ireland. Despite these limitations, the results extend our understanding of drug-related mortality risk in the Northern Ireland population.

Scope for future analyses

Drug usage is an under-researched area in Northern Ireland. To provide further analyses and insight, a 'deep dive' into Coroners' records on a sample of drugs misuse deaths may help address knowledge gaps including accessing and assessing data on circumstances of deaths, substance misuse history, the role of prescription drugs and patterns of multiple drug usage. Cross-sectional surveys and longitudinal studies[24] are important to provide reliable and recent data into patterns of drug usage and to examine the social stigma of drug addiction in Northern Ireland. There are further record linkage opportunities for researching drug outcomes in Northern Ireland involving data on hospital admissions, prescriptions, offending, and social security benefits. Drug-related deaths in Northern Ireland are at the highest ever recorded levels[1]. This paper quantifies the socio-economic determinants of DRDs in Northern Ireland and should assist policy makers in their ongoing development and targeting of drug misuse prevention strategies.

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About ADR UK[27] and ADR-NI

ADR UK (Administrative Data Research UK) is a partnership transforming the way researchers access the UK's wealth of public sector data, to enable better informed policy decisions that improve people's lives. ADR UK is made up of three national partnerships (ADR Scotland, ADR Wales, and ADR NI) and the Office for National Statistics (ONS). It is funded by the Economic & Social Research Council which is part of the UK Research and Innovation.

Administrative Data Research Northern Ireland (ADR NI) is a partnership between the Administrative Data Research Centre Northern Ireland (ADRC NI, comprising Queen's University Belfast and Ulster University), and the Northern Ireland Statistics and Research Agency (NISRA). Together they support the acquisition, linking and analysis of administrative data sets, developing cutting-edge research to improve knowledge, policymaking and public service delivery.

Feedback: Your comments and suggestions are welcome and will assist ADR NI in continuously developing research outputs. Please send your comments to:

John.Hughes@nisra.gov.uk or Jos.IJpelaar@nisra.gov.uk

Annex 1 References

1. https://www.nisra.gov.uk/statistics/cause-death/drug-related-deaths
2. https://www.psni.police.uk/crime/drugs/controlled-drugs-and-the-law/
3. http://www.legislation.gov.uk/ukpga/2016/2/contents/enacted/data.htm
4. https://www.nisra.gov.uk/support/research-support/northern-ireland-longitudinal-study-nils
5. https://ec.europa.eu/eurostat/documents/3859598/5926869/KS-RA-13-028-EN.PDF
6. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsrelatedtodrugpoisoninginenglandandwales/2017registrations
7. https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/11DC_Guidance_1_0.pdf
8. Making Life Better - A Whole System Strategic Framework for Public Health 2013 - 2023 (https://www.health-ni.gov.uk/sites/default/files/publications/dhssps/making-life-better-strategic-framework-2013-2023_0.pdf)
9. http://www.hscbusiness.hscni.net/orecni.htm
10. https://www.nisra.gov.uk/statistics/deprivation/northern-ireland-multiple-deprivation-measure-2010-nimdm2010
11. https://www.executiveoffice-ni.gov.uk/sites/default/files/publications/ofmdfm_dev/the-use-of-spatial-measures-for-the-targeting-of-need.pdf
12. https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/settlement15-guidance.pdf
13. https://socialsciences.mcmaster.ca/jfox/Books/Companion-1E/appendix-cox-regression.pdf
14. https://www.nature.com/articles/6601120.pdf
15. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/10713numberofdrugrelateddeathsinvolvinggabapentinorpregabalinwithorwithoutanopioiddrugenglandandwales2018
16. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2358-1
17. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4008086/
18. https://pubmed.ncbi.nlm.nih.gov/26541690/
19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5374256/
20. https://www.health-ni.gov.uk/publications/alcohol-and-drug-misuse-strategy-and-reports
21. https://commonslibrary.parliament.uk/parliament-and-elections/devolution/northern-ireland-assembly-new-decade-new-approach/
22. https://www.executiveoffice-ni.gov.uk/publications/outcomes-delivery-plan-201819
23. https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/IMPACT-OF-REGISTRATION-DELAYS-ON-SUICIDE-STATISTICS-IN-NORTHERN-IRELAND.pdf
24. https://pure.qub.ac.uk/en/publications/the-belfast-youth-development-study-byds-a-prospective-cohort-stu
25. https://esrc.ukri.org/
26. https://www.ukri.org/
27. https://www.adruk.org/
28. https://www.nisra.gov.uk/publications/drug-related-deaths-northern-ireland-information-paper.
29. https://www.nisra.gov.uk/statistics/population/mid-year-population-estimates.
30. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5969114/
31. https://arxiv.org/ftp/arxiv/papers/1511/1511.05728.pdf
32. https://www4.shu.ac.uk/research/cresr/sites/shu.ac.uk/files/overcoming-deprivation-disconnection-uk-cities.pdf

Annex 2 Data and Definitions

Drug-related deaths are deaths where the underlying cause recorded on the death certificate is drug poisoning, drug abuse or drug dependence. **Drug-misuse deaths** are a subset of drug-related deaths and occur where the underlying cause is drug poisoning, drug abuse or drug dependence **and** where any of the substances controlled under the Misuse of Drugs Act (1971) are involved. Further information can be found on the NISRA website[28].

All figures in this document refer to drug-related deaths and were defined using the 10th edition of the International Classification of Disease Codes (ICD-10 codes). The codes used to define drug-related deaths are:

F11-F16, F18-F19:	Mental & behavioural disorders due to drug use (excluding alcohol and tobacco);
X40-X44:	Accidental poisoning by drugs, medicaments and biological substances;
X60-X64:	Intentional self-poisoning by drugs, medicaments and biological substances;
***X85*:**	Assault by drugs, medicaments and biological substances; and
***Y10-Y14*:**	Poisoning by drugs, medicaments and biological substances, undetermined intent.

Year of Registration & Year of Occurrence: All deaths, where the use of illicit drugs is considered a possible factor, are referred to the Coroner which can lead to a delay between the date of a death and subsequent registration. This delay might mean that a considerable number of deaths are registered in a different year to which they occurred. All figures in Section 1 are based on year of registration[P] as official figures in the UK are produced on this basis.

NISRA publish annual figures for drug-related deaths[1]. Figures in Section 2 are based on year of occurrence of the drug-related death as this was a more appropriate means to undertake the modelling based analyses.

European Age Standardised Rate (EASR): Age standardization is a method to control for different age distributions among populations or over time. The EASR is the rate that would have been found if the population of Northern Ireland had the same age-composition (proportion of total population in each five year age class) as a hypothetical European population, known as the European Standard Population (ESP)[5].

Age-specific Mortality Rate: For some subgroups analysed in the study (e.g. Local Government District in Figure 4) the number of deaths is too small to report a rate with reliability. Therefore rates are based on the average number deaths over a period, e.g. rates

[P] Collected on the Northern Ireland Registration Office System (NIROS)

in Figure 4 (per 100,000 population) are calculated for 2014-2018 and use mid-year population estimates for 2016[29].

Cox Proportional Hazards Regression is a time-to-event analysis (or survival analysis) assessing the time from the start of a study to an event (e.g. drug-related death). The Cox proportional hazards model is a multiple regression analysis method employed in time-to-event or survival analysis to estimate the effect of a number of covariates or predictor variables on the time until death[13]. The present study sought to estimate the socio-demographic, area and health factors associated with drug-related death among the Northern Ireland population, between April 2011 and December 2017.

Censoring involves a DRD coded as 0 if the respondent did not die or died from other causes. Time to death or to 'censoring' was defined as the number of months from baseline (Census 2011) to death or to the end of the year 2017.

Variable Selection: All Northern Ireland residents were initially analysed to examine the impact of each individual predictor variable, adjusted for age and sex. Weaker predictor variables (p>.05) were then removed from the initial selection of models and the model was rerun to examine all remaining predictors variables simultaneously. Area deprivation was retained in the full Northern Ireland model as it was a potential confounder[30] i.e. area deprivation wasn't significant (P>.05) when adjusted for age and sex for Northern Ireland overall but has the potential to be strongly associated with DRD when taking other factors into consideration e.g. Local government District as drug problems are disproportionately concentrated in areas of disadvantage.

Hazard Ratio is a likelihood ratio from the Cox proportional hazards modelling. The other categories of the variable are compared against the reference category to derive the hazard ratio(s). The reference category will always have a HR of 1.

- A HR of 1 for the comparison group indicates no difference between the reference category and the comparison group.
- A HR of greater than 1 indicates that the comparison group is more likely to experience a drug-related death compared to the reference group. For example, a HR of 1.83 for having a limiting illness (compared to not having a limiting illness) indicates that there is an 83% greater likelihood of drug-related death from having a limiting illness compared to not having a limiting illness.
- A HR of less than 1 indicates that the comparison group is less likely to experience a drug-related death compared to the reference group. For example, a HR of 0.56 for students (compared to being employed) indicates that there is a 44% less likelihood of drug-related death among students compared to those in employment.

The hazard ratios shown in the "fully adjusted model" where each explanatory variable had been examined or adjusted for the other explanatory variables—that is, the effect of one individual variable on drugs mortality when all other explanatory variables are held constant.

95% Confidence Intervals (CI's) are a range of likely values around the hazard ratio. CIs that do not cross 1 are statistically significant while CIs that do cross 1 are not statistically significant.

Proportionality assumption: Proportional hazard assumptions were graphically checked for each explanatory variable included in the models. When deriving a hazard ratio, it is assumed that the ratio of the rates of death between the two categories is constant—that is, that they are proportional during follow-up. Tests for interactions were used to determine whether DRDs differed by age or sex and area deprivation[31].

Limiting Illness was derived from the following questions "Are day-to-day activities limited because of a health problem or disability which has lasted, or is expected to last, at least 12 months?". The available responses were; 'No', 'limited a little' and 'limited a lot'.

The presence of **mental ill health** was based on the following question in the 2011 Northern Ireland Census: "*Do you have any of the following conditions which have lasted, or are expected to last, at least 12 months*?". Respondents ticked all categories from the list provided and mental health status was identified if respondents ticked the category, '*an emotional, psychological or mental health condition (such as depression or schizophrenia)*".

Local Government District (LGD) is an area of residence variable. Greater Belfast included residency at baseline in Belfast, Antrim & Newtownabbey and Lisburn and Castlereagh Local Government Districts[7]. Due to a smaller number of drug-related deaths, it was not possible to perform more in-depth analyses for Derry City and Strabane Local Government District which along with Belfast LGD are the LGD's that contain the highest proportion of deprived areas within them, largely associated with the cities of Derry and Belfast respectively[32].

The **Northern Ireland Multiple Deprivation Measure[10] (NIMDM, 2010)** identifies seven separate domains of deprivation and an overall summary measure. The income domain was used to assign individuals to one of five equal groups (or quintiles) ranging from most deprived to least deprived, based on their usual address of residence. Although the NIMDM measure was updated in 2017, the 2010 based NIMDM measure was included in the analyses given it was based on data sources relating to a time period aligned with Census 2011 (i.e. the source for baseline characteristics in the study).

Urban/Rural Residence: Eight Settlement Bands (A-H) based on the 2011 Census population were used to classify settlements[12]. Settlements with a population of greater than or equal to 5,000 people were classified as 'Urban' while settlements with a population of less than 5,000 people were classified as 'rural'.

Economic Activity comprised 4 groups: employed, unemployed, student and the economically inactive. The economically inactive including long term sick, people looking after their family and home, a small number of people who are retired before 65 and people who are inactive for other reasons such as temporarily sick, injured and discouraged workers. There were an insufficient number of deaths to provide analyses in the report for each of the economically inactive classifications.

Annex 3- Exclusions and Weighting of DRDs

Individuals living in communal establishments (including 17 DRDs) were excluded from the analyses as they had missing information at the household level and they would be little influenced by area level factors. Other individuals (including 19 DRDs) were excluded due to missing information for either limiting tong term illness/ urban residency or highest level of education. The resulting cohort available for analyses comprised 1,089,205 individuals aged 10-64 years at the time of the Census 2011.

Official statistics indicated that there were a total of 816 DRDs occurring between April 2011 and December 2017, either directly (main cause of death was drug-related) or indirectly (contributory cause of death was drug-related) drug-related. On the research dataset, 533 people were identifiable as having died from a DRD between April 2011 and December 2017. The difference (283 deaths) between the registered number of DRDs and DRDs identified on the research dataset is due to a number of reasons including migration and differences in personal attributes (e.g. name, date of birth and address) as well as non-enumeration of Census 2011 records. A weighting adjustment was therefore applied to Table 1 to allow for the extent of underrepresentation of DRDs in each sex-specific age group. Weights were obtained by dividing the number of official DRDs[Q] in each sex-specific age group by the corresponding number of deaths in the research dataset (Table 3).

Table 3 Sex and Age Specific Weights Applied to DRDs

	Weights	
Age-group	***Males***	***Females***
<25	1.04	1.32
25-34	2.22	1.26
35-44	1.71	1.24
45-54	1.77	1.34
55-64	1.56	1.05

[Q] Official DRDs occurring in each sex-specific age group during the study period received from NISRA Vital Statistics Team

Annex 4- Characteristics of Greater Belfast compared to the Rest of NI

Table 4 Distribution of Socio-demographic and Health Determinants of the (i) Study Population and (ii) Among Those Who Died of a Drug-related Cause, Ages 10-64 Years, Comparing Greater Belfast with the 'Rest of Northern Ireland' (NI)

		(i) Study Population (%)		(ii) Drug-related Deaths (%)	
		(1)	*(2)*	*(3)*	*(4)*
		Greater Belfast (n=368,235)	***Rest of NI*** (n=720,970)	***Greater Belfast*** (n=241)	***Rest of NI*** (n=292)
Sex	Male	48.0	49.2	68.5	60.6
	Female	52.0	50.8	31.5	39.4
Age	10-24	19.1	18.1	22.8	16.4
	25-34	21.9	20.1	24.5	23.6
	35-44	21.2	22.0	23.2	28.4
	45-54	21.7	22.0	19.1	19.5
	55-64	16.1	17.8	10.4	12.0
Religious Affiliation	Catholic	40.1	48.7	42.7	46.7
	Protestant	52.0	46.7	47.7	46.9
	Other/none/unknown	7.8	4.5	9.5	6.4
Living Arrangements	Living in couple	49.9	55.3	16.6	26.4
	Living alone	12.7	9.6	37.8	31.2
	Other	37.4	35.1	45.6	42.5
Marital Status	Single	44.5	38.9	63.9	54.1
	Married	42.6	49.7	11.6	22.6
	Separated/divorced/widowed	12.9	11.3	24.5	23.3
Educational Attainment	Degree level or higher	29.1	24.5	8.7	10.3
	School level or other (intermediate)	50.8	53.4	47.3	46.6
	No qualifications	20.1	22.1	44.0	43.2
Economic Activity	Employed	64.2	63.8	29.5	31.5
	Unemployed	5.2	5.7	10.4	9.2
	Student	10.8	9.7	7.1	4.5
	Inactive	19.8	20.8	53.1	54.8
Number of Cars	None	19.5	10.8	53.5	37.3
	1	36.7	31.8	34.4	37.0
	2 or more	43.8	57.4	12.0	25.7
Housing Tenure	Owner occupied	68.3	75.6	38.2	45.2
	Private rental	15.0	13.6	18.7	18.5
	Social rental	16.7	10.8	43.2	36.3
Urban Residence	Urban	85.5	52.2	95.0	72.3
	Rural	14.5	47.8	5.0	27.7
Area Deprivation	Quintile 1 (Most deprived)	26.5	15.3	51.0	28.4
	Quintile 2	13.5	23.5	17.0	28.4
	Quintile 3	14.5	23.5	13.7	19.2
	Quintile 4	14.0	24.8	9.1	16.4
	Quintile 5 (Least deprived)	31.5	13.0	9.1	7.5
Mental Health	No	91.6	92.7	61.8	60.6
	Yes	8.4	7.3	38.2	39.4
Limiting Illness	No	82.8	83.0	48.5	48.3
	Yes	17.2	17.0	51.5	51.7

Annex 5- Results from Models 1-3

Table 5 Hazard Ratios (HR) with 95% Confidence Intervals for Socio-demographic and Health Factors Among 10-64 year Olds, Comparing Greater Belfast, the 'Rest of Northern Ireland' & Northern Ireland Models[R]

		Northern Ireland		Greater Belfast		Rest of Northern Ireland	
		Model 1		Model 2		Model 3	
		Age & sex Adjusted[S]	Fully Adjusted[T]	Age & sex Adjusted	Fully Adjusted[U]	Age & sex Adjusted	Fully Adjusted
Sex	Female	1	1	1	1	1	1
	Male	1.80 (1.51, 2.15)	1.89 (1.58, 2.27)	2.11 (1.62, 2.76)	2.17 (1.65, 2.86)	1.6 (1.27, 2.03)	1.70 (1.33, 2.17)
Age	Under 25 years	1.56 (1.13, 2.14)	3.37 (2.31, 4.91)	1.80 (1.12, 2.89)	3.89 (2.23, 6.78)	1.31 (0.85, 2.03)	2.94 (1.75, 4.94)
	25-34	1.75 (1.29, 2.38)	3.10 (2.23, 4.30)	1.72 (1.08,2.74)	3.13 (1.90, 5.15)	1.71 (1.14, 2.58)	3.12 (2.01, 4.86)
	35-44	1.81 (1.34, 2.45)	2.71 (1.98, 3.71)	1.69 (1.05,2.70)	2.55 (1.57, 4.14)	1.89 (1.27, 2.80)	2.85 (1.89, 4.29)
	45-54	1.34 (0.97, 1.84)	1.59 (1.15, 2.20)	1.36 (0.83,2.21)	1.59 (0.97, 2.61)	1.30 (0.85, 1.98)	1.58 (1.03, 2.43)
	55-64 (ref)	1	1	1	1	1	1
Educational Attainment	Degree level or higher (ref)	1	1	1	1	1	1
	Intermediate	2.41 (1.78, 3.26)	1.56 (1.14, 2.13)	3.09 (1.93, 4.95)	1.77 (1.09, 2.87)	2.09 (1.40, 3.11)	1.40 (0.93, 2.10)
	None	6.61 (4.85, 9.00)	1.96 (1.40, 2.74)	8.86 (5.51, 14.26)	2.16 (1.28, 3.65)	5.57 (3.71, 8.36)	1.76 (1.13, 2.72)
Mental Health	No (ref)	1	1	1	1	1	1
	Yes	9.18 (7.67, 10.98)	2.42 (1.93, 3.03)	8.32 (6.37, 10.88)	2.11 (1.50, 2.96)	9.60 (7.54, 12.23)	2.68 (1.98, 3.64)
Limiting Illness	No (ref)	1	1	1	1	1	1
	Yes	7.01 (5.87, 8.37)	1.82 (1.42, 2.34)	7.08 (5.44, 9.23)	1.83 (1.26, 2.66)	6.88 (5.41, 8.75)	1.78 (1.28, 2.49)
Economic Activity	Employed (ref)	1	1	1	1	1	1
	Unemployed	2.74 (2.00, 3.75)	1.57 (1.14, 2.13)	3.32 (2.08, 5.29)	1.61 (1.00, 2.61)	2.74 (1.77, 4.24)	1.51 (0.96, 2.36)
	Inactive	7.95 (6.51, 9.69)	2.16 (1.66, 2.80)	8.79 (6.51, 11.85)	2.06 (1.38, 3.07)	7.96 (6.10, 10.38)	2.15 (1.52, 3.06)
	Student	0.68 (0.46, 1.02)	0.63 (0.41, 0.97)	0.95 (0.52, 1.71)	0.71 (0.39, 1.29)	0.77 (0.41, 1.47)	0.55 (0.29, 1.05)
Living Alone	Living in a couple (ref)	1	1	1	1	1	1
	Living alone	7.82 (6.20, 9.88)	2.67 (2.05, 3.47)	8.75 (6.03,12.70)	3.00 (2.00, 4.51)	6.97 (5.14, 9.45)	2.45 (1.73, 3.48)
	other	3.23 (2.52, 4.13)	1.79 (1.40, 2.30)	3.72 (2.50,5.55)	1.87 (1.25, 2.79)	2.95 (2.14, 4.06)	1.76 (1.28, 2.42)

[R] Religious affiliation was not significant (P>0.5) in models adjusted for age and sex (not shown) and therefore omitted.

[S] Unadjusted estimates are included to show the independent effect for each predictor variable. Age and sex are likely to influence the impact of each predictor variable and have therefore been taken into account or 'controlled' for.

[T] The fully adjusted estimates takes into effect all of the additional predictor variables where all variables were entered into the model simultaneously i.e. the estimates show the independent effect for each predictor variable while holding all other variables in the model constant.

[U] The fully adjusted estimates takes into effect all of the additional predictor variables where all variables were entered into the model simultaneously i.e. the estimates show the independent effect for each predictor variable while holding all other variables in the model constant.

(continued)		Northern Ireland		Greater Belfast		Rest of Northern Ireland	
		Model 1		Model 2		Model 3	
		Age & sex Adjusted[V]	Fully Adjusted[W]	Age & sex Adjusted	Fully Adjusted[X]	Age & sex Adjusted	Fully Adjusted
Number of Cars	*2 or more (ref)*	1	1	1	1	1	1
	1 or more	2.98 (2.35, 3.79)	1.44 (1.11, 1.87)	3.53 (2.31, 5.39)	1.76 (1.12, 2.76)	2.65 (1.97, 3.56)	1.24 (0.89, 1.73)
	none	9.17 (7.28, 11.56)	1.95 (1.46, 2.61)	10.51 (7.02, 15.73)	2.38 (1.44, 3.84)	8.00 (5.96, 10.74)	1.55 (1.03, 2.33)
Housing Tenure	Owner occupied (ref)	-	-	-	-	1	1
	Private rental	-	-	-	-	2.22 (1.61, 3.07)	0.91 (0.64, 1.30)
	Social rental	-	-	-	-	5.84 (4.52, 7.55)	1.49 (1.08, 2.05)
Local Government District	Rest of Northern Ireland (ref)	1	1	-	-	-	-
	Greater Belfast	1.62 (1.36, 1.92)	1.21 (1.01, 1.46)	-	-	-	-
Urban Residence	Rural (ref)	1	1	1	1	1	1
	Urban	2.75 (2.20, 3.44)	1.63 (1.27, 2.09)	3.23 (1.80, 5.76)	1.09 (0.58, 2.05)	2.41 (1.87, 3.11)	1.68 (1.29, 2.20)
Area Deprivation	Quintile 1 (Most deprived)	4.72 (3.41, 6.54)	1.25 (0.85, 1.83)	6.7 (4.25, 10.56)	1.80 (1.08, 3.01)	-	-
	Quintile 2	2.67 (1.90, 3.77)	1.35 (0.93, 1.95)	4.37 (2.60,7.34)	1.80 (1.03, 3.14)	-	-
	Quintile 3	1.88 (1.31, 2.70)	1.33 (0.93, 1.90)	3.24 (1.89, 5.56)	1.84 (1.05, 3.23)	-	-
	Quintile 4	1.43 (0.98, 2.09)	1.35 (0.96, 1.92)	2.23 (1.24, 4.03)	1.58 (0.87, 2.89)	-	-
	Quintile 5 (ref) (least deprived)	1	1	1	1	-	-

1= reference category, HR <1 = decreased risk, HR >1 = increased risk,

HR's shaded in fully adjusted models are significant, P<0.05

Sensitivity Analyses

A sensitivity analysis was performed by running a separate Cox Proportional Hazard model to examine risk of drug-related mortality in Belfast Local Government District separately. The sensitivity analyses yielded very similar results to the Greater Belfast results (Model 2) yielding comparable HRs for all predictor variables (results available from authors on request).

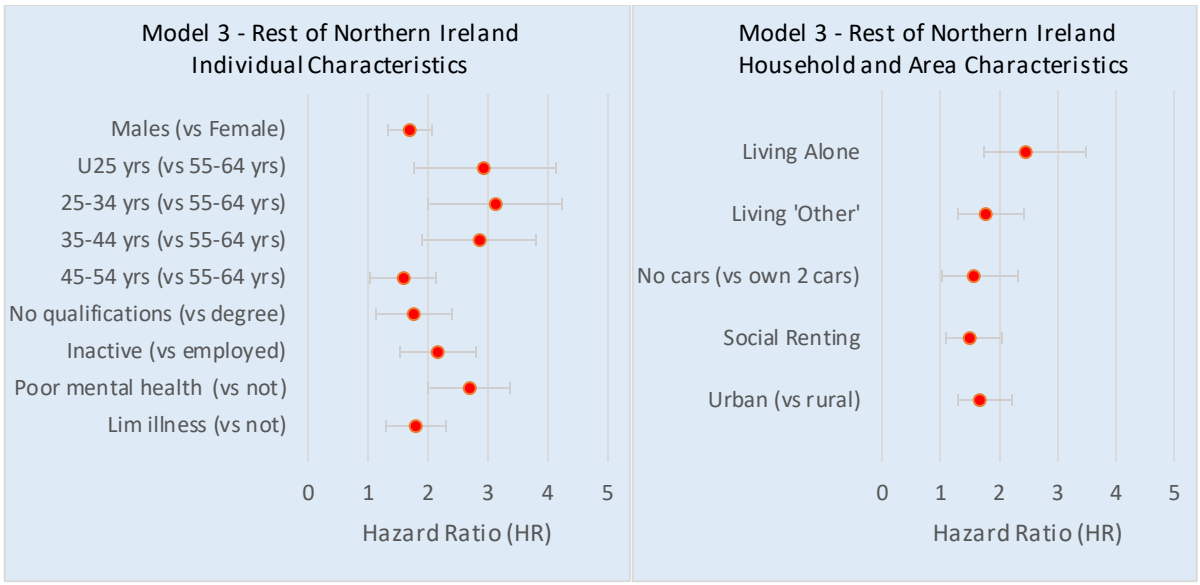
[V] Unadjusted estimates are included to show the independent effect for each predictor variable. Age and sex are likely to influence the impact of each predictor variable and have therefore been taken into account or 'controlled' for.

[W] The fully adjusted estimates takes into effect all of the additional predictor variables where all variables were entered into the model simultaneously i.e. the estimates show the independent effect for each predictor variable while holding all other variables in the model constant.

[X] The fully adjusted estimates takes into effect all of the additional predictor variables where all variables were entered into the model simultaneously i.e. the estimates show the independent effect for each predictor variable while holding all other variables in the model constant.

Annex 6 - Assessing Variation in DRDs in the 'Rest of Northern Ireland'

Figure 9 Cox Proportional Hazards (95% confidence Intervals*) for Drug-related Mortality, Aged 10-64 years, Fully Adjusted Hazard ratios – Rest of Northern Ireland (Model 3)



Lim illness = Limiting Illness

*Confidence Intervals that do not cross 1 are statistically significant