Covid-19 Deaths in Wave One: Analysis of Equality Group, Health and Socio-demographic Characteristics

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Revision note: Following release, an error was discovered in the calculation of age-standardized mortality rates (ASMRs) by disability status (Figure 4, page 13). As a result, six ASMRs have been affected for disabled people whose activities were 'limited a little' and 'limited a lot'. Figure 4 has now been amended. (Updated 7 February 2022, 3pm)

Background

The World Health Organisation (WHO) declared the novel coronavirus (Covid-19) a pandemic on 11 March 2020[1]. As of 26 November 2021, 3,881 Covid-19 related deaths have occurred in Northern Ireland[2]. The Northern Ireland Statistics & Research Agency (NISRA) has published weekly[2] and quarterly[3] information on Covid-19 related deaths. To supplement these reports and to provide a more complete picture of mortality during the pandemic, NISRA also published a suite of reports focusing on age-standardized mortality rates[4] (ASMRs), excess mortality[5], and pre-existing conditions[6]. Mortality analyses in Northern Ireland during the pandemic have been largely based on information recorded on death certificates and information gaps remain. This research addresses some evidence gaps[A] by linking death registrations to extensive socio-demographic, health and equality group (e.g. health problem/disability and religion/religion of upbringing) information from the 2011 Census of population.

[A] Identified by senior government officials and third sector policy leads

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The overarching aim of this research is to extend understanding of Covid-19 and non Covid-19 mortality during the pandemic. For both Covid-19 and non-Covid 19 deaths during the first wave of the pandemic in Northern Ireland, this research:

- assesses equality group, socio-demographic and self-reported health associations;
- calculates age-standardised mortality rates by self-reported disability and religion; and
- undertakes statistical modelling to examine how Covid-19 mortality risk differs by (A) "disability" and (B) "religion/religion of upbringing".

Key Findings

The analyses are based on the deaths of persons aged 30 years and over at the time of death, who could be linked to the 2011 Census, the most recent Census data available. It covers deaths that occurred between **1 March 2020 and 30 September 2020**, and which were registered by 31 October 2020.

This study could not take into account any changes in circumstances between 2011 and time of death occurring between March and September 2020. For example, health and socio-economic data included are based on information self-reported in 2011.

For deaths of persons aged 30 years and above

- Taking into account the age structure of the population in Northern Ireland, the Covid-19 age-standardised mortality rate (ASMR) for March 2020 to September 2020 per 100,000 was higher for those who identified as Protestants (72.4) than those who identified as Catholics (54.7).
- However, after accounting for sex and area of residence, in addition to age, there was no significant difference in risk of Covid-19 death, for the time period March to September 2020, for those who identified as Protestant at the time of the 2011 Census, compared to Catholics.
- Taking into account the age structure of the population in Northern Ireland, Covid-19 ASMRs (per 100,000) were higher for disabled persons (activities limited 'a lot' (111.4), activities limited 'a little' (71.2) than 'non-disabled' persons (48.5).
- Males had higher Covid-19 ASMRs compared to females for disabled persons whose activities were limited 'a lot' (m-119.2, f-105.2) and limited 'a little' (m-85.8, f-64.1).
- After adjusting for age, sex, area of residence, socio-demographic characteristics and health, there was a 48% and 40% higher risk for persons self-reporting having a disability at the time of the 2011 Census (compared to 'non-disabled' people) for Covid-19 and non Covid-19 mortality respectively.
- The numbers of Covid-19 deaths broken down by ethnicity were too small to analyse. For non Covid-19 deaths during the reporting period, the majority (99.6%) of the population had identified as having white ethnicity.

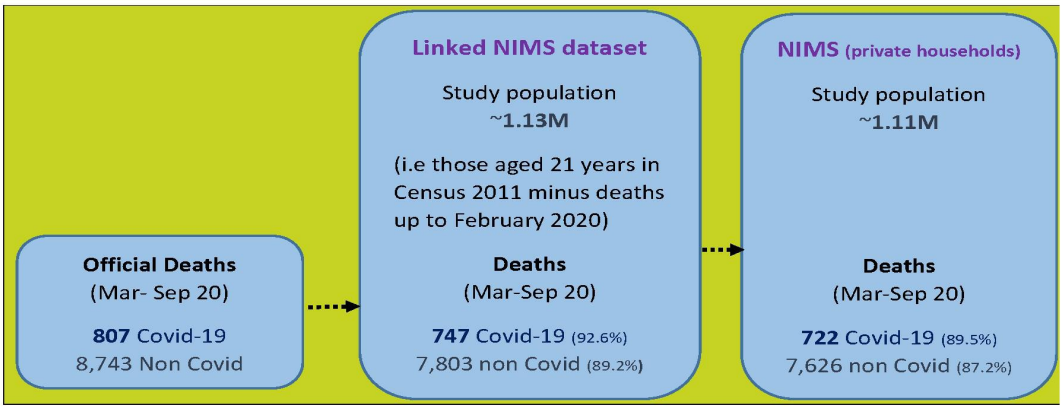
Design and Setting

The Northern Ireland Mortality study[8] (NIMS), a population based research dataset linking 2011 Census data to subsequent registered deaths from April 2011 to October 2020, was used to undertake analyses. 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 analysis purposes. The study population for analysis comprised 1,128,383 individuals enumerated in the 2011 Census, **aged 30 years and over**[B] on 1 March 2020[C]. Within this group, on the linked dataset, there were 747 Covid-19 deaths and 7,803 non Covid-19 deaths between 1 March 2020 and 30 September 2020.

[B] There were no Covid-19 deaths in persons aged under 30 years old during Wave One of the pandemic in Northern Ireland.
[C] Individual aged 21 years and over at the time of the 2011 Census and who were alive on 1 March 2020.

This represented 92.6% (747 out of 807[D]) of all confirmed Covid-19 deaths and 89.2% (7,803 out of 8,743) of all non Covid-19 deaths that occurred during this period.

Figure 1: Study population (over 30 years)



Study Time Period

All figures and rates in this report are based on deaths occurring in Northern Ireland in the 7-month period between **1 March 2020 and 30 September 2020**[E]**.** For the period March to September 2020, Covid-19 was the underlying primary cause of death in 89.5%[6] of all deaths which mentioned Covid-19 on the death certificate[F].

Analyses

The report is divided into three analytical sections examining deaths from Covid-19 and other causes during Wave One of the pandemic. Section 1 provides a descriptive summary of socio-demographic, health, equality and household characteristics among those who died from Covid-19 and other causes compared to the general population. Section 2 presents age-standardised mortality rates by religion/religion of upbringing and by disability status. In Section 3, regression modelling is used to estimate the relative risk of Covid-19 and non Covid-19 deaths in persons over 30 years by (i) religion/religion of upbringing and (ii) activity limitation. Percentages included in the figures and charts may not add up to 100 per cent precisely due to rounding.

Deaths due to Covid-19

The definition **of a Covid-19 death used in this report** includes all deaths where Covid-19 was found to be the *underlying cause of death*. The ICD-10 codes, issued by the World Health Organisation (WHO), to code deaths involving Covid-19 were U07.1 (Covid-19, virus identified through laboratory testing) and U07.2 (Covid-19, virus not identified but Covid-19 is suspected through clinical or epidemiological diagnoses). The definition used in this report is based on confirmed cause of death coding and figures are therefore not directly comparable with NISRA's weekly statistics' bulletins[2] which reflect where Covid-19 or 'suspected' or 'probable' Covid-19 was mentioned anywhere on the death certificate.

Wave One of the Pandemic

There is no strict definition for when a wave of the Covid-19 pandemic starts and ends. For the purpose of this report, Wave One relates to deaths in Northern Ireland that occurred between **1 March 2020 and 30 September 2020**, and which were registered by 31 October 2020.

[D] Total underlying Covid-19 deaths occurring during the period received from NISRA Vital Statistics Unit.
[E] Based on registrations up to and including 31 October 2020.
[F] Based on the time period in which a death was registered.

Key Definitions

Equality Groups

Section 75 (S75) of the Northern Ireland Act[10] is underpinned by the promotion of equality and good relations. The nine equality of opportunity categories defined under S75 are age, men and women generally, marital status, people of different religion/religion of upbringing[G], racial group, people who are disabled and those who are not, people who have dependants and those without, political opinion and sexual orientation. Statistics on Covid-19 deaths for different S75 equality groups are keenly sought by central and local government, academics, the third sector and the general public. Statistics have previously been published in Northern Ireland by age, sex and geographic area. To meet user need for more information, this output provides Covid-19 mortality rates for people of different religion/religion of upbringing and for people who are disabled and those who are not. Similar analyses by marital status and by ethnicity were also considered[H]. It was not possible to report on political opinion, sexual orientation and having dependants[I] for Covid-19 deaths as this information is not recorded on either death certificates or on the 2011 Census.

(i) Religion/religion of upbringing

The NISRA religion/religion of upbringing definition combines information from two questions, as collected in the 2011 Census in Northern Ireland[11];

(i) What religion, religious denomination or body do you belong to?, and of those with no current religion (ii) What religion, religious denomination or body were you brought up in?

The derived categories used in this analyses, in line with the main religious groups typically reported for the Northern Ireland population, were (i) Catholic (ii) Protestant and (iii) other religion/no religion or religion not stated. The Protestant category includes persons brought up in or belonging to the Presbyterian Church in Ireland, Church of Ireland, Methodist Church in Ireland and other (non-Catholic) Christian related denominations.

(ii) **Disability** This study used self-reported health problem/**disability**, as collected in the 2011 Census in Northern Ireland[11]. A distinction was made between those reporting that their day-to-day activities were '**limited a little**' or '**limited a lot**' due to a health condition or disability which has lasted, or is expected to last at least 12 months. People who reported no limitation to their activities are categorised as having '**no activity limitation'.** This definition of disability is broadly consistent with the Government Statistical Service (GSS) harmonised standard and Disability Discrimination Act (DDA) 1995 definition (see Annex 2).

(iii) Ethnicity Due to the small number of deaths available for analysis and the distribution across ethnic groups in Northern Ireland[J], it was not possible to use a **BAME** (Black, Asian and minority ethnic) categorisation for deaths in Northern Ireland. A binary white/non-white distinction was used to categorise ethnicity in the analyses and in line with standard disclosure protocols[12], proportions were only reported based on counts of 10 or greater. For the study time period, it was impossible to provide a breakdown of Covid-19 deaths by ethnic group because counts were under 10 and thus too low for statistical analysis and to meet privacy controls (see Annex 2).

[G] NISRA uses the approach set out in the Fair Employment (Monitoring) Regulations (Northern Ireland) 1999[13]

[H] Disclosure protection protocols measures prevent publication of information where cell sizes are less than 10.

[I] Only child dependants can be deduced from the Census.

[J] Northern Ireland is not as ethnically diverse as other countries in the UK[14]. Previous research[4] reported on Covid-19 deaths in Northern Ireland by country of birth.

Long-term Health Conditions

While data from the 2011 Census were nine years old at the beginning of the pandemic in March 2020, the self-reported long term conditions question[11], ***'Do you have any of the following conditions which have lasted, or are expected to last, at least twelve months'*** is a rich source to measure the presence of chronic health problems at the population level.

Following the question above, respondents selected relevant condition/s from categories including:

- Communication difficulty (a difficulty with speaking or making yourself understood);
- A mobility or dexterity difficulty (a condition that substantially limits one or more basic physical activities such as walking, climbing stairs, lifting or carrying);
- A learning difficulty, an intellectual difficulty, or a social or behavioural difficulty;
- An emotional, psychological or mental health condition (such as depression or schizophrenia);
- Long-term pain or discomfort;
- Shortness of breath or difficulty breathing (such as asthma); &
- A chronic illness (such as cancer, HIV, diabetes, heart disease or epilepsy)

The distribution of these self-reported long-term health conditions among those who died of Covid-19 and non-Covid-19 deaths is included in Table 1.

However, long-term conditions reported in the Census vary according to individuals' own interpretations and experiences and are not aligned with clinical diagnosis definitions used by medical practitioners. For example, a **self-reported learning difficulty,** reported in Table 2, is distinct from a medically diagnosed learning difficulty or **learning disability.** In the medical sense, a **learning difficulty** constitutes a condition which creates an obstacle to a specific form of learning, but does not affect the overall IQ of an individual while a **learning disability** constitutes a condition which affects learning and intelligence across all areas of life. For example, dyslexia is classed as a learning difficulty while Down's syndrome is classed as a learning disability. The 2021 Northern Ireland Census will, for the first time, report on self-reported learning disability in the household.

Area of Residence

An area of residence variable based on the five former NUTS III areas was included in the analysis. The NUTS III areas, in use at the time of Census 2011 (Table 3, Annex 2), were aggregated into two geographical areas reflecting geographical variation in the spread of Covid-19 during the first wave of the pandemic. One area included residence in Belfast, Outer Belfast and the East of Northern Ireland. The other area included residence in the North, West and South of Northern Ireland.

Section 1: Socio-demographic, Health and Equality Group Characteristics

Table 1 presents a descriptive summary of socio-demographic, health and equality group associations[K] among those who died from Covid-19 or other causes in the first wave of the pandemic in Northern Ireland, compared to the general population characteristics for two age groups: (i) 30 years and over and (ii) 70 years and over. These age groups for the general population were selected for comparison as there were no Covid-19 deaths in persons under 30 years in the first wave of the pandemic in Northern Ireland[4], and the 70 years and over age group accounted for 88.3% of all Covid-19 related[L] deaths in the first 7 months of the pandemic.

In the study population, from 1 March to 30 September 2020, 8,550 deaths occurred[M] in Northern Ireland. This included 747 Covid-19 deaths, accounting for 8.7% of all deaths during the period. Using official mortality data, weighted proportions (Annex 3) were generated for Covid-19 and non Covid-19 deaths to account for under-representation of deaths for age-sex specific groups during the study period (March 2020 – September 2020)[N].

Findings highlighted below compare Covid-19 and non Covid-19 deaths with general population characteristics for all persons over 70 years. The findings should be interpreted in light of Covid-19 mortality risk increasing sharply with increasing age.

Socio-demographic factors

- Although there is a higher proportion of females in the general population aged 70 and over (m – 44.2%, f – 55.8%), males and females accounted for equal proportions of Covid-19 (m -49.7%, f- 50.3%) and non Covid-19 deaths (m – 49.3%, f – 50.7%).
- Compared to non Covid-19 deaths (60.3%) and the general population aged 70 and over (55.4%), there was a greater proportion of Covid-19 deaths (67.6%) for persons with no educational qualifications. Similarly, a higher proportion of Covid-19 deaths was evident in persons who were economically inactive/unemployed (90.2%) compared to non Covid-19 deaths (81.6%) and the general population aged 70 and over (80.4%).

Religion and Ethnicity

- The proportion of Covid-19 deaths that were Catholic (28.6%) was smaller than those of Catholics in the general population aged 70 and over (35.4%) and non Covid-19 deaths (36.7%). In contrast, 69.3% of Covid-19 deaths were Protestant or other Christian; this proportion was higher than those for non Covid-19 deaths (60.9%) and the general population aged 70 and over (62.5%).
- From the 2011 Census in Northern Ireland, for non Covid-19 deaths (99.6%), the general population[O] (98.4%) and the general population aged 70 and over (99.5%), the majority of the population had identified as having white ethnicity.

Long Term Health Conditions

- Of all Covid-19 deaths occurring between March and September 2020, two-thirds (66.1%) of individuals had self-reported a limiting[P] health problem/disability compared to 45.1% of the study population aged 70 years and above. A higher proportion of Covid-19 deaths (66.1%) compared to non Covid-19 deaths

[K] Sex, health and equality group characteristics retrieved from the 2011 Census.
[L] Covid-19 related deaths reflected where Covid-19 or 'suspected' or 'probable' Covid-19 was mentioned anywhere on the death certificate, including in combination with other health conditions.
[M] Based on deaths that could be linked to enumerated 2011 Census records (See Figure 1).
[N] Weighted proportions are generated using age at death for the research dataset and official mortality data and are based on death registrations up to and including 31 March 2021.
[O] The general population reflected 2011 Census records, excluding those who were linked to a death registration up to February 2020.
[P] Either limited 'a little' or limited 'a lot'

(59.8%) self-reported a limiting[Q] health problem/disability, therefore suggesting that persons with a disability were disproportionately negatively impacted by the Covid-19 pandemic.

- Apart from an emotional, psychological or mental health condition (8.6% for Covid-19 deaths; 9.2% for non Covid-19), the proportions for other long-term health conditions were marginally higher for those who died from Covid-19 compared to non Covid-19 deaths. The most commonly reported long-term conditions, for both Covid-19 and non Covid-19 deaths were a mobility/dexterity difficulty and long term pain or discomfort.
- Compared to the general population aged 70 years and above, there was a higher prevalence of Covid-19 deaths for the following health conditions: a mobility or dexterity difficulty (44.6% versus 27.6%); long-term pain or discomfort (31.7% versus 24.2%); shortness of breath or difficulty breathing (19.8% versus 14.3%); frequent periods of confusion or memory loss (9.3% versus 3.0%); and a chronic illness (22.7% versus 17.1%)

Table 2 presents a descriptive summary of the household and area level factors among those who died from Covid-19 or a non-Covid-19 cause in Wave One of the pandemic in Northern Ireland compared to general population characteristics for age groups (i) 30 years and over and (ii) 70 years and over. The distribution of mortality by population density, a known risk factor for Covid-19 mortality[15], is reported in Table 2. The distribution of Covid-19 deaths for different geographical areas including Local Government Districts, area deprivation and urban/rural residence has been previously published[4]. Only individuals identified as living in households in Census 2011 were considered in this section to allow assessment of household-level variables, such as tenure, household composition and access to a car. Individuals in communal establishments in Census 2011 such as care homes, prisons, homeless hostels, hospitals and prisons, were therefore excluded.

- Compared to non Covid-19 deaths (23.1%) and the general population over 70 years (18.8%), there were greater proportions of Covid-19 deaths (27.9%) for people who were widowed. For those living alone, higher proportions of Covid-19 deaths (35.6%) and non Covid-19 deaths (31.9%) were evident compared to the general population over 70 years (24.4%).
- There was a higher prevalence of Covid-19 deaths (26.7%) and non-Covid-19 deaths (22.6%) compared to the general population over 70 years (14.3%) for those in social rented accommodation. Covid-19 (34.7%) and non Covid-19 (28.3%) deaths were more likely to be living in a household and without access to a car in 2011 compared to the general population aged 70 years and over (17.6%).
- Higher proportions of Covid-19 deaths (25.0%) were evident for individuals living in the top 20% most densely populated areas compared to non Covid-19 deaths (19.4%) and the general population over 70 years (15.9%).
- In Wave One of the pandemic, compared to non Covid-19 deaths (65.1%), and the general population over 70 years (63.5%), there were higher proportions of Covid-19 deaths (76.5%) for residents in Belfast, Outer Belfast and East of Northern Ireland.

[Q] Either limited 'a little' or limited 'a lot'

Table 1 **Distribution[R] of socio-economic, equality group and health characteristics among (i) Covid-19 deaths, (ii) non Covid-19 deaths and persons in the study population (iii) 30 years and over and (iv) 70 years and over:** March to September 2020

Characteristics	Value	Covid-19 (%) (n=747)	Non Covid-19 (%) (n=7,803)	Population>=30 (%) (n=1,128, 383)	Population >=70 (%) (n=230,621)
Sex	Male	49.7	49.3	47.5	44.2
Sex	Female	50.3	50.7	52.5	55.8
Age	30-59	3.5	11.5	62.3	-
Age	60-69	7.3	13.3	17.2	-
Age	70-79	23.1	23.7	12.8	62.6
Age	80-89	42.1	33.8	6.2	30.3
Age	90+	24.0	17.7	1.5	7.1
Educational[S] attainment	Degree level	12.4	13.2	27.3	17.4
Educational attainment	School level or other[T]	20.0	26.5	46.2	27.2
Educational attainment	No qualifications	67.6	60.3	26.5	55.4
Economic[K] inactivity	Employed incl. student	9.8	18.4	64.1	19.6
Economic inactivity	Inactive/unemployed	90.2	81.6	35.9	80.4
Religion (of upbringing)	Protestant & other Christian	69.3	60.9	51.0	62.5
Religion (of upbringing)	Catholic	28.6	36.7	43.9	35.4
Religion (of upbringing)	Other/none/missing	2.1	2.4	5.1	2.2
Ethnicity	White	-	99.6	98.4	99.5
Ethnicity	Non-white	-	0.4	1.6	0.5
Activity limitation	None	33.9	40.2	78.1	54.9
Activity limitation	Limited a little	26.1	24.1	9.9	21.1
Activity limitation	Limited a lot	40.0	35.7	11.9	24.0
Self-rated health	Very good	10.2	13.0	39.9	18.9
Self-rated health	Good	31.0	31.5	37.1	38.4
Self-rated health	Fair	40.9	39.6	17.0	32.9
Self-rated health	Bad	15.0	12.8	4.8	8.1
Self-rated health	Very bad	3.0	3.1	1.1	1.7

[R] Weighted by age and sex to take into account any under representation in the study period of (i) Covid-19 deaths, (ii) non Covid-19 deaths and the general population.
[S] Based on responses provided at 2011 Census.
[T] School level qualification, other vocational qualification or apprenticeship.

Table 1 **Distribution[U] of socio-economic, equality group and health characteristics among (i) Covid-19 deaths, (ii) non Covid-19 deaths and persons in the study population (iii) 30 years and over and (iv) 70 years and over:** March to September 2020 (continued)

Characteristics	Value	Covid-19 (%) (n=747)	Non Covid-19 (%) (n=7,803)	Population>=30 (%) (n=1,128, 383)	Population >=70 (%) (n=230,621)
Condition	Communication difficulty	3.5	2.7	1.1	1.3
Condition	A mobility or dexterity difficulty	44.6	38.0	11.9	27.6
Condition	A learning, intellectual, social or behavioural difficulty	2.7	2.4	1.4	0.8
Condition	An emotional, psychological or mental health condition	8.6	9.2	7.6	5.8
Condition	Long-term pain or discomfort	31.7	28.3	12.1	24.2
Condition	Shortness of breath or difficulty breathing	19.8	18.9	8.3	14.3
Condition	Frequent periods of confusion or memory loss	9.3	5.9	1.6	3.0
Condition	A chronic illness	22.7	21.8	6.9	17.1

[U] Weighted by age and sex to take into account any under representation in the study period of (i) Covid-19 deaths, (ii) non Covid-19 deaths and the general population.

Table 2 **Distribution[V] of socio-economic, equality group and health characteristics among (i) Covid-19 deaths, (ii) non Covid-19 deaths and persons in the study population (iii) 30 years and above and (iv) 70 years and above:** 1 March 2020–30 September 2020

Characteristic	Value	*Covid-19 (%)* *(n=722)*	Non Covid-19 (%) *(n=7,626)*	Population (%) *(n=1,111, 921)*	Population >=70(%) *(n=230,621)*
Living arrangements	Living in a couple	51.5	53.1	59.9	64.9
Living arrangements	Living alone	35.6	31.9	13.6	24.4
Living arrangements	Living 'other[W]'	12.9	14.9	26.5	10.7
Marital status	Single	11.4	13.6	30.5	7.7
Marital status	Married	52.3	52.5	54.1	64.9
Marital status	Divorced	8.4	10.8	10.6	8.6
Marital status	Widowed	27.9	23.1	4.8	18.8
Housing tenure	Owner occupied	67.4	70.4	74.6	80.7
Housing tenure	Private rental	5.9	6.9	12.8	4.9
Housing tenure	Social rental	26.7	22.6	12.6	14.3
Number of cars[X]	None	34.7	28.3	14.1	17.6
Number of cars	1	44.6	47.1	36.4	48.3
Number of cars	2 or More	20.7	24.7	49.5	34.1
Population density	Quintile 1 (most densely populated)	25.0	19.4	18.0	15.9
Population density	Quintile 2	21.4	20.0	18.4	19.3
Population density	Quintile 3	19.9	20.3	20.0	20.4
Population density	Quintile 4	19.4	19.9	21.4	21.6
Population density	Quintile 5 (least densely populated)	14.3	20.4	22.2	22.8
Local Government District	Belfast/Outer Belfast/East of NI	76.5	65.1	62.4	63.5
Local Government District	North, West & South of NI	23.5	34.9	37.6	36.5

This section has shown that lower socio-economic groups are disproportionately negatively impacted by Covid-19 and non Covid-19 mortality, and that having certain long term health conditions is associated with higher Covid-19 and all-cause mortality. The variation in Covid-19 and non Covid-19 mortality for different areas within Northern Ireland in Wave One of the pandemic, confirms previously published research[4]. Comparing associations of Covid-19 and non Covid-19 deaths with corresponding characteristics of the general population over 70 years needs to be interpreted in light of the increasing risks of Covid-19 and non Covid-19 mortality with older ages[4]. In section 2, further examination of Covid-19 and non-Covid 19 mortality by disability status and by religion/religion of upbringing, are made to adjust for different age profiles in different sub populations (e.g. by religion/religion of upbringing) within Northern Ireland.

[V] Weighted by age and sex to take into account any under representation in the study period of (i) Covid-19 deaths, (ii) non Covid-19 deaths and the general population.
[W] The living 'other' category includes cohabiting individuals not part of a couple, for example, living with friends or with other family members (e.g. as part of a multi-generational household).
[X] A proxy for income.

Section 2: Age-standardised Mortality rates

Mortality rates generally increase with age. A population with a larger proportion of older people is expected to have more deaths per population. To adjust for different age profiles in certain populations (e.g. disability is more common in older populations), age-standardised mortality rates (ASMRs) are used to adjust or 'standardise' mortality rates among sub-populations. In this report ASMRs for disability status and religion/religion of upbringing are reported in light of user need. ASMRs are presented per 100,000 people and are standardised to the 2013 European Standard Population.

Age-standardised Mortality Rates (ASMRs) by Religion/Religion of Upbringing

In Northern Ireland, Catholics, as well as those belonging to the 'Other religion' grouping and those with no religion[Y], have younger age distributions than those who are Protestants and other Christian[16]. Figure 2 shows that after taking account of the age structure of the Northern Ireland population, Covid-19 ASMRs for March 2020 to September 2020 (per 100,000) were 54.7 for Catholics and 72.4 for Protestants (both significantly different from the NI average of 66.4). Protestant males (87.8) had higher Covid-19 ASMRs (per 100,000) than Protestant females (62.5). Similarly, Covid-19 ASMRs (per 100,000) for Catholic males (70.4) were higher than those for Catholic females (45.1). For non-Covid-19 deaths during the same period (Figure 3), Catholics (706.6) and Protestants (690.4) had similar ASMRs (per 100,000).

Figure 2 Covid-19 ASMRs by religion/religion of upbringing and sex, aged 30 and over, March to September 2020

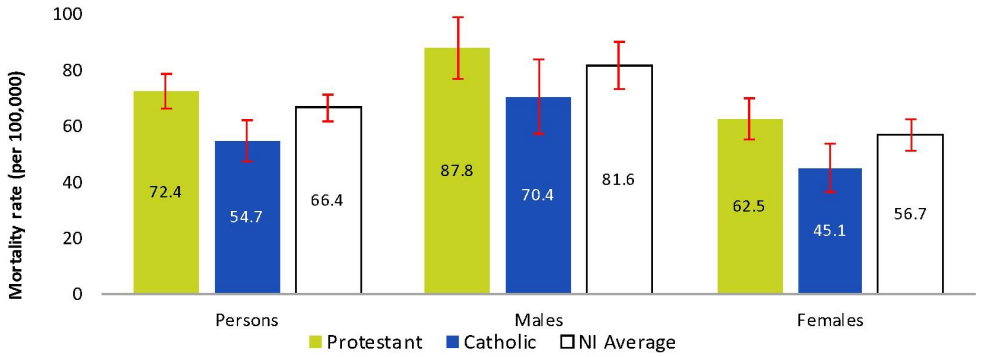
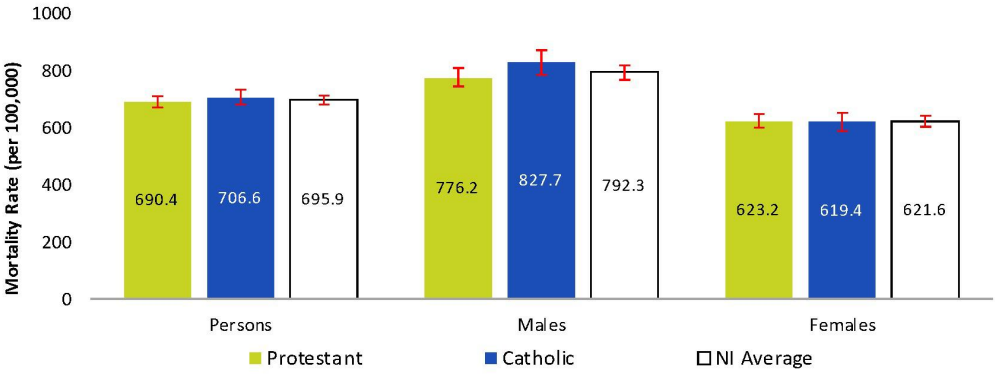


Figure 3 Non Covid-19 ASMRs by religion/religion of upbringing and sex, aged 30 and over, March to September 2020

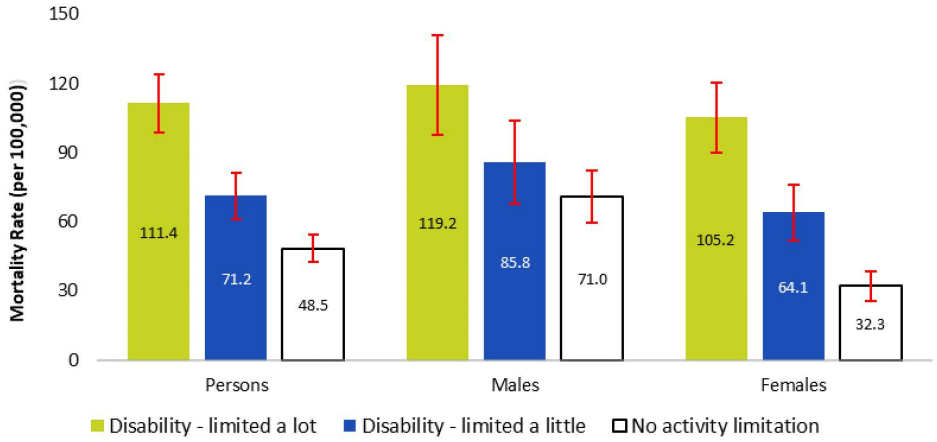


[Y] Including those who have not stated a religion.

Age-standardised Mortality Rates by Disability Status

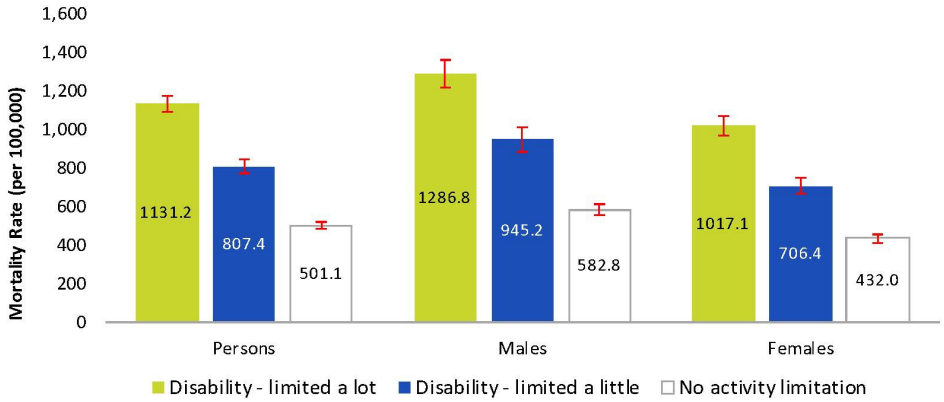
ASMRs allow populations with different age structures to be compared more fairly. Health problems and disabilities are more common in older populations, therefore it is important to adjust for age. Figure 4 shows that after taking into account the age structure of the Northern Ireland population[z], the Covid-19 ASMRs for March 2020 to September 2020 were significantly higher for disabled people whose activities were limited 'a lot' (111.4) and limited 'a little' (71.2) compared to those without a disability (48.5). Males had higher Covid-19 ASMRs (per 100,000) than females for those whose activities were 'limited a lot' (males-119.2, females-105.2), and those whose activities were limited 'a little' (males-85.8, females- 64.1) as well as people with 'no activity limitation' (males-71.0, females-32.3). While Covid-19 ASMRs were higher for males, the relative increase in risk of Covid-19 death compared to non-disabled people was greater for females whose activities were limited 'a lot' (females – 3.3 times, males – 1.7 times) and limited 'a little' (females 2.0 times, males 1.2 times).

Figure 4 Covid-19 ASMRs by disability and sex, aged 30 and over, March to September 2020



For non-Covid-19 deaths during the same period (Figure 5), males had higher ASMRs than females for both people whose activities were limited 'a lot' (1,286.8 for males, 945.2 for females) and limited 'a little' (males 945.2, females 706.4).

Figure 5 Non Covid-19 ASMRs by disability and sex, aged 30 and over, March to September 2020



[z] See Annex 2 for further details on methods used.

Section 3: Modelling Risk of Death

Cox-Proportional Hazard Regression Model

Sections 1 and 2 of this report demonstrated the variation in Covid-19 ASMRs by religion/religion of upbringing and by activity limitation. To explore this further, statistical models (Cox proportional hazards regression[17]) were used to estimate if the risk of Covid-19 and non Covid-19 mortality differed after adjusting for a range of factors affecting both the risk of infection and risk of death if infected. These factors included age, sex, area of residence, number of long-term health conditions and socio-economic status. The results do not imply causality[AA].

Cox regressions and hazard ratios

Cox regression (proportional hazards regression) methodology[17], a standard approach for analysing NIMS data, was used to estimate the risk of Covid-19 mortality for a characteristic such as disability, while adjusting for other factors also expected to be associated with the outcome. For further details on methods used, see Annex 2 and an equivalent study undertaken by the Office for National Statistics[18].

Hazard ratios (HRs) from the Cox proportional hazards models are presented in Figures 6 and 7. The Hazard Ratio (HR) is a measure of how much greater or less the rate of Covid-19 mortality was, for example, for persons with an activity limitation compared to persons without an activity limitation. A HR greater than 1 indicates that the comparison group (e.g. persons with an activity limitation) is more likely to experience Covid-19 death compared to the reference group (e.g. persons without an activity limitation)[BB].

Statistical Analyses

Modelling was undertaken to aid understanding of the factors driving the differences in Covid-19 mortality by Religion/Religion of Upbringing (Model 1) and persons with and without an activity limitation (Model 2). Statistical modelling was based on people aged 30 years and over in March 2020, who were enumerated in the 2011 Census (excluding those records that were linked to death registrations up to February 2021). The exposure time period for risk of death was from 1 March 2020 to 30 September 2020 (seven months). Only individuals living in households at the time of the Census 2011 were considered in order to assess the role of household-level variables, such as household tenure, access to a car, and location. Individuals in communal establishments, prisons, homeless hostels, hospitals and prisons were therefore excluded.

In our baseline models, we present unadjusted HRs (i.e. for religion/religion of upbringing without adjustment for any other factor). We then incrementally adjust for[CC]:

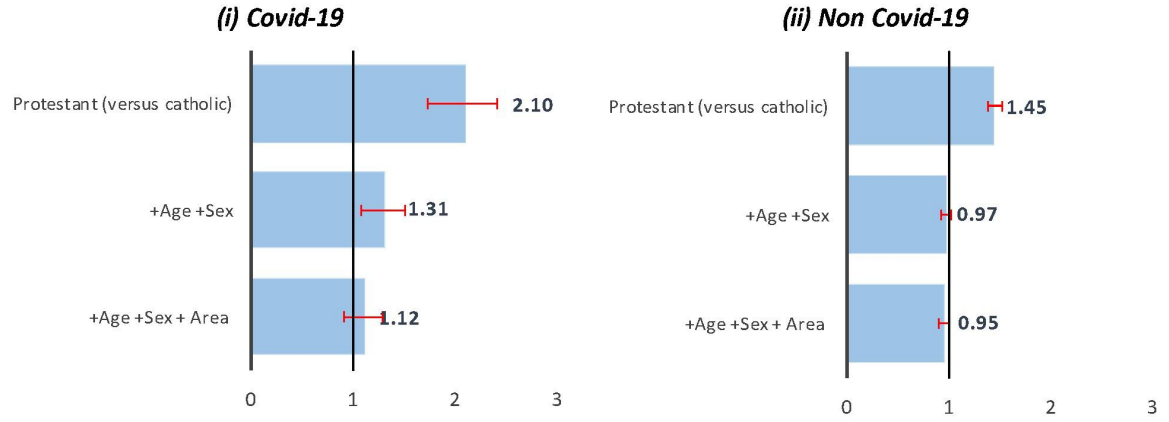
1. Age and sex
2. Area (Belfast, Outer Belfast/East of NI versus North/West and South of NI[Z])
3. Socio-demographic factors (educational attainment, number of household cars and religion[DD])
4. Number of chronic health conditions and disability[EE]

[AA] Regression analysis can identify statistical relationships between factors; however, it cannot imply causation.
[BB] A HR of less than 1 would indicate that the comparison group (e.g. disabled persons) is less likely to experience Covid-19 death compared to the reference group (e.g. non-disabled persons).
[CC] See Annex 2 for further details on regression methods used.
[DD] For disability model only.
[EE] For religion model only.

Model 1 Risk of Covid-19 and Non-Covid-19 Death by Religion/religion of Upbringing

For Protestants, the **unadjusted** model (that is, no other factors are taken into account when looking at the relationship between persons identifying as Protestant and Covid-19 mortality risk) indicated over a two-fold (HR 2.10) greater likelihood of Covid-19 death for Protestants compared to Catholics (Figure 6). Adjusting for age and sex reduced the excess risk of Covid-19 mortality for Protestants to 31% (HR 1.31). However, after adjusting for area of residence, there was no significant difference between Protestants and Catholics (HR 1.12[FF]) in Wave One. For non-Covid-19 deaths, the unadjusted model indicated a 45% greater likelihood (HR 1.45) of non-Covid-19 death for Protestants compared to Catholics. However, adjusting for age and sex only, there was no significant difference between Protestants and Catholics (HR 0.97[GG]).

Figure 6 Wave 1 mortality hazard ratios (95% CI's*) for Protestants, incrementally adjusted for socio-demographic and area factors, 30 years and over



HR > 1 – Protestants higher mortality risk compared to Catholics, HR <1 – Protestants lower mortality risk compared to Catholics. If the confidence intervals cross 1, the hazard ratios are not significant

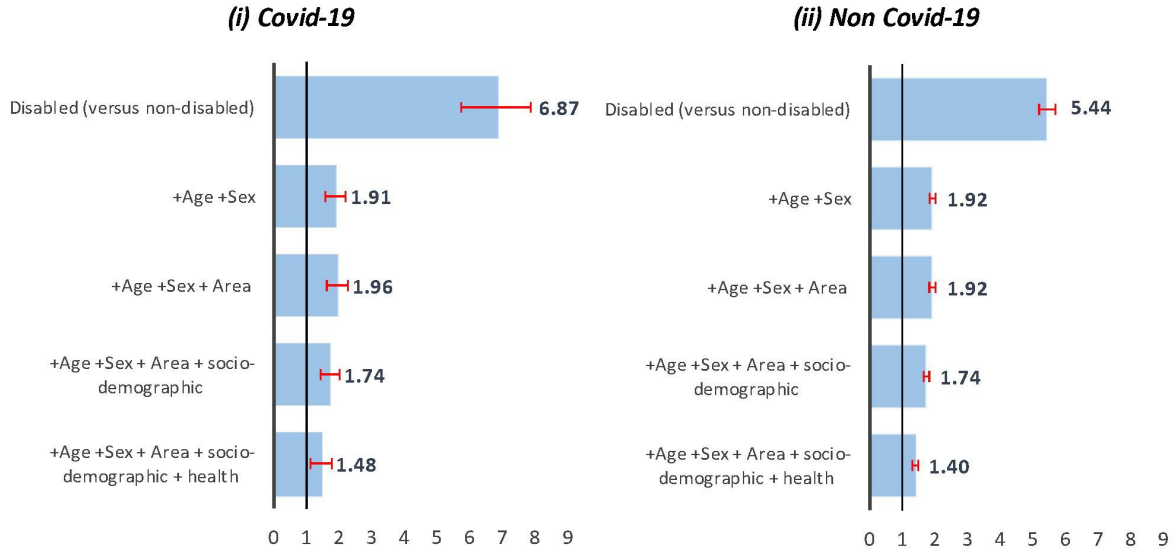
Model 2 Risk of Covid-19 and Non-Covid-19 Death by Self-Reported Activity Limitation

For disabled people[HH], the **unadjusted** model (that is, no other factors are taken into account when looking at the relationship between disability and Covid-19 mortality risk) indicated a nearly seven-fold (HR 6.87) greater likelihood of Covid-19 death for disabled people compared to non-disabled people (Figure 7). Adjusting for age and sex reduced the likelihood of Covid-19 mortality to an almost two-fold (HR 1.91) excess risk for disabled people. After adjusting for area of residence, socio-demographic factors and health, a 48% greater likelihood of a Covid-19 death in Wave One for disabled people was evident (HR 1.48).

For non-Covid-19 deaths, the disability effect was similar, with the unadjusted model indicating over a five-fold (HR 5.44) greater likelihood of non-Covid-19 death for disabled people compared to non-disabled people. Adjusting for age and sex reduced the likelihood of non Covid-19 mortality to an almost two-fold (HR 1.92) excess risk. After further adjusting for area of residence, socio-demographic factors and health, a 40% greater likelihood of a non Covid-19 death in Wave One for disabled people was evident (HR 1.40), again statistically significant.

[FF] Not statistically significant as confidence intervals cross 1.
[GG] Not statistically significant as confidence intervals cross 1.
[HH] In the statistical modelling, disability status is based on a self-reported assessment that that day-to-day activities were limited 'a little' or 'a lot' due to a health problem or disability which has lasted, or is expected to last, at least 12 months

Figure 7 Wave 1 mortality hazard ratios (95% CI's*) for disability, incrementally adjusted for socio-demographic, area and health factors, 30 years and over



HR > 1 – Persons with a disability higher mortality risk compared to persons without a disability, HR < 1 Persons with a disability lower mortality risk compared to persons without a disability. If the confidence intervals cross 1, the hazard ratios are not significant

These results align with findings from England showing a raised risk of death for disabled people compared to non-disabled persons for Covid-19 deaths[18]. There may be a number of unmeasured factors, not included in our analyses, that are important to all-cause mortality risk including place of residence (i.e. living in a care home or communal establishment) and severity of health related factors. Other studies indicated that an important part of the raised risk could be that disabled people are disproportionately exposed to a range of generally disadvantageous circumstances compared with non-disabled people[18].

Strengths and limitations

A key strength of our study is that it used a high quality population based research dataset which had comprehensive linkage to deaths including Covid-19 mortality (93% coverage) during the study period. As such, there is no selection bias for our study population. We were able to adjust for a wide range of factors that might confound or mediate the effect of disability or religion/religion of upbringing sequentially to identify the overall association while also considering possible explanatory factors without over-adjusting the models. The study uses rich socio-demographic data (e.g. qualifications and religion/religion of upbringing) sourced from the Census where no equivalent administrative data with sufficient population coverage exists.

This study has a few **limitations**. Firstly, the study could not take into account any changes in health, disability, socio-economic and household factors after Census 2011. The research dataset includes people who migrated out of Northern Ireland after Census 2011, although older people tend to migrate less than younger people[19]. Health and disability measures were self-reported and were not based on clinical records. However, Northern Ireland 2011 Census remains the most suitable comprehensive source of health and disability data for a large-scale linkage-based analysis like this one. Despite the disability definition relying on individuals' own perceptions and experiences, it is aligned with the current Government Statistical Service (GSS) harmonised "core" definition of disability. Hence, our analysis identifies disabled people in a similar way to how disability is identified within public health strategies and in the promotion of equal opportunity among Section 75 groups.

In our analyses, it was not possible to adjust for place of residence in 2020 (i.e. private households, care homes and other communal establishments). It is plausible that the higher proportion of deaths in care homes during the pandemic could be a key contributory factor in examining observed differences in mortality risk by disability. There may be a number of other unmeasured factors not included in our analyses that are important for Covid-19 mortality risk including, for example, healthcare quality and access for disability groups.

Analysis of Future Waves

The time period for analyses in this report was determined by availability of deaths data on the research dataset. When more recent deaths data are added to the research dataset, there will be further opportunities to undertake analyses to gain an understanding of any differential Covid-19 mortality risk during later waves of the pandemic. These may indicate changed geographical and social incidences of mortality as has been seen in other studies in other geographical contexts outside Northern Ireland. It may also make it possible to extend the analysis to smaller sub-populations within Northern Ireland.

Research Team

The project team consisted of NISRA's ADR researchers and researchers from Queen's University Belfast. This analysis has been supported by the ADR NI.

ADR UK (Administrative Data Research UK[20]) 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.

Acknowledgements

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We also thank colleagues in the Northern Ireland Statistics & Research Agency, Department of Health and the Department for Communities who contributed with comments and knowledge to an earlier version of the report.

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.

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Annexes

Annex 1 References

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Annex 2 Data and Definitions

The study population consisted of people enumerated in the 2011 Census, who were alive on 1 March 2020 and aged 30 years and over. Persons younger than 30 years were excluded as no Covid-19 deaths in Wave One occurred in persons aged younger than 30 years.

Mortality rates in this report have been calculated based on the number of deaths occurring over a 7-month period from 1 March 2020 to 30 September 2020. Mortality rates generally increase with age. A population with a greater proportion of older people is expected to have more deaths per population. To adjust for different age profiles in different populations (e.g. disability is more common in older populations), age-standardised mortality rates (ASMRs) are calculated to adjust or 'standardise' mortality rates among populations to be compared. In this report ASMRs for disability status and Religion/religion of Upbringing are reported in light of user need. ASMRs are presented per 100,000 people and are standardised to the 2013 European Standard Population.

Lower and upper 95% confidence limits have been provided in all Figures. These form a **confidence interval**, which is a measure of the statistical precision of an estimate and shows the range of uncertainty around the estimated figure. As a general rule, non-overlapping confidence intervals are considered to be statistically significant.

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. Covid-19 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[17]. The Cox proportional hazards model is more appropriate than a logistic regression[23] to model the risk of death from a given cause as it accounts not only for whether the individual dies from this disease but also the timing of the death, and death from other causes. Given the short study period (seven months from March to September 2020), very similar results (odds ratios) were obtained when running the analyses using logistic regression models.

Censoring involves a Covid-19 death 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 (1 March 2020) to death or to 30 September 2020.

A **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 Covid-19 death compared to the reference group. For example, a HR of 1.48 for people with a disability (compared to not having a disability) indicates that there is a 48% greater likelihood of a Covid-19 death for disabled people compared to non-disabled people.

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

Disability

To define disability in this publication, we refer to the self-reported answers to the 2011 Census question, "Are your day-to-day activities limited because of a health problem or disability which has lasted, or is expected to last, at least 12 months? - Include problems related to old age" ("Yes, limited a lot" or "yes, limited a little" or "no"). This is slightly different to the current Government Statistical Service (GSS) harmonised "core" definition: this identifies as "disabled" a person who self-reports having a physical or

mental health condition or illness that has lasted or is expected to last 12 months or more that reduces their ability to carry-out day-to-day activities. The GSS definition differs from the DDA definition of disability, excluding the following groups which are "non-core" under DDA: People with a progressive condition (specified in the Equality Act and HIV/AIDS, cancer or multiple sclerosis) that does not currently reduce their ability to carry out day-to-day activities.

Ethnicity

Studies from Wave One of the pandemic reported that BAME groups had a higher risk of infection and death from Covid-19 compared with the White British population in England and Wales[24]. A number of factors have been identified as contributory factors to the higher risk of Covid-19 infection in BAME groups in England[25] including a disproportionate number of BAME groups in lower socio-economic groups, multi-generational households, disproportionate employment in lower band key worker roles and co-morbidities (e.g. cardiovascular disease, renal disease, diabetes and complex multi-morbidities).

Population Density

Population density, the number of persons per square kilometre, was assigned based on the geographical area (Super Output Area or SOA[26]) of the usual address of residence based on the 2011 Census. SOA's were ranked from the most densely populated (rank 1) to the least densely populated (rank 890). These rankings were used to assign individuals into one of five equal groups or quintiles (ranging from 1- most densely populated to 5 - least densely populated).

District Councils

A geography variable based on the former 26 Local Government Districts in Northern Ireland was included in the modelling analysis. The former 26 Districts were aggregated into two larger geographical areas based on the former NUTS III areas, in use at the time of Census 2011. (Table 3). In 2008, the Northern Ireland Assembly approved the reform of Local Government. The change moved Local Government from 26 former Local Government Districts (LGD1992) to 11 existing Local Government Districts (LGD2014). The 11 new Districts became operational in April 2015[27]. The current NUTS III areas are synonymous with the 11 Local Government Districts.

Table 3 Former NUTS III Areas and former Districts in Northern Ireland

NUTS III Area	Districts Included	Study area
Belfast	Belfast	Area 1
Outer Belfast	Carrickfergus, Castlereagh, Lisburn, Newtownabbey & North Down	Area 1
East	Antrim, Ards, Ballymena, Banbridge, Craigavon, Down & Larne	Area 1
North	Ballymoney, Coleraine, Derry, Limavady, Moyle & Strabane	Area 2
South & West	Armagh, Cookstown, Dungannon, Fermanagh, Magherafelt, Newry and Mourne & Omagh	Area 2

Urban/Rural Residence:

Eight Settlement Bands (A-H) based on the 2011 Census population were used to classify settlements[28]. 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 3 groups: Employed (including students), unemployed and the economically inactive. The economically inactive included those who are long term sick, people looking after their family and home, 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 economic activity classifications.

Annex 3 Weighting

The study population for analyses comprised 1,128,383 individuals enumerated in the 2011 Census, **aged 30 years and over** on 1 March 2020[II]. There were no Covid-19 deaths aged under 30 years old during Wave One of the pandemic in Northern Ireland. On the research dataset, between 1 March and 30 September 2020, there were 747 Covid-19 deaths and 7,803 non Covid-19 deaths. This represented 92.6% (~747 out of 807[JJ]) of all confirmed Covid-19 deaths and 89.2% (7,803 out of 8,743) of all non Covid-19 deaths that occurred during this period. The difference (1,000 deaths) between the registered number of deaths and deaths 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.

For the household and area analyses in Table 2 and for modelling analyses, individuals living in communal establishments were excluded due to non-response at the household level. Other individuals were excluded due to non-response (either missing or edited) in the variables limiting long term illness, urban residency or highest level of education. These exclusions resulted in 25 further Covid-19 deaths and 177 non Covid-19 deaths being omitted from the analytical dataset.

Weighting adjustments were applied in Tables 1 and 2 to allow for the extent of underrepresentation of deaths in each sex-specific age group. Weights were obtained by dividing the number of official Covid-19 and non Covid-19 deaths in each sex-specific age group by the corresponding number of deaths in the research dataset (Tables 4 and 5).

Table 4: Sex and age specific weights applied to Covid-19 and non Covid-19 deaths: residents of households and communal establishments

Cause of death	Sex	Aged 30-59	Aged 60-69	Aged 70-79	Aged 80-89	Aged 90+
Covid-19	Males	1.31	1.32	1.13	1.07	1.05
Covid-19	Females	1.10	1.10	1.07	1.04	1.06
Non Covid-19	Males	1.59	1.22	1.08	1.09	1.07
Non Covid-19	Females	1.26	1.11	1.08	1.07	1.06

Table 5: Sex and age specific weights applied to Covid-19 and non Covid-19 deaths: residents of households only

Cause of death	Sex	Aged 30-59	Aged 60-69	Aged 70-79	Aged 80-89	Aged 90+
Covid-19	Males	1.55	1.42	1.18	1.11	1.07
Covid-19	Females	1.10	1.16	1.13	1.06	1.07
Non Covid-19	Males	1.63	1.24	1.10	1.11	1.09
Non Covid-19	Females	1.31	1.12	1.11	1.10	1.10

[II] Individual aged 21 years and over at the time of the 2011 Census and who were alive on 1 March 2020.
[JJ] Total underlying and contributory Covid-19 deaths occurring during the period received from NISRA Vital Statistics Unit.