# Risk of suicide after diagnosis of severe physical health conditions: A retrospective cohort study of 47 million people

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## Summary

**Background** The diagnosis of a severe physical health condition can cause psychological distress and lead to severe depression. The association between severe physical health conditions and the risk of suicide, and how the risk of suicide changes in the months following diagnosis, are not clear.

**Methods** We estimated whether a diagnosis of severe physical health conditions is associated with an increase in the risk of death by suicide using a dataset based on the 2011 Census linked to hospital records and death registration records covering 47,354,696 people alive on 1 January 2017 in England. Patients diagnosed with a low-survival cancer, chronic ischaemic heart disease, chronic obstructive pulmonary disease, or degenerative neurological condition were matched to individuals using socio-demographic characteristics from the Census. Using the Aalen-Johansen estimator, we estimated the cumulative incidence of death by suicide occurring between 1 January 2017 and 31 December 2021 (registered by 31 December 2021) in patients and matched controls, adjusted for other potential confounders using inverse probability weighting.

**Findings** Diagnosis of severe conditions was associated with an increased risk of dying by suicide. One year after diagnosis, the rate of suicide was 21.6 (95% confidence intervals: 14.9–28.4, number of events (N): 39) per 100,000 low-survival cancer patients compared to 9.5 (5.6–14.6, N:16) per 100,000 matched controls. For COPD patients, the one-year suicide rate was 22.4 (19.4–25.5, N:208) per 100,000 COPD patients (matched controls: 10.6, 8.3–13.0, N:85), for ischaemic heart disease 16.1 (14.1–18.2, N:225) per 100,000 patients (matched controls: 8.8, 7.1–10.4, N:128), for degenerative neurological conditions 114.5 (49.6–194.7, N:11) per 100,000 patients. The increase in risk was more pronounced in the first six months after diagnosis or first treatment.

**Interpretation** A diagnosis of severe physical illness is associated with higher suicide risk. The interaction of physical and mental illness emphasises the importance of collaborative physical and mental health care in these patients.

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**Keywords:** Suicide; Severe illness

## Introduction

Suicide is a major public health problem, with over 5500 suicides having been registered in England and Wales in 2021.[1] Many factors contribute to the risk of suicide, including biological, psychological, clinical, social and environmental factors.[2] Whilst people with psychiatric illness are recognised to be a group with a high suicide risk,[3,4] less attention has been paid to people diagnosed with severe physical health conditions. The diagnosis of a severe physical health condition can cause psychological distress and lead to severe depression.[5–7] Examining the rate of suicide in people diagnosed with severe, life-threatening conditions is important, because the worsening mental health following such diagnosis could lead to an increase in the risk of suicide, which would call for a better provision of mental health services for this vulnerable group of patients.

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## Research in context

### Evidence before this study

We searched PubMed for studies investigating the association between the diagnosis of severe conditions and the risk of death by suicide, published up to June 2022, using search terms like 'Suicide' and 'terminal condition', and individual conditions (such as cancer or heart diseases). We reviewed studies based on patient-level data estimating the risk of suicide after the diagnosis of a range of severe conditions. Existing evidence suggests that a wide range of physical health conditions, such as coronary heart disease, cancer, neurological conditions, diabetes, stroke, chronic obstructive pulmonary disease, and osteoporosis, are linked to a higher risk of suicide. However, there is variation between studies, and a lack of large-scale population-level analyses that examine the association between the diagnosis of physical health conditions and suicide. In addition, very few studies examine how the risk of suicide varies by time following diagnosis.

### Added value of this study

In this retrospective cohort study that included 47,354,696 people living in England, the rate of death by suicide was over twice as high in patients diagnosed with a severe physical health condition (low-survival cancers, chronic ischaemic heart disease, chronic obstructive pulmonary disease, and degenerative neurological conditions) as in people with similar characteristics but not diagnosed with any of these conditions. The increase in risk was highest immediately following diagnosis or first treatment.

### Implications of all the available evidence

People diagnosed with severe physical health conditions such as low-survival cancers, COPD, chronic ischemic heart disease, or degenerative neurological diseases are at elevated risk of death by suicide. Providing better support to recently diagnosed patients is critical to help people cope with a severe condition diagnosis. Further research is needed to understand the mechanisms driving the elevated risk of suicide and help provide the best support to these patients.

A wide range of physical health conditions, such as coronary heart disease, cancer, neurological conditions, diabetes, stroke, chronic obstructive pulmonary disease, and osteoporosis, are linked to a higher risk of suicide.[8–13] However, there is variation between studies and a lack of large-scale population-level analyses that examine the association between the diagnosis of physical health conditions and suicide. In addition, few studies examine how the risk of suicide varies by time following diagnosis.

In this study, we conducted a retrospective cohort study using a novel population-wide linked dataset from England to investigate the risk of suicide in patients diagnosed with low-survival cancers, chronic ischemic heart disease, chronic obstructive pulmonary disease, and degenerative neurological diseases. The aim was to estimate the association between the diagnosis of these conditions and the risk of suicide after adjusting for the potential confounding factors, leveraging a rich linked dataset based on the 2011 Census.

## Methods

### Data

We used a novel linked dataset combining the 2011 Census, death registration records, and the Hospital Episode Statistics (HES). The 2011 Census was held on 27 March 2011 and collected a wide range of information on individuals residing in the UK, covering around 94% of the population.[14] HES data contain records of all admissions, Accident and Emergency attendances and outpatient appointments at hospitals run by the National Health Service (NHS) in England. Death registration data contain information recorded when deaths are certified and registered, including the date and cause of death.

To obtain NHS numbers for the 2011 Census, we linked the 2011 Census to the 2011–2013 NHS Patient Registers using deterministic and probabilistic matching, with an overall linkage rate of 94.6%. All subsequent linkages were performed based on NHS numbers, with a linkage rate of 90.9% from HES to Census for persons diagnosed with severe conditions (See Supplementary Fig. S1).

The study population consisted of all persons aged 6 or above (as younger people would not have been born at the time of the 2011 Census), alive on 1st January 2017, residing in England and who were enumerated at the 2011 Census. Our analytical data include 47,354,696 people, covering 89.2% of the estimated 2017 population of people aged 6 or over in England.[13]

### Outcome

Our primary outcome was time to death by suicide from the date of diagnosis or treatment for a severe physical health condition. Death by suicide was defined as any death from intentional self-harm (ICD-10 codes X60–X84 among those aged 10 years and above). We examined deaths occurring between 1 January 2017 and 31 December 2021, registered by 31 December 2021.

### Exposure

The exposure was the time since diagnosis or treatment of a range of severe conditions, based on the first

diagnosis code for hospital admission. We selected conditions with poor prognosis and a high risk of death. We included low-survival cancers, which were defined as cancers with a 5-year survival rate lower than 20%, based on data published by Public Health England,[15] which included malignant neoplasm of pancreas (ICD-10 codes C25-C25.9), malignant neoplasm of meninges (ICD-10 codes C70-C70.9), malignant neoplasm of bronchus and lung (ICD-10 codes C34-C34.9) and Oesophagus (ICD-10 codes C15-C15.9), liver cell carcinoma (ICD-10 codes C22-C22.9) and mesothelioma (ICD-10 codes C45-C45.9). We also included chronic ischemic heart disease (ICD-10 codes I25.0-I25.9), chronic obstructive pulmonary disease (ICD-10 codes J44.0-J44.9), and degenerative neurological diseases (Huntington and motor neurone diseases ICD-10 codes G10, G12.2).

For each condition, the first diagnosis or treatment was identified by the first hospital admission (either inpatient, outpatient and accident and emergency datasets) occurring after 1 January 2017 (and before 31 March 2020) for individuals who had no admission for the specified condition in 2015 or 2016.

### Matching variables and other covariates

We aimed to estimate the association between the diagnosis of severe physical health conditions and suicide, after adjusting for factors associated with the incidence of these conditions and the risk of suicide. We matched patients to controls from the general population based on socio-demographic factors likely to be associated with suicide rates in the general population. Socio-demographic factors were derived from the 2011 Census and included age, sex, self-reported ethnicity, religion, decile of the Index of Multiple Deprivation (based on place of residence) and region of residence (see Supplementary Table S1 for more detail). Missing data for 2011 Census data were imputed using nearest neighbour donor imputation, the methodology employed by the Office for National Statistics across all 2011 Census variables.

The analyses were further adjusted for other factors that may confound the relationship between diagnosis of a severe condition and suicide, including any history of hospital admission for mental health problems in the two years before diagnosis, highest qualification (degree/no degree), health in 2011 (being disabled, having reported being in poor or very poor health), and marital status (Single, married, widowed, divorced).

### Statistical analysis

For each condition, patients were matched 1:1 to controls with exact matching using the socio-demographic factors (age, sex, self-reported ethnicity, religion, decile of index of multiple deprivation and region of residence). An additional condition was that the matched control should be alive on the date the person with a severe illness first received their diagnosis. All individuals who had not been identified as having a severe physical health condition between 1 January 2017 and 31 March 2020 were included in the pool of potential controls. Once an individual was matched to a patient with a severe condition illness, they were removed from the pool of controls.

For each condition, we estimated the cumulative incidence of suicide in patients and matched controls, by using the Aalen–Johansen estimator, treating mortality from other causes as a competing risk. To adjust for factors not included in matching, we estimated the cumulative incidence of suicide adjusted for these potential confounders using inverse probability weighting.[16] In the matched sample, we fitted a logistic regression model for the probability of being diagnosed with a severe physical health condition, adjusting for a history of hospital admission for mental health problems, highest qualification (degree/no degree), health in 2011 (being disabled, having reported being in poor or very poor health), and marital status (Single, married, widowed, divorced). Weights were equal to the inverse of the predicted probability of being diagnosed for those who had been diagnosed, and to the inverse of the probability of not having been diagnosed for those who had not been diagnosed. We used a statistical adjustment rather than matching for these factors, as including them in the matching would have led to a lower matching rate. We also calculated the cumulative incidence of suicide not adjusted using IPW as a sensitivity analysis. Confidence intervals were derived via bootstrapping (500 iterations), using the matched pairs as clusters.

The time at risk started at the time of the first hospitalisation episode with a primary diagnosis for a terminal condition. Follow-up ended on the earliest of: date of death (suicide or other cause) or end of study date (31 December 2021). By design, everybody who did not die was followed up for at least 640 days. Matched controls were assigned the diagnosis date of the matched individual. The analysis was also stratified by sex.

The matching was implemented in Python 3. The survival analysis was conducted using R 3.6.

### Role of the funding source

The work was conducted by ONS employees. No external funding was received.

## Results

### Characteristics of study population

Our study population included 47,354,696 persons who lived in England and were enumerated in the 2011 Census, linked to the 2011–2013 patient registers, and

| | All study participants | | Chronic ischaemic heart disease | | COPD | | Low survival cancers | | Degenerative neurological conditions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| Study population | 45,971,684 | | 1,383,016 | | 885,716 | | 176,709 | | 10,320 | |
| Suicide | 17,195 | 0.04 | 465 | 0.03 | 455 | 0.05 | 58 | 0.03 | 13 | 0.13% |
| Age (years) | | | | | | | | | | |
| Mean | 39.6 | – | 66.2 | | 65.2 | | 65.2 | | 58.9 | |
| Sex | | | | | | | | | | |
| Female | 23,986,846 | 52.2 | 510,438 | 36.9 | 442,971 | 50.0 | 77,464 | 43.8 | 4,673 | 45.3% |
| Male | 21,984,838 | 47.8 | 872,578 | 63.1 | 442,745 | 50.0 | 99,245 | 56.2 | 5,647 | 54.7% |
| Ethnic group | | | | | | | | | | |
| White British (English/Welsh/Scottish/Northern Irish/British) | 37,184,190 | 80.9 | 1,216,950 | 88.0 | 825,216 | 93.2 | 162,903 | 92.2 | 9,328 | 90.4% |
| Irish | 422,456 | 0.9 | 22,752 | 1.6 | 17,994 | 2.0 | 3,365 | 1.9 | 140 | 1.4% |
| Gypsy or Irish traveller | 42,126 | 0.1 | 1,376 | 0.1 | 1,278 | 0.1 | 131 | 0.1 | 5 | 0.0% |
| Other White | 1,919,661 | 4.2 | 26,653 | 1.9 | 11,216 | 1.3 | 3,059 | 1.7 | 178 | 1.7% |
| White and Black Caribbean | 320,329 | 0.7 | 2,431 | 0.2 | 1,929 | 0.2 | 341 | 0.2 | 24 | 0.2% |
| White and Black African | 121,441 | 0.3 | 731 | 0.1 | 461 | 0.1 | 102 | 0.1 | 7 | 0.1% |
| White and Asian | 262,627 | 0.6 | 2,270 | 0.2 | 1,062 | 0.1 | 198 | 0.1 | 29 | 0.3% |
| Other mixed | 214,609 | 0.5 | 2,045 | 0.1 | 1,263 | 0.1 | 250 | 0.1 | 28 | 0.3% |
| Indian | 1,197,212 | 2.6 | 35,823 | 2.6 | 6,782 | 0.8 | 1,404 | 0.8 | 163 | 1.6% |
| Pakistani | 942,995 | 2.1 | 25,645 | 1.9 | 5,242 | 0.6 | 918 | 0.5 | 107 | 1.0% |
| Bangladeshi | 363,600 | 0.8 | 8,436 | 0.6 | 2,096 | 0.2 | 410 | 0.2 | 30 | 0.3% |
| Chinese | 280,971 | 0.6 | 2,303 | 0.2 | 675 | 0.1 | 514 | 0.3 | 12 | 0.1% |
| Other Asian | 631,771 | 1.4 | 11,910 | 0.9 | 2,383 | 0.3 | 638 | 0.4 | 62 | 0.6% |
| African | 759,213 | 1.7 | 4,297 | 0.3 | 1,166 | 0.1 | 573 | 0.3 | 48 | 0.5% |
| Caribbean | 487,971 | 1.1 | 10,436 | 0.8 | 4,285 | 0.5 | 1,260 | 0.7 | 94 | 0.9% |
| Other Black | 171,565 | 0.4 | 1,551 | 0.1 | 641 | 0.1 | 160 | 0.1 | 9 | 0.1% |
| Arab | 144,627 | 0.3 | 2,522 | 0.2 | 710 | 0.1 | 160 | 0.1 | 19 | 0.2% |
| Any other ethnic group | 222,046 | 0.5 | 4,785 | 0.3 | 1,255 | 0.1 | 311 | 0.2 | 31 | 0.3% |
| No code required | 282,274 | 0.6 | 100 | 0.0 | 62 | 0.0 | 12 | 0.0 | 6 | 0.1% |
| English Region | | | | | | | | | | |
| North East | 2,267,985 | 4.9 | 81,788 | 5.9 | 64,768 | 7.3 | 11,053 | 6.3 | 623 | 6.0% |
| North West | 6,116,898 | 13.3 | 214,494 | 15.5 | 159,080 | 18.0 | 25,934 | 14.7 | 1,301 | 12.6% |
| Yorkshire and the Humber | 4,579,039 | 10.0 | 149,771 | 10.8 | 100,298 | 11.3 | 21,190 | 12.0 | 1,118 | 10.8% |
| East Midlands | 4,006,347 | 8.7 | 122,977 | 8.9 | 78,999 | 8.9% | 17,149 | 9.7 | 929 | 9.0% |
| West Midlands | 4,878,606 | 10.6 | 146,466 | 10.6 | 94,999 | 10.7 | 19,729 | 11.2 | 1,148 | 11.1% |
| East of England | 5,174,119 | 11.3 | 151,125 | 10.9 | 87,457 | 9.9 | 17,757 | 10.0 | 1,078 | 10.4% |
| London | 6,658,259 | 14.5 | 154,557 | 11.2 | 90,141 | 10.2 | 18,785 | 10.6 | 1,165 | 11.3% |
| South East England | 7,624,312 | 16.6 | 207,697 | 15.0 | 124,664 | 14.1 | 25,708 | 14.5 | 1,776 | 17.2% |
| South West England | 4,666,119 | 10.1 | 154,141 | 11.1 | 85,310 | 9.6 | 19,404 | 11.0 | 1,182 | 11.5% |

(Table 1 continues on next page)

| | All study participants | | Chronic ischaemic heart disease | | COPD | | Low survival cancers | | Degenerative neurological conditions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| (Continued from previous page) | | | | | | | | | | |
| Area deprivation decile group | | | | | | | | | | |
| 1 (most deprived) | 4,338,516 | 9.4 | 147,833 | 10.7 | 143,713 | 16.2 | 20,940 | 11.8 | 960 | 9.3% |
| 2 | 4,448,697 | 9.7 | 136,975 | 9.9 | 113,818 | 12.9 | 19,155 | 10.8 | 926 | 9.0% |
| 3 | 4,526,998 | 9.8 | 135,368 | 9.8 | 101,048 | 11.4 | 18,462 | 10.4 | 920 | 8.9% |
| 4 | 4,575,259 | 10.0 | 139,747 | 10.1 | 94,419 | 10.7 | 18,198 | 10.3 | 1,068 | 10.3% |
| 5 | 4,618,025 | 10.0 | 140,128 | 10.1 | 87,023 | 9.8 | 17,642 | 10.0 | 1,067 | 10.3% |
| 6 | 4,680,152 | 10.2 | 140,970 | 10.2 | 80,739 | 9.1 | 17,611 | 10.0 | 1,050 | 10.2% |
| 7 | 4,642,001 | 10.1 | 139,756 | 10.1 | 75,785 | 8.6 | 17,218 | 9.7 | 1,113 | 10.8% |
| 8 | 4,690,762 | 10.2 | 138,958 | 10.0 | 71,177 | 8.0 | 16,778 | 9.5 | 1,088 | 10.5% |
| 9 | 4,704,478 | 10.2 | 133,870 | 9.7 | 64,275 | 7.3 | 15,999 | 9.1 | 1,022 | 9.9% |
| 10 (least deprived) | 4,746,796 | 10.3 | 129,411 | 9.4 | 53,719 | 6.1 | 14,706 | 8.3 | 1,106 | 10.7% |
| Religious group | | | | | | | | | | |
| No religion | 11,400,512 | 24.8 | 173,123 | 12.5 | 116,236 | 13.1 | 24,530 | 13.9 | 1,874 | 18.2% |
| Christian | 27,406,764 | 59.6 | 1,020,658 | 73.8 | 682,554 | 77.1 | 134,377 | 76.0 | 7,211 | 69.9% |
| Buddhist | 190,406 | 0.4 | 2,930 | 0.2 | 1,443 | 0.2 | 424 | 0.2 | 31 | 0.3% |
| Hindu | 685,254 | 1.5 | 20,173 | 1.5 | 3,884 | 0.4 | 818 | 0.5 | 92 | 0.9% |
| Jewish | 218,348 | 0.5 | 8,006 | 0.6 | 2,743 | 0.3 | 825 | 0.5 | 41 | 0.4% |
| Muslim | 2,183,917 | 4.8 | 48,197 | 3.5 | 11,206 | 1.3 | 2,176 | 1.2 | 211 | 2.0% |
| Sikh | 354,724 | 0.8 | 11,755 | 0.8 | 1,641 | 0.2 | 378 | 0.2 | 62 | 0.6% |
| Other religion | 194,444 | 0.4 | 5,732 | 0.4 | 3,567 | 0.4 | 621 | 0.4 | 41 | 0.4% |
| Not stated or required | 3,055,041 | 6.6 | 92,342 | 6.7 | 62,380 | 7.0 | 12,548 | 7.1 | 751 | 7.3% |
| No code required | 282,274 | 0.6 | 100 | 0.0 | 62 | 0.0 | 12 | 0.0 | 6 | 0.1% |

***Table 1:*** **The socio-demographic characteristics of the study population and patients with severe physical health conditions.**

alive on 1 January 2017. 2,455,761 (5.2%) of these persons were diagnosed with severe health conditions between the 1 of January 2017 and the 31 March 2020 (Table 1).

People diagnosed with these severe physical health conditions were older than the general population (39.6 years old): the mean age in 2017 was 65.2 for individuals diagnosed with low-survival cancers, 65.2 for COPD, 66.2 for chronic ischemic heart disease and 59.0 for neurological disease. There was a higher proportion of men in people diagnosed with chronic ischemic heart disease (63.1%), low-survival cancers (56.2%) and degenerative neurological diseases (54.7%) than in the general population (47.8%). A higher proportion of people diagnosed with these conditions were of the White British ethnic group compared to the general population. Patients differed from matched controls in several characteristics not included in the matching (Supplementary Table S2). For instance, patients diagnosed with low-survival cancer were less likely than matched controls to have reported being in good or very good health at the 2011 Census, (53.0% vs 61.4%), to have a degree (15.8% vs 21.2%) or to be married (59.9% vs 63.6%). These characteristics were included in our statistical adjustment.

A total of 17,195 (36.3 per 100,000) people from our study population died by suicide between 1 January 2017 and 31 December 2021. 58 (32.8 per 100,000) patients diagnosed with low-survival cancers died from suicide in the study period, 465 (33.6 per 100,000) patients with chronic ischemic heart disease, 455 (51.4 per 100,000) patients diagnosed with COPD and 13 (126.0 per 100,000) occurred in patients diagnosed with degenerative neurological conditions.

Out of the 176,709 individuals diagnosed with low survival cancers, 175,654 (99.4%) were matched to a control. Out of the 1,383,016 individuals diagnosed with chronic ischemic diseases, 1,369,736 (99.0%) were matched to a control. Out of the 885,716 individuals diagnosed with COPD, 880,656 (99.4%) were matched to a control and 10,222 out of 10,320 (99.1%) of patients with a degenerative neurological disease were matched to a control (See Supplementary Fig. S1).

### Risk of suicide in patients with severe physical health conditions

For each condition of interest, Fig. 1 shows the cumulative incidence of death due to suicide per 100,000 persons (panel A) and the hazard rate of death due to suicide (panel B), from first hospitalisation, in the matched sample, and further adjusted using inverse probability weighting. Data are reported in Supplementary Table S3.

A diagnosis or first treatment for a low-survival cancer was associated with an increased rate of death due to suicide, compared to matched controls. Six months after diagnosis, the rate of suicide was 16.6 (95% confidence interval: 10.7–23.2, number of events (N):30) per 100,000 persons in low-survival cancer patients, compared to 5.7 (2.6–9.9, N:9) per 100,000 persons in controls (See Supplementary Table S3). One year after diagnosis, the rate of suicide was 21.6 (14.9–28.4, N:39) per 100,000 low-survival cancer patients compared to 9.5 (5.6–14.6, N:16) per 100,000 matched controls. In low-survival cancer patients, the hazard rate of suicide was highest in the first few months following diagnosis but remained elevated afterwards too. The hazard rate of suicide for matched controls was constant.

A diagnosis or first treatment for COPD was associated with a consistently higher risk of death due to suicide, compared to matched controls. The rate of suicide six months after diagnosis was 13.7 (11.3–16.2, N:128) per 100,000 patients with COPD, compared to 5.6 (4.0–7.2, N:43) per 100,000 persons in matched controls. The one-year rate of suicide was 22.4 (19.4–25.5, N:208) per 100,000 patients with COPD compared to 10.6 (8.3–13.0, N:85) per 100,000 matched controls. In patients with COPD, the hazard rate of suicide was highest in the first few months following diagnosis but remained elevated throughout the two years following diagnosis. The hazard rate of suicide for matched controls was constant .

A diagnosis or first treatment for chronic ischaemic heart disease was associated with an elevated risk of death due to suicide, particularly in the first 6 months following first diagnosis or treatment. In patients with the chronic ischaemic heart disease, the rate of suicide six months after diagnosis was 11.0 (9.5–12.8, N:156) per 100,000 persons in low-survival cancer patients, compared to 4.2 (3.1–5.3, N:56) per 100,000 persons in matched controls. The one-year rate of suicide was 16.1 (14.1–18.2, N:225) per 100,000 patients with chronic ischaemic heart disease compared to 8.8 (7.1–10.4, N:116) per 100,000 matched controls. In patients with chronic ischaemic heart disease, the hazard rate of suicide was highest in the first few months following diagnosis but was similar to that of matched controls in the second year after diagnosis.

The rate of suicide was particularly high after diagnosis or first treatment for degenerative neurological conditions, with a one-year suicide rate of 114.5 (49.6–194.7, N:11) per 100,000 patients. However, the estimate was imprecise due to the low number of suicides.

Results stratified by sex are presented in Supplementary Fig. S2. The patterns were similar in both men and women, with evidence of elevated risk of suicide in patients diagnosed with severe conditions compared to matched controls. The estimates were less precise because the number of suicides were low, especially amongst women. The cumulative incidences estimated not adjusted further for other potential confounders were very similar (Supplementary Fig. S3).

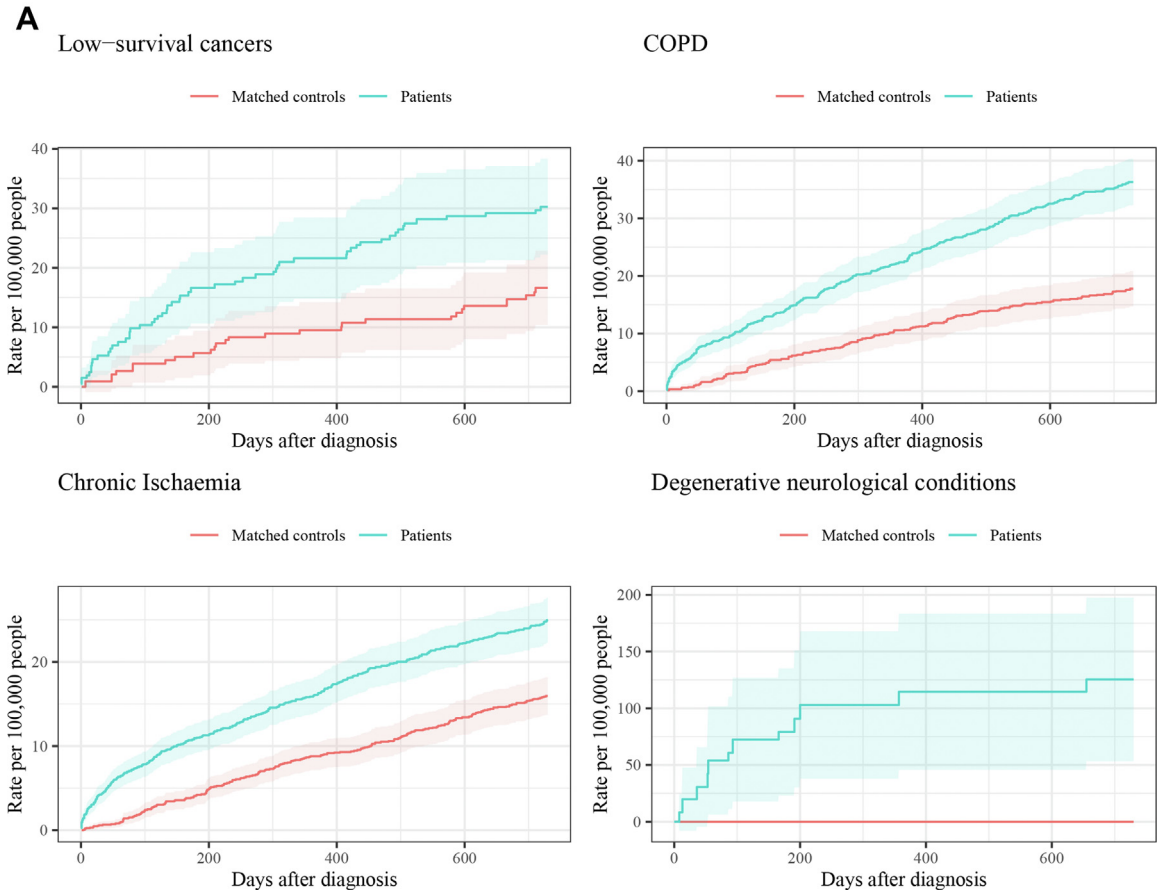


*Fig. 1:* Rate of death due to suicide following diagnosis of low-survival cancers, chronic ischaemic disease, COPD or degenerative neurological disease. Panel A–Cumulative incidence of death due to suicide. Panel B–Hazard rate of death due to suicide. Cumulative incidence with other causes of death treated as a competing risk; cumulative incidence curves are based on a matched sample and are further adjusted for a history of hospital admission for mental health problems, highest qualification (degree/no degree), health in 2011 (being disabled, having reported being in poor or very poor health), and marital status (Single, married, widowed, divorced) using inverse probability weighting. Risk table can be found in Supplementary Table S3.

The rate of death from causes other than suicide was high for patients diagnosed with severe conditions (Supplementary Table S3). The one-year mortality rate was 60,170.5 (59,939.9–60,401.0) per 100,000 persons for people diagnosed with low-survival cancer, 19,090.3 (19,006.5–19,174.1) per 100,000 patients with COPD, 14,561.5 (14,502.8–14,620.3) per 100,000 patients with chronic ischaemic heart disease, and 44,436.8 (43,451.3–45,422.3) for patients with degenerative neurological conditions. There was no administrative censoring for the first 640 days, and the proportion of people who were censored at the end of study time after two year of follow-up was below 7% for all conditions.

## Discussion

### Main findings

This study shows that the diagnosis or first treatment of severe physical health conditions such as low-survival cancers, COPD, chronic ischaemic heart disease, and degenerative neurological diseases is associated with an increased risk of death by suicide. The one-year rate of suicide was between two and three times higher in patients compared to controls with similar socio-demographic characteristics. The increase in risk was highest immediately following diagnosis or first treatment. In low-survival cancer patients, we observed an increase in the risk of suicide in the second year after diagnosis, which could correspond to cancer recurrence.[17]

### Comparison with other studies

Our results are in line with existing evidence showing that a wide range of physical conditions, such as cancer coronary heart disease, stroke, chronic obstructive pulmonary disease, and osteoporosis, are linked to a higher risk of suicide.[8–13] In particular, a study from England examining the risk of suicide after cancer diagnosis found a suicide rate of 1.9 per 100,000 person-year, but

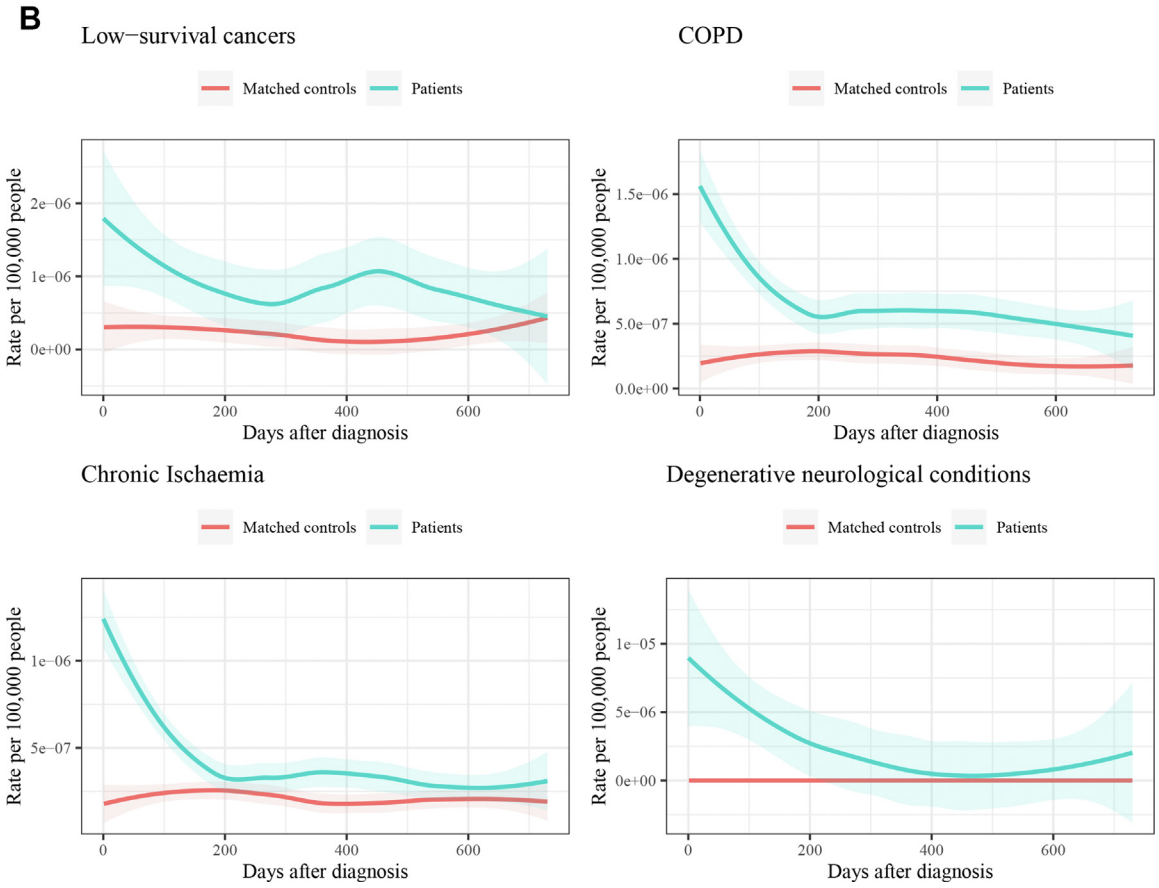


***Fig. 1:*** (continued)

rates for low-survival cancers were in line with our estimates.[13] A study from South Korea also found elevated risk of suicide amongst cancer patients.[18] Our results are also consistent with evidence from Denmark showing slightly elevated risk of suicide in patients diagnosed with neurological diseases.[19]

A study from New Zealand found that older people with terminal cancer who died by suicide were less likely to have a diagnosis of depression or previous contact with mental health services than those without terminal cancer.[20] However, depression and other mental health problems tend to be underdiagnosed in terminally ill patients because distinguishing depressive disorders from the normal emotional responses of a person coping with a terminal illness is difficult.[21] There is some evidence from the US that about a third of terminally ill patients seeking aid in dying from physicians suffer from depression,[5] but the data are small and potentially not representative. Our study contributes to the literature by showing an elevated risk of suicide in patients diagnosed with severe physical health conditions in a population-level dataset, even after adjustment for important socio-demographic factors and a history of severe mental problems. It also demonstrates that the increase in risk is most pronounced in the few months following diagnosis.

## Strengths and limitations

The use of linked 2011 Census to HES and mortality data is a key strength of our analysis. This is the first population-level analysis of suicide among patients diagnosed with a range of severe physical health conditions in England. The linkage to the Census not only provides a large pool of potential controls but also includes information about socio-demographic factors typically not included in routinely collected health data, such as self-reported ethnicity, religion, marital status and education. These factors may confound the relationship between severe illness and suicide because they may be associated with a higher risk of developing these conditions, a delay in diagnosis and the risk of suicide. Owing to the large pool of controls, we achieved high matching rates (99% or over) based on exact matching on a wide range of socio-demographic characteristics. The detailed information used in the matching allowed us to build a control group that is very similar to the group of diagnosed patients. As a result, we can

estimate the association between a diagnosis of severe conditions and the risk of suicide whilst adjusting for key confounding factors. Another strength of our study is that owing to the size we could look at relatively rare diseases, such as degenerative neurological conditions.

Our study has several limitations. First, whilst we adjusted for hospital admissions in the two years prior to diagnosis, we were not able to adjust fully for the history of depression or self-harm. Some of the differences may, therefore, be due to residual confounding, but this is unlikely, since residual confounding could not account for the sharp increase in the risk of suicide just following diagnosis.

Second, because suicide is a rare event, the estimates are rather imprecise and are associated with large confidence intervals.

Third, our data only include suicides that occurred in England and Wales. People who travelled abroad for the purpose of assisted suicide would not appear as having died in our data. As a result, the differences in the rate of suicide between people who have been diagnosed with a severe condition and those who have not may be underestimated.

Another limitation is that the late registration of deaths caused by external causes including suicide and accidental poisoning means that our analysis will be missing most deaths that occurred within the last six months. However, this is unlikely to differ by whether the person had been diagnosed with a severe condition, and therefore is unlikely to bias our results.

Finally, our analysis is restricted to people enumerated at the 2011 Census who were linked to the 2011–2013 patient register. While this covers most usual residences of England, an estimated 10.2% of the 2017 population of England is not included in our analysis. Our analysis excludes people not enumerated at the 2011 census, those who did not link to the NHS patient register, and people who moved to England since 2017. Whilst this may reduce the external validity of our study slightly, it will not bias the estimated differences in suicide rate for our study population.

## Conclusion

People diagnosed with severe physical health conditions such as low-survival cancers, COPD, chronic ischemic heart disease, or degenerative neurological diseases are at elevated risk of death by suicide. Further research is needed to understand the mechanisms driving the elevated risk of suicide and help provide the best support to these patients. In the meantime, providing better support to recently diagnosed patients is critical to help people cope with a severe condition diagnosis. Evidence indicates that psychotherapy and short-term psychosocial interventions for patients can mitigate symptoms of depression and anxiety and improve quality of life, including for patients with severe physical health conditions.[22,23] Diagnosing conditions as early as possible could also help improve prognosis and minimise the mental health effects.

### Contributors

VN, MG and JT conceptualised and designed the study. JM, AB and VN prepared the study data. VN and performed the statistical analysis, which were quality checked by AB and IW. All authors contributed to interpretation of the findings. VN and JM wrote the original draft. All authors contributed to review and editing of the manuscript and approved the final manuscript.

### Ethical approval

This study was ethically self-assessed against the ethical principles of the National Statistician's Data Ethics Advisory Committee (NSDEC) using NSDEC's ethics self-assessment tool. We engaged with the UK Statistics Authority Data Ethics team, who were satisfied that no further ethical approval was required.

### Data sharing statement

The microdata used for this study can be accessed through the ONS Secure Research Service.

### Declaration of interests

None.

### Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanepe.2022.100562.

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