Factors affecting 12-month unplanned readmissions for chronic obstructive pulmonary disease patients: the effect of mental disorders in an Australian cohort

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ABSTRACT

Background Many individuals with chronic obstructive pulmonary disease (COPD) experience frequent hospitalization and readmissions, which is burdensome on the health system. This study aims to investigate factors associated with unplanned readmissions and mortality following a COPD-related hospitalization over a 12-month period in Australia, focusing on mental disorders and accounting for the acute phase of the COVID-19 pandemic.

Methods A retrospective cohort study using linked hospitalization and mortality records identified individuals aged ≥40 years who had at least one hospital admission with a principal diagnosis of COPD between 2014 and 2020 in New South Wales, Australia. A semi-competing risk analysis was conducted to examine factors associated with unplanned readmission and mortality.

Results Adults with a mental disorder diagnosis, specifically anxiety, had a higher risk of 12-month unplanned readmission. Individuals with anxiety and dementia also had a higher risk of mortality pre- and post-unplanned readmission. Individuals who were admitted during the acute phase of the COVID-19 pandemic period had lower risk of unplanned readmission, but higher risk of mortality without unplanned readmission.

Conclusion Interventions aimed at reducing admissions should consider adults living with mental disorders such as anxiety or dementia to improve healthcare delivery and health outcomes for individuals living with COPD.

Keywords chronic obstructive pulmonary disease, hospitalization, mortality, readmissions

Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of death worldwide,[1] and presents one of the highest global disease burdens.[2] In the United States (US), annual healthcare costs for COPD are estimated at USD$29 billion,[3] while in the United Kingdom (UK), the annual burden of COPD is estimated at £1.9 billion.[4] In Australia, approximately 55% of the AUD$934 million annual cost of COPD is from treatment in Australian hospitals.[5]

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Many individuals living with COPD experience recurrent hospitalizations. Around 20% of patients hospitalized for an acute exacerbation of COPD are readmitted within 30 days, and approximately half of these readmissions are for non-respiratory causes.[6–8] In the US, COPD-related readmission costs are around 20% higher than initial hospitalization costs,[8] and 1:10 of these readmissions are considered to be potentially avoidable.[9]

Prior studies have examined predictors of readmission and mortality following COPD-related hospitalization, including factors such as age, sex and ethnicity,[10–13] comorbid conditions,[8,14,15] and history of health service use.[9,15–17] Mental disorders, including depression and anxiety, have been identified as highly comorbid with COPD[18,19] with several studies finding mental disorders to be predictive of hospital readmissions for individuals with COPD.[9,13,20–23] However, previous studies were limited by their use of health insurance-related data[21,23] or data from single health providers.[9,20] No studies have examined the role of mental disorders in readmissions for individuals with COPD using data from the predominantly publicly funded Australian health system.

The COVID-19 pandemic has had an impact on hospital admissions both in Australia and internationally, with studies finding a reduction in COPD admissions across the pandemic.[24,25] However, 30-day mortality estimates for patients admitted with COPD are inconsistent between studies.[24,26] In examining predictors of readmission for individuals with COPD, no studies have taken into account the COVID-19 period alongside other risk factors. This study aims to investigate the factors associated with unplanned readmissions and mortality following a COPD-related hospitalization over a 12-month period in Australia, focusing on mental disorders and accounting for the acute phase of the COVID-19 pandemic.

Method

Study design and study population

A retrospective cohort study using linked hospitalization and mortality records identified adults aged ≥40 years who had at least one hospital admission with a principal diagnosis of COPD between 1 January 2014 and 31 December 2020 in New South Wales (NSW), Australia. Ethical approval and a waiver of consent was obtained from the NSW Population and Health Services Research Ethics Committee (approval number 2022/ETH00861).

Data source and linkage

NSW hospitalization data includes both public and private hospitals, with dates of hospital episodes and up to 51 diag-nosis and procedure codes classified using the International Statistical Classification of Diseases and Related Health Problems, Australian modification (ICD-10-AM). The hospitalization data were provided for the period 1 January 2013 to 31 December 2021 with private hospital admissions to 30 June 2021. All hospital episodes of care related to the same admission were grouped into a period of hospital care. All episodes of care provided in a public in-patient aged care facility were excluded from the count of hospitalizations.

Mortality data was obtained from death registrations (fact of death) from the NSW Registry of Birth, Deaths and Marriages for the period 1 January 2014 to 30 June 2022. The Centre for Health Record Linkage conducted probabilistic matching to link the hospitalization and mortality data, and was supplemented by manual clerical review. Logic errors (e.g. admission post-death) were identified, and all admissions related to these patients were removed.

Case definition

COPD admissions, both planned and unplanned, were identified from the hospitalization data with a principal diagnosis of COPD (ICD-10-AM: J40, J41, J42, J43, J44). The first COPD admission between 1 January 2014 and 31 December 2020 was designated as the index admission for each patient.

Identification of covariates

The Australian Statistical Geography Standard (ASGS) 2016 categories of remoteness[27] were used to derive urban or rural classification, based on the individual's residential Statistical Areas Level 2 (SA2). The Index of Relative Socio-Economic Disadvantage (IRSD) of Socio-Economic Index for Areas (SEIFA) was also assigned based on the individual's residential SA2.[28]

The number of comorbidities was calculated using the Charlson Comorbidity Index[29] using a 12-month lookback period with COPD and dementia excluded from the count. The number of comorbidities was categorized as nil, 1–2 and ≥3 comorbidities. Due to clinical relevance to COPD, acute myocardial infarction, congestive heart failure and renal disease were identified separately using the Charlson Comorbidity Index. Mental and behavioural disorders were identified according to ICD-10-AM Chapter V and dementia was identified by including two additional codes (ICD-10-AM: G30, G31; Appendix A). Past and current smoking status and obesity were identified using corresponding ICD-10-AM codes within the 12-month lookback period.

Frailty risk was aggregated using the validated Hospital Frailty Risk Score[30] which assigns a score ranging from 0.1 and 7.1 to each of the 109 ICD-10-AM diagnosis or external

cause codes based on its frailty characteristics. Dementia and depression, as conditions of interest, were excluded from the final score. The score for an individual was calculated using ICD-10-AM codes in hospitalization records in the 12-month lookback period. Frailty risk was aggregated as low (<5), intermediate (5-15), or high (>15).

Unplanned readmission and mortality

All-cause acute and emergency admissions, including both public and private hospitals' post-index admission date of discharge, were identified as unplanned readmissions. If more than one readmission occurred within the follow-up period, the first readmission was considered the event of interest. All deaths were identified and deaths during the index admission were excluded from subsequent analysis.

Data management and analysis

Data management was conducted using SAS version 9.4 (SAS Institute, Cary NC) and statistical analysis used R version 4.2.2 with packages survival (3.5-3) SemiCompRisks (3.4).[31] Number and percentages were calculated for categorical variables. For continuous variables, mean and standard deviation (SD) were calculated. The chi-square test of independence or Fisher's exact test and Kruskal–Wallis rank sum test were used to determine differences between demographic characteristics by outcome.

All patients in the study population who were discharged alive were followed for 365 days post-discharge or to death. To understand the complex relationship between unplanned readmission and death, illness-death models were built using all-cause unplanned readmission after discharge, with death before end of follow-up as a semi-competing event.[32] The Grambsch, Therneau and Fleming plot[33] was used to assess the distribution of data. Time to unplanned readmission and/or death were modelled using parametric regression following the Weibull distribution with post-readmission death modelled using the Markov assumption with subject specific frailty. An indicator variable was created for individuals with >1 unplanned readmission and this indicator was included in the modelling for post-readmission death.

Variables previously identified as associated with hospital readmission and available in the data were assessed for modelling.[8,15,26,34] An indicator variable was added to identify hospital episodes from the start of the first COVID-19 cases recorded in NSW (13 January 2020) to the end of the study period. Univariate Weibull time-to-event regression was used to assess factors associated with unplanned readmission; those that did not significantly contribute to risk of unplanned readmission at $p < 0.1$ were excluded. The final multivariable

cause-specific model included: age group, sex, Aboriginality (Y/N), number of Charlson comorbidities (nil, 1–2, ≥3), frailty risk (low, moderate, high), urban or rural status, past and/or current smoking status (Y/N), mental disorder diagnosis (Y/N; or breakdown in different mental disorders), renal disease (Y/N), congestive heart failure (Y/N), residence in an aged care facility (Y/N) and index admission during the COVID-19 pandemic period (Y/N). Hazard ratios (HR) were calculated, and 95% confidence intervals (CIs) reported.

Results

There were 64 850 adults aged ≥40 years who had at least one COPD admission between 1 January 2014 and 31 December 2020, and 2450 (3.8%) died during the index admission. Of the 62 400 adults discharged alive, more than half (*n* = 34 513, 55.3%) had at least one unplanned readmission, and 15.8% died during the 365-day follow-up period. Of those who had at least one unplanned readmission, 22.6% (*n* = 7811) died during the follow-up period, and over half (*n* = 18 678; 54.1%) had more than one unplanned readmission (Supplementary Fig. 1). The risk of unplanned readmission and death post-readmission decreased rapidly within the first month post-discharge (Fig. 1). The risk of death prior to an unplanned readmission was relatively small throughout the 12-month follow-up period.

Individuals who had at least one unplanned readmission and who were alive at the end of the follow-up period were younger (mean age 73.2, SD 11.5), had a higher proportion of females (49.9%), and a higher proportion with no comorbidities (52.3%) compared with those who died following an unplanned readmission (Table 1). Individuals who had no unplanned readmissions and who were alive at the end of the follow-up period were younger (mean age 70.5, SD 11.6) and had a higher proportion of females (53.2%) compared with individuals who died pre- or post-readmission. Of those who had no readmission or death, nearly two-thirds (64.8%) had no comorbidities and 80% had a low frailty risk.

Individuals who died during the follow-up period without an unplanned readmission were older (≥85 years; 38.9%), with almost one-fifth (19.9%) residing in an aged care facility. A higher proportion of individuals who died without readmission had a mental disorder (44.8%), mainly dementia (11.6%), compared with individuals with no readmission or who had a readmission without death.

Individuals aged ≥85 years (HR 1.66, 95% CI 1.59–1.73), with ≥3 comorbidities (HR 1.66, 95% CI 1.57–1.76), who had a high frailty risk (HR 1.55, 95% CI 1.46–1.65), or at least one mental disorder diagnosis (HR 1.19, 95% CI 1.16–1.22) had a

Table 1 Characteristics at index admission of adults aged ≥40 years who had a COPD hospital admission between 1 January 2013 and 31 December 2021 by outcome at the end of 12-month follow-up in NSW

Characteristic	No event	Readmission without death	Death prior to readmission	Death post-readmission	p-value [a]
	n = 25 837	n = 26 702	n = 2050	n = 7811	
Age, mean (SD)	70.5 (11.6)	73.2 (11.5)	79.7 (10.7)	77.7 (10.3)	< 0.0001
Age group					< 0.0001
40–64	7601 (29.4%)	5831 (21.8%)	210 (10.2%)	863 (11.0%)	
65–74	8159 (31.6%)	7741 (29.0%)	380 (18.5%)	1873 (24.0%)	
75–84	7050 (27.3%)	8613 (32.3%)	663 (32.3%)	2887 (37.0%)	
≥85	3027 (11.7%)	4517 (16.9%)	797 (38.9%)	2188 (28.0%)	
Sex					< 0.0001
Male	12 083 (46.8%)	13 375 (50.1%)	1127 (55.0%)	4537 (58.1%)	
Female	13 754 (53.2%)	13 327 (49.9%)	923 (45.0%)	3274 (41.9%)	
Index admission LOS (days)	5.8 (21.6)	6.8 (18.7)	13.4 (39.4)	9.8 (18.7)	< 0.0001
ICU stay during index admission	1042 (4.0%)	1024 (3.8%)	95 (4.6%)	317 (4.1%)	0.2532
Index admission during COVID pandemic	1868 (7.2%)	1734 (6.5%)	167 (8.1%)	547 (7.0%)	0.001
Total days in hospital due to unplanned readmission	–	25.8 (58.4)	–	33.6 (43.7)	< 0.0001
More than one unplanned readmission	–	14 209 (53.2%)	–	4469 (57.2%)	< 0.0001
Aged care resident	538 (2.1%)	603 (2.3%)	408 (19.9%)	535 (6.8%)	< 0.0001
Residential location					< 0.0001
Urban	14 534 (58.5%)	16 489 (62.5%)	1195 (58.5%)	4810 (61.9%)	
Rural	10 307 (41.5%)	9893 (37.5%)	849 (41.5%)	2957 (38.1%)	
Not known	996	320	6	44	
SEIFA IRSD quintile					0.0004
1 (most disadvantaged)	7258 (29.2%)	7856 (29.8%)	556 (27.2%)	2324 (29.9%)	
2	7577 (30.5%)	7685 (29.1%)	666 (32.6%)	2348 (30.2%)	
3	4559 (18.4%)	5056 (19.2%)	348 (17.0%)	1415 (18.2%)	
4	2475 (10.0%)	2701 (10.2%)	209 (10.2%)	813 (10.5%)	
5 (least disadvantaged)	2970 (12.0%)	3080 (11.7%)	265 (13.0%)	865 (11.1%)	
Not known	998	324	6	46	
Number of comorbidities[b]					< 0.0001
nil	16 735 (64.8%)	13 955 (52.3%)	782 (38.1%)	2857 (36.6%)	
1–2	8000 (31.0%)	10 205 (38.2%)	961 (46.9%)	3575 (45.8%)	
≥ 3	1102 (4.3%)	2542 (9.5%)	307 (15.0%)	1379 (17.7%)	
Frailty risk					< 0.0001
Low	20 681 (80.0%)	17 992 (67.4%)	908 (44.3%)	3846 (49.2%)	
Intermediate	4542 (17.6%)	7312 (27.4%)	857 (41.8%)	3130 (40.1%)	
High	614 (2.4%)	1398 (5.2%)	285 (13.9%)	835 (10.7%)	
Smoking (past & current)	19 469 (75.3%)	20 736 (77.7%)	1434 (70.1%)	5997 (76.5%)	< 0.0001
Obesity	2291 (8.9%)	2747 (10.3%)	133 (6.5%)	587 (7.5%)	< 0.0001
Mental and behaviour disorders	7291 (28.2%)	9277 (34.7%)	919 (44.8%)	3242 (41.5%)	< 0.0001
Dementia	452 (1.7%)	758 (2.8%)	238 (11.6%)	493 (6.3%)	< 0.0001
Depression	162 (0.6%)	397 (1.5%)	25 (1.2%)	101 (1.3%)	< 0.0001
Anxiety	977 (3.8%)	1552 (5.8%)	137 (6.7%)	584 (7.5%)	< 0.0001
Other mental disorder	6466 (25.0%)	8169 (30.6%)	710 (34.6%)	2683 (34.3%)	< 0.0001
Congestive heart failure	2824 (10.9%)	5024 (18.8%)	625 (30.5%)	2378 (30.4%)	< 0.0001
Renal disease	1292 (5.0%)	2702 (10.1%)	320 (15.6%)	1382 (17.7%)	< 0.0001

[a]Pearson's Chi-squared test; Kruskal-Wallis rank sum test; Wilcoxon rank sum test
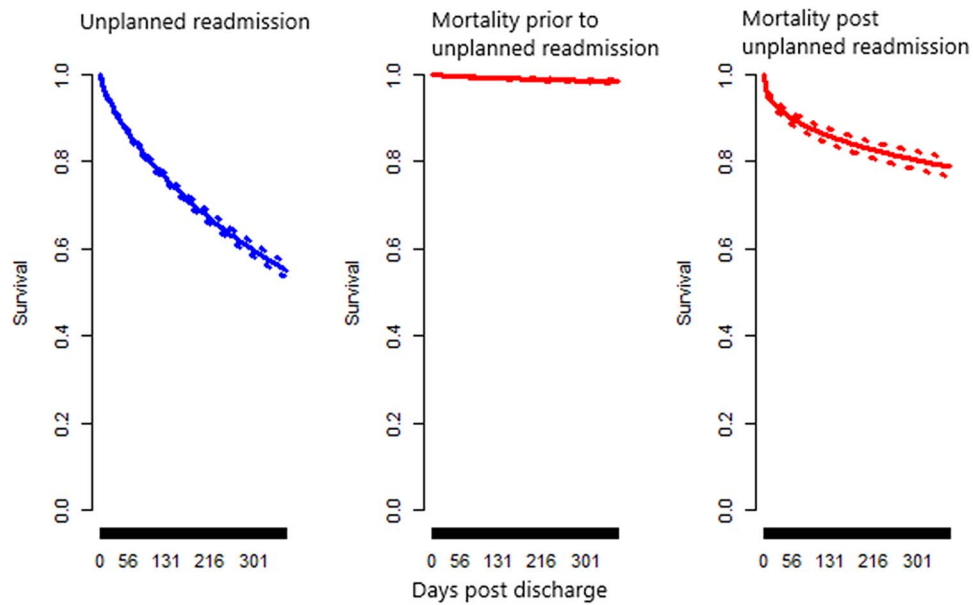[b]excluding COPD, mental health and behaviour disorders.

Fig. 1 Extended readmission-mortality model with semi-competing risks for unplanned readmission and death prior to readmission, and death after unplanned readmission in days, linked NSW hospitalization and aged care records, 1 January 2014 to 30 December 2021.

higher risk of having an unplanned readmission compared to reference categories. Females (HR 0.88, 95% CI 0.86–0.90), individuals living in a rural area (HR 0.94, 95% CI 0.92–0.97), those living in an aged care facility (HR 0.85, 95% CI 0.79–0.91), and those with an index admission during the COVID-19 pandemic (HR 0.93, 95% CI 0.88–0.97) all had a lower risk of having an unplanned readmission compared to reference categories (Table 2).

Being in an older age group, having a higher number of comorbidities and increased frailty were all associated with an increased risk of death either pre- or post- unplanned readmission compared with reference groups. Individuals who lived in a rural area also had higher risk of death both pre- (HR 1.25, 95% CI 1.14–1.37) and post- (HR 1.16, 95% CI 1.11–1.22) unplanned readmission compared with individuals in urban areas. Individuals who had their index admission during the acute phase of the COVID-19 pandemic had increased risk of death without having an unplanned readmission (HR 1.18, 95% CI 1.00–1.39), but no statistically significant difference in the risk of death post-readmission, compared to individuals who had index admission prior to COVID-19 pandemic.

A mental disorder diagnosis was associated with having an unplanned readmission (HR 1.19, 95% CI 1.16–1.22), death pre- (HR 1.43, 95% CI 1.30–1.58) and post- (HR 1.21, 95% CI 1.15–1.27) unplanned readmission compared with adults who did not have a mental disorder diagnosis. When modelled on different mental disorders, individuals with an anxiety disorder had 1.33 times the risk (95% CI 1.25–1.41) of having an

unplanned readmission, 1.33 times the risk (95% CI 1.09–1.62) of death pre- unplanned readmission, and 1.38 times the risk (95% CI 1.25–1.53) of death post-readmission compared to adults without an anxiety disorder diagnosis. Having a dementia diagnosis was associated with higher risk of death both pre- (HR 1.70, 95% CI 1.46–1.98) and post- (HR 1.35, 95% CI 1.21–1.50) unplanned readmission (Table 3).

Discussion

Main findings of this study

This study examined the factors associated with unplanned readmissions and mortality following a COPD-related hospitalization over a 12-month period in Australia, focusing on mental disorders and accounting for the acute phase of the COVID-19 pandemic. Being of older age, being female, having a higher number of comorbidities, having higher frailty risk, a mental disorder diagnosis, living in rural areas, and having an index admission during the COVID-19 period were found to be predictive of an unplanned hospital readmission.

What is already known on this topic & what this study adds

Individuals with a mental disorder, specifically anxiety, had a higher risk of unplanned readmission compared with individuals without these diagnoses. Mental disorders, such as anxiety and depression, have previously been predictive of hospital admissions of individuals with COPD.[9,23] The effects of

Table 2 Semi-competing risk analysis of common factors associated with unplanned hospital readmission and mortality up to 12-month follow-up, linked NSW hospitalization and death records, 1 January 2013 to 31 December 2021

	Readmission		Death prior to readmission		Death post-readmission	
	Adjusted HR	95% CI	Adjusted HR	95% CI	Adjusted HR	95% CI
Sex						
Male	1	–	1	–	1	–
Female	0.88	(0.86, 0.90)	0.73	(0.66, 0.80)	0.76	(0.73, 0.80)
Age group						
40–64	1	–	1	–	1	–
65–74	1.23	(1.19, 1.28)	1.39	(1.17, 1.65)	1.53	(1.40, 1.66)
75–84	1.49	(1.43, 1.54)	2.13	(1.81, 2.50)	1.98	(1.82, 2.15)
≥85	1.66	(1.59, 1.73)	3.87	(3.27, 4.58)	2.7	(2.47, 2.96)
Number of comorbidities[a]						
nil	1	–	1	–	1	–
1–2	1.27	(1.23, 1.31)	1.55	(1.39, 1.74)	1.41	(1.33, 1.5)
≥3	1.66	(1.57, 1.76)	1.93	(1.61, 2.31)	1.79	(1.63, 1.97)
Frailty risk						
Low	1	–	1	–	1	–
Intermediate	1.41	(1.37, 1.46)	2.02	(1.81, 2.24)	1.5	(1.42, 1.59)
High	1.55	(1.46, 1.65)	2.57	(2.19, 3.02)	1.61	(1.47, 1.77)
Residential location						
Urban	1	–	1	–	1	–
Rural	0.94	(0.92, 0.97)	1.25	(1.14, 1.37)	1.16	(1.11, 1.22)
Mental disorder diagnosis						
No	1	–	1	–	1	–
Yes	1.19	(1.16, 1.22)	1.43	(1.30, 1.58)	1.21	(1.15, 1.27)
Aged care resident						
No	1	–	1	–	1	–
Yes	0.85	(0.79, 0.91)	3.84	(3.39, 4.35)	2.05	(1.85, 2.28)
Index admission during COVID-19 pandemic						
No	1	–	1	–	1	–
Yes	0.93	(0.88, 0.97)	1.18	(1.00, 1.39)	1.05	(0.96, 1.16)

Abbreviation: Adjusted HR, adjusted hazard ratio.

Note: model also adjusted for Aboriginality, past and current smoking status, congestive heart failure, renal disease diagnosis during lookback periods. Death post-readmission model component also adjusted for multiple unplanned readmissions.

[a]excluding COPD, mental health and behaviour disorders.

anxiety on an individual with COPD are bidirectional,[35] and can lead to a high symptom burden for individuals. In relation to readmissions, it is possible that a COPD-related breathing difficulty may be misattributed as a symptom of anxiety, or vice versa, which could lead to heightened arousal and an increased need for readmission.[23]

A higher risk of death both pre- and post- unplanned readmission was also found in this study for COPD patients with a mental disorder diagnosis, specifically anxiety or dementia. A prior meta-analysis found comorbid depression and anxiety increased the risk of COPD exacerbations and mortality, as poor mental health can hinder adherence to treatment plans

and COPD prognosis.[35] Individuals with mental disorders, especially those with dementia, may also have limited social support and reduced capacity to self-manage COPD symptoms.[19,23,36] These factors may contribute to the higher risk of death pre- and post-admission found for COPD patients with mental disorders in this study.

In this study, individuals living in rural areas had a lower risk of unplanned readmission, and higher risk of death, both pre- and post-unplanned readmissions. A previous US study identified that adjusting for travel time, patients in rural areas had fewer COPD-related hospitalizations,[37] highlighting the importance of service accessibility. In this study, individuals

Table 3 Semi-competing risk analysis of common factors and separate mental disorders diagnosis associated with unplanned hospital readmission and mortality up to 12-month follow-up, linked NSW hospitalization and death records, 1 January 2013 to 31 December 2021

	Readmission		Death prior to readmission		Death post-readmission	
	Adjusted HR	95% CI	Adjusted HR	95% CI	Adjusted HR	95% CI
Sex						
Male	1	–	1	–	1	–
Female	0.88	(0.85, 0.90)	0.73	(0.67, 0.80)	0.76	(0.72, 0.80)
Age group						
40–64	1	–	1	–	1	–
65–74	1.24	(1.19, 1.28)	1.37	(1.16, 1.63)	1.52	(1.39, 1.65)
75–84	1.5	(1.44, 1.56)	2.07	(1.75, 2.43)	1.95	(1.79, 2.12)
≥85	1.68	(1.61, 1.75)	3.71	(3.13, 4.40)	2.65	(2.42, 2.90)
Comorbidity count[a]						
nil	1	–	1	–	1	–
1–2	1.27	(1.24, 1.31)	1.55	(1.39, 1.74)	1.41	(1.33, 1.50)
≥3	1.67	(1.58, 1.77)	1.96	(1.63, 2.35)	1.79	(1.63, 1.97)
Frailty risk						
Low	1	–	1	–	1	–
Intermediate	1.40	(1.36, 1.45)	2.01	(1.81, 2.24)	1.50	(1.42, 1.59)
High	1.52	(1.43, 1.61)	2.53	(2.15, 2.98)	1.61	(1.46, 1.76)
Residential location						
Urban	1	–	1	–	1	–
Rural	0.94	(0.92, 0.97)	1.25	(1.14, 1.37)	1.16	(1.11, 1.22)
Anxiety diagnosis						
No	1	–	1	–	1	–
Yes	1.33	(1.25, 1.41)	1.33	(1.09, 1.62)	1.38	(1.25, 1.53)
Depression diagnosis						
No	1	–	1	–	1	–
Yes	1.33	(1.17, 1.5)	0.91	(0.59, 1.41)	0.65	(0.52, 0.82)
Dementia diagnosis						
No	1	–	1	–	1	–
Yes	1.09	(1.02, 1.17)	1.70	(1.46, 1.98)	1.35	(1.21, 1.5)
Other mental and behaviour disorder diagnosis						
No	1	–	1	–	1	–
Yes	1.14	(1.11, 1.18)	1.22	(1.10, 1.35)	1.09	(1.04, 1.16)
Aged care resident						
No	1	–	1	–	1	–
Yes	0.85	(0.79, 0.91)	3.69	(3.25, 4.19)	2.03	(1.83, 2.25)
Index admission during COVID-19 pandemic						
No	1	–	1	–	1	–
Yes	0.93	(0.89, 0.98)	1.19	(1.01, 1.4)	1.06	(0.96, 1.16)

Abbreviation: Adjusted HR, adjusted hazard ratio.

Note: model also adjusted for Aboriginality, past and current smoking status, congestive heart failure, renal disease diagnosis during lookback periods. Death post-readmission model component also adjusted for multiple unplanned readmissions.

[a]excluding COPD, mental health and behaviour disorders.

with COPD in rural areas may avoid hospital due to distance and may have only presented to hospital for very severe, or late-stage symptoms, reflected in the observed mortality. However, a US study found that rural living was not associated with mortality over the long-term for COPD patients.[37] These differing findings to the current study may be attributed to different study populations, where the US study only included US veterans aged ≥65 years, and employed

different analysis methods[37] which may have influenced risk estimates.

Individuals with COPD who had their index admission during the COVID-19 pandemic had lower risk of unplanned readmission, but higher risk of death without readmission in this study. Prior literature found that hospital admissions decreased during this period,[24,25] indicating that concerns about infection or overloading the health system[38] may have increased the threshold for healthcare utilization. However, the lower risk of readmission and higher risk of death without readmission highlight that potentially, individuals may have had severe symptoms but were not presenting to hospital. Alternatively, individuals with COPD admissions during this period may have been differentially affected by mental or physical health challenges,[25] thus worsening the burden of COPD and contributing to the observed mortality.

Limitations of this study

The strengths of this study include that it used population-level linked health data, a 12-month lookback period, a 12-month follow-up period, and investigated mental disorders in an Australian context. However, the prevalence of mental disorders is lower in this study than previous cohorts,[18] as only diagnoses related to episodes of care were recorded in the administrative data, compared with other identification methods.[39] The lack of clinical measures in the dataset limited the study, as disease severity was unable to be adjusted for. Cause of death was also not available for all deaths in this study, which would broaden interpretation of all-cause versus COPD-related mortality. The interpretation of the effect of COVID-19 was also limited by its inclusion in the model only as an indicator variable.

Conclusion

The factors identified in this study, particularly mental disorders and rurality, could inform the development of a risk stratification algorithm to predict readmission or mortality outcomes for COPD patients.[8,13,40] COPD-related hospitalization could then be mitigated through interventions targeted at high-risk individuals. Factors such as anxiety are treatable through non-acute healthcare services,[41] which reduce the burden on hospitals and related healthcare expenditures, and improve patient outcomes for individuals living with COPD.

Acknowledgements

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Declaration of interest

Funding

Authors' contributions

SW and ZS wrote the first draft of the manuscript. ZS conducted the data analysis with assistance from RM and TBP. All authors (i.e., SW, ZS, TBP, JL, JB, DC, JFL, DW, JW, RM) edited and approved the final manuscript.

Ethics approval

Ethical approval and a waiver of consent was obtained from the NSW Population and Health Services Research Ethics Committee (approval number 2022/ETH00861) in view of the retrospective nature of the study.

Data availability

The data that support the findings of this study are available from the NSW Ministry of Health. Restrictions apply to the availability of these data, which were used under licence for the current study, so are not publicly available.

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Appendix A

ICD-10-AM codes used for identifying comorbidity and conditions not included in Charlson Comorbidity Index:

All mental disorders: F00-F99, G30, G31.
Anxiety disorder: F40-F48.
Dementia: F00-F03, F05.1, G30, G31.
Depressive disorder: F20.4, F31.3, F31.4, F31.5, F32, F33, F34.1, F41.2, F43.2.
Other mental disorders: all mental disorders code excluding anxiety, depressive disorders and dementia code.
Obesity: E66, U78.1.
Smoking: F17, Z72.0, Z71.6, Z86.43.