Factors contributing to COPD hospitalisations from 2010–2015: Variation among rural and metropolitan Australians.

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DT conceived and designed the study; DT analyzed the data; HN, JK and MRI contributed to the analysis and interpretation of the results; MRI revised and wrote in part, and DT, HN and JK wrote the paper. All authors read and approved the final manuscript.

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Factors contributing to COPD hospitalisations from 2010–2015: Variation among rural and metropolitan Australians.

Introduction: Rural and remote populations experience the greatest burden of chronic obstructive pulmonary disease (COPD), the fifth leading cause of death in Australia. Currently there is a need to prioritise health services to improve health outcomes among those at higher risk of COPD.

Objectives: To investigate the differences in COPD hospitalisation between rural and urban populations and determine predictive factors contributing to COPD hospitalisation.

Methods: State-wide hospitalisation data from 2010 to 2015 were obtained through the Victorian Admitted Episodes Dataset and other key datasets. The rates of hospitalisation were analysed using hierarchical multiple regression to examine the association between COPD hospitalisations and a number of predictor variables.

Results: The highest COPD incidence occurred in metropolitan males aged 85 years of age and older (35.092 hospitalisations per 1000 population). Among metropolitan residents, smoking, population density, and household income had a significant association with COPD hospitalisations for both sexes. Among rural males, smoking rates, household income, and rural land use (farming) were significant predictors of COPD hospitalisations. There was an overall stability in state-wide COPD hospitalisation over the five years to 2015, p=0.420.

Conclusion: This investigation highlights many rural and regional areas have much lower COPD hospitalisation rates than metropolitan areas. Between males and females, there are heterogenetic factors that contribute to the significant variation associated with COPD hospitalisation in metropolitan and rural areas, such as rural land use among rural males. This indicates that risk factor assessments, beyond smoking alone, need to be individualised and prioritised in practice to optimise care.

Keywords: Chronic Obstructive Pulmonary Disease, Hospitals, Chronic Disease, Self-Management, Urban Population, Rural Population

Introduction

Chronic obstructive pulmonary disease (COPD) is an umbrella term that encompasses a group of progressive life-threatening lung diseases characterized by airway inflammation and airflow limitations[1]. COPD cannot be fully reversible and this chronic respiratory condition usually entails symptoms such as breathlessness, chronic cough, and sputum production with increasingly serious complications and exacerbations[1]. According to a recent report by WHO[2], COPD claimed 3.17 lives per 100,000 population in 2015, accounting for 5.7% of global total deaths and making it the fourth leading cause of deaths. In their projections about COPD in the next 15 years, Khakban and his colleagues[3] predicted a substantial increase in the total number of COPD diagnoses (155%), COPD-related hospitalisations (210%) and the burden of inpatient care (182%) by 2030.

In Australia, COPD is also a notable cause of mortality and disability that exerts a heavy burden on the health care system[4]. COPD affects about 17% of Australians aged 40 or over, and 29% of Australians in the 75-or-over age range[5]. As the fifth leading cause of death in Australia, COPD claimed the lives of 6,462 people in 2013 (4.4% of the national total mortality) currently costing AUD$929 million/year and as much as AUD$8.8 billion in loss of productivity[6].

The well-documented risk factors of COPD include tobacco smoking; exposure to indoor, outdoor or occupational pollutants; socio-economic status (SES); age; and geographic location [5,7-10] For example, in Australia, COPD is reported in a higher proportion of the population in regional, rural and remote settings than in major cities[7]. People with COPD in rural areas encounter difficulties typical of lower socio-economic regions, such as extensive travel to access health care, poorer health services, unstable

local physician availability, exposure to health hazards, and a lack of respiratory-related education and support[11].

In the state of Victoria, Australia, hospitalisation rates for COPD have reflected the national trend with higher rates in rural than in metropolitan areas, and significant associations have been found between COPD hospitalisation rates and socio-economic status and remoteness of the area[12]. In their recent analysis of hospitalisation, readmissions, mortality, and burden of disease, Ore and Ireland [13] found significant inverse associations between COPD and SES, with Victorians in the most disadvantaged areas being most affected by COPD.

Current evidence highlights the need to consider various contributing factors to COPD, and to prioritise health services and interventions to improve outcomes, especially for those with a higher risk of COPD.

Aims

To further understand COPD trends and associations in Australia, this paper aims to (1) investigate the differences in COPD hospitalisation across Victorian rural and urban areas and between age groups, (2) determine the key factors that have an impact on COPD among males and females in rural and urban regions; and (3) examine why key factors have a different impact on COPD hospitalisation between rural and urban counterparts.

Materials and Methods

Research site

Victoria has a similar population size to Denmark with more than 6.1 million people living across the 237,269 square kilometre area[14]. It encompasses 79 local government

areas (LGA) that range from 20 to 22,213 square kilometres in size with population densities across the LGAs ranges from 0.47 to 4413.26 people per square kilometre. In the state, there are over 300 public and private hospitals including district hospitals and bush nursing services[15].

Data collection

Hospitalisation data for a five-year period from 1 July 2010 to 30 June 2015 were obtained from the Victorian Admitted Episodes Dataset (VAED). As discussed elsewhere[16], data included sex, age (5-year age groups), LGA or region of residence, private or public patient, bed days used as the unit of measurement for length of stay, type of discharge, and diagnosis on hospitalisation according the ICD-10-AM. COPD as the principal diagnosis was identified using the ICD-10-AM codes J43.1, J43.2, J43.8, J43.9, J44.0, J44.1, J44.8, and J44.9. Ethical approval for the research was obtained in March 2015. Others sources of data were included as outlined previously[16], and were sourced from the Australian Bureau of Statistics[17].

Data analysis

Population figures at the LGA level were used to calculate hospitalisation rates across the 79 LGAs in Victoria. Hospitalisations were divided by the corresponding population estimates for each year according to gender, age group and LGAs to obtain standardised hospitalisation rates. Age groups were examined only among adults (≥40 years), given the relatively small number of COPD cases among individuals aged less than 40 years and the greater proportion of hospital expenditure occurring among the ≥40 years of age groups[5].

COPD and predictor variables were analysed according to hospitalisation rates using Statistical Package for the Social Sciences (SPSS, Version 22.0). Hierarchical

multiple regression was used to examine the association between COPD hospitalisations and a number of predictor variables. To adjust for percentage of smokers, this variable was entered at step 1 after which GPs per 1000 population, percentage of Aboriginal and Torres Strait Islanders, the four Socio-Economic Indexes for Areas which includes Index of Relative Socio-economic Advantage and Disadvantage (IRSAD), Index of Relative Socio-economic Disadvantage (IRSD), Index of Economic Resources (IER), Index of Education and Occupation (IEO), and also Accessibility and Remoteness Index of Australia 2011 (ARIA+) were entered into step 2. The initial analysis was conducted to ensure there was no violation of the assumptions of normality, homoscedasticity, multicollinearity, and liberality[18]. Significance was determined at two-tailed $p < 0.05$.

Results

Between the financial years 2010-11 and 2014-15, there were 71,262 total hospitalisations for COPD among Victorians aged 40 years old and older, of which 46,074 (64.6%) occurred at metropolitan hospitals, 56,080 (78.6%) were 65 years of age or older, and 51,651 (72.4%) were publically funded hospitalisations. Females contributed towards 32,754 (46.0%) of all hospitalisations (Table 1).

[Table 1 about here or as an online supplement]

The incidence rate of COPD hospitalisations across the whole State over the five-year period was 5.264 (95% CI: 5.260-5.268) per 1000 population. The incidence rates were higher among the male population than the female population, while males aged 65 years and older had a higher incidence rate than females in the same age group. In addition to State averages, the mean hospitalisation rates were significantly higher among metropolitan males compared with rural males and were different among rural

and metropolitan females where rural females had higher rates than metropolitan females. However, when examining State-wide hospitalisation rates among the 85 years of age and over population, the mean rates were significantly higher among metropolitan males than rural males. Similarly, among females aged 85 years of age and over, metropolitan females had higher hospitalisation rates than rural females as demonstrated in Table 2 and Figure 1.

[Table 2 about here]

Figure 1: Hospitalisation incidence rate per 1000 population according to age, sex and residence

[Figure 1 about here]

Standardised hospitalisation rates for COPD between 2010-11 and 2014-15, and the overall mean Victorian incidence rates remained relatively stable with a non-significant increase of 0.77% in the average hospital hospitalisations over the time period, p=0.420. The data highlights that despite differences between metropolitan and rural male and female hospitalisations, the change in rates between each group over the time period remained relatively similar. However, hospitalisation rates for COPD were consistently higher among metropolitan males compared to metropolitan females and both male and female rural Victorians over the five-year period, p=0.001.

Figure 2: Variation of hospitalisation incidence rates per 1000 population for COPD between 2010-11 and 2014-15

[Figure 2 about here]

Multiple regression analyses highlighted several significant predictors of COPD hospitalisation rates between metropolitan and rural sexes. After controlling for percentage of smokers, it was indicated that the predictor variables explained between 60% and 78% of the variance that attributes to COPD hospitalisation (Table 3).

[Table 3 about here]

Among metropolitan residents, as outlined in Table 4, smoking, population density, and household income had a significant association with COPD disease hospitalisation rates for both females and males. Among metropolitan males the number of GPs per 1,000 population was also an additional significant predicting factor.

When examining rural female residents, there were no significant associations with any of the factors identified. However, among rural males, percentage of smokers and household income were identified as significant predictors. Lastly, among rural males, rural land use such as farming, which is the most common use of rural land[19], was also a predictor for COPD disease hospitalisation rates among rural males.

[Table 4 about here]

Discussion

The overall findings are in line with the literature that has identified smoking as contributing to COPD[23], and is reflective of it being one of the key factors leading to

hospitalisation among all cohorts except for rural females. Although smoking was indicated not to be significant among rural females, it was identified to be the factor that was likely to cause hospitalisation in this group. Apart from smoking having an association with COPD hospitalisations, there were divergent findings between metropolitan and rural males and female cohorts. For example, one of the key factors among metropolitan males was the proportion of GPs, where the greater the number of GPs in the areas, the more likely metropolitan males were to be hospitalised, which may reflect the increased diagnosis of COPD or the need of hospitalisations among males.

This too may be reflective of why there is a higher hospitalisation rate among aboriginal men in metropolitan areas. These findings may be due to a lower percentage of aboriginal men and women in metropolitan Victoria[24]. This would suggest either there is greater proportion of metropolitan male aboriginals with a diagnosis of COPD, or this group of men seek care at the tertiary level, rather than at the primary care level[25]. Regardless, the rate remains alarming and highlights who shoulders the greater burden of disease and where health services need to prioritise key interventions to improve outcomes.

Among metropolitan females, it was found that those who are more socioeconomically disadvantaged are more likely to be hospitalised with COPD, which suggests that they do not have appropriate access to or are less likely to engage with primary health care services, and may be more likely to have the low levels of health literacy concerning COPD management[11]. Further, among rural males, a key finding was as household income increased, their rate of COPD hospitalisation decreased. However, of greatest concern is the percentage of land use impacting COPD hospitalisation among rural males. It was highlighted that the greater the percentage of land being used for farming rural areas the greater the rate of COPD hospitalisations

occurred. One possible reason is living and working in rural areas has the potential for greater exposure to fumes, dust, pesticides and herbicides which may be a contributing factor to chronic respiratory illnesses such as COPD[26].

Regardless of these findings, the study demonstrated that there was an overall stability in state-wide hospitalisation for COPD over the five years from 2010 to 2015 with the highest incidence occurring among metropolitan males, and contrary to previous research or projections[12]. Further, it was highlighted that hospitalisation rates among rural females aged 65 years and over were significantly higher than their metropolitan counterparts, and consistent with the globally observed increase in the prevalence of COPD in females[20].

Overall, metropolitan males aged 85 or more years of age had the highest hospitalisation rates than all age groups and cohorts, and males aged 75 years and older were consistently higher than other cohorts of the same age. However, rural females shared a similar incidence rates with metropolitan males until the age of 75 year or older when rural female hospitalisation rates steadily decreased until they paralleled rural males and metropolitan females over the age of 85 years. These findings are in line with the current body of research which indicates that COPD incidence increases with age[5,8] and peaks among those aged 75 or older[21].

Beyond the key factors identified as contributing to COPD hospitalisations, patients may experience delays in accessing medical care, particularly in rural area, or may tolerate worsening symptoms and only seek medical care when symptoms reach a critical point[27]. Further, it has been identified that knowledge of COPD is often inadequate among patients and they are less-equipped to manage acute episodes. In one study, it was shown that only a third of people diagnosed with COPD received a written

action plan, compared with asthma patients who were given written action plans by GPs in 52.9% of cases[28].

The current best practice for diagnosing and care of individuals with COPD focuses on confirming diagnosis and severity of COPD, optimising function, preventing deterioration, developing support networks and self-management strategies[29]. However, clinical practice does not always reflect current recommendations and identifying COPD symptoms and risk factors may be under-appreciated in practice[30]. Nevertheless, this research has highlighted the relative stable hospitalisation rates over a five-year period, suggesting inroads are being achieved. However, the study also emphasised the groups that are most vulnerable, key factors contributing to COPD, while indicated where resources and health services need to be prioritised.

A limitation of this study was that it was a retrospective study that examined COPD hospitalisation data. The dataset used in this study provided information on each admitted patient episode; however, waiting times, severity of illness, rates of patient readmission, or quality of treatment were not provided, and therefore, could not be determined or analysed. Nevertheless, the study incorporates a complete dataset of state-wide COPD hospitalisation between 2010 and 2015 and provides insight into the urban-rural differences across an Australian state where more than one-quarter of the Australian population resides.

This investigation provides insight into the key factors that contribute to the significant variation associated with COPD hospitalisation in metropolitan and rural areas in Victoria. Those key factors are smoking, social disadvantage, cultural background, access to primary care, gender and age. It was found that COPD among older metropolitan males was much higher than other cohorts. It may indicate that these higher rates occur due to greater accessibility to primary health care or that greater

numbers of GPs in the LGA increases the likelihood for interventions at the tertiary level. These results add to the emerging literature concerning geographic and gender disparities among patients with COPD. Thus, public health efforts and health services interventions concerning COPD management should aim to improve the quantity and quality of primary health care delivery, while focusing on holistic strategies that address the needs of the individual, community, workplace and policies for in both rural and metropolitan areas. Although barriers to healthcare access are diverse and often complex, future research and healthcare must appreciate the unique factors that impact COPD outcomes among different groups of individuals.

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Table 1: Descriptive data associated with COPD hospitalisations between rural and metropolitan males and females from 2010-11 to 2014-15

	Females				Males			
Patient factor	Metropolitan		Rural		Metropolitan		Rural	
Age (years)	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
40–44 years	259	1.2	168	1.5	170	0.7	100	0.7
45–49 years	464	2.2	267	2.4	334	1.4	182	1.3
50–54 years	706	3.3	563	5.0	524	2.1	393	2.8
55–59 years	1217	5.7	806	7.1	1278	5.2	583	4.2
60–64 years	1977	9.2	1116	9.8	1922	7.8	1153	8.3
65–69 years	2820	13.2	1453	12.8	2993	12.1	1786	12.9
70–74 years	3163	14.8	1983	17.5	3788	15.3	2306	16.7
75–79 years	3266	15.3	1880	16.5	4420	17.9	2488	18.0
80–84 years	3657	17.1	1649	14.5	4653	18.9	2552	18.5
85+ years	2864	18.1	1476	13.0	4599	18.7	2284	16.6
Where hospitalised								
Metropolitan	20762	98.9	631	5.4	24073	99.0	608	4.3
Rural	227	1.1	11134	94.6	252	1.0	13575	95.7
Patient type								
Public	14232	67.8	9281	78.8	17354	71.3	10784	76.0
Private	6724	32.0	2479	21.1	6892	28.4	3366	23.7
Other	33	0.2	5	0.1	79	0.3	33	0.2
Hospitalisation type								
Elective	17045	81.2	9303	79.1	3575	83.9	11385	80.3
Emergency	3629	17.3	2093	17.8	20410	14.7	2448	17.3
Other	315	1.5	369	3.1	340	1.4	350	2.5
Hospital discharge mode								
To private accommodation	15680	76.3	9220	81.8	18725	78.4	11191	81.8
To other care	3994	19.4	1548	13.7	4030	16.8	1809	13.2
Left against medical advice	137	0.9	89	0.8	194	1.0	108	0.8
Death	748	3.6	421	3.7	920	3.8	574	4.2
Length of stay								
Mean	6.29		6.43		5.76		6.17	
Range	1.00 – 181.00		1.00 – 325.00		1.00-231.00		1.00 – 260.00	

Table 2: Incidence rate per 1000 population of COPD hospitalisations

	Incidence rate	95% CI	Incidence rate	95% CI	p-vale
	Rural		Metropolitan		
Males	3.728	3.723-3.734	6.261	6.251-6.270	.001
- Aged over 65 years	8.886	8.862-8.910	16.302	16.259-16.345	.001
- Aged over 85 years	14.034	13.918-14.149	35.092	34.810-35.374	.001
Females	4.059	4.054-4.063	6.334	6.321-6.346	.001
- Aged over 65 years	12.717	12.676-12.758	9.998	9.977-10.019	.001
- Aged over 85 years	13.599	13.489-13.709	14.435	14.361-14.509	.001

* $p < 0.05$

Table 3: Hierarchical Multiple Regression model summary

	Percentage of variance[§]	ANOVA[†]
Metropolitan males	78.2%	F(13,30)= 4.678, p = .002
Rural Males	69.5%	F(13,47)= 5.967, p = .001
Metropolitan Females	75.6%	F(13,30)= 4.048, p = .004
Rural Females	60.4%	F(13,47)= 3.982, p = .001

[§]Indicates the proportion that the factors in the model are responsible for COPD. [†] F-statistic used to test the hypothesis that the data set in the regression analysis follows the simpler of two proposed linear models that are nested within each other.

Table 4: Regression analysis of COPD and rurality from 2010-11 to 2014-15

	Females					
	Metropolitan			Rural		
Predictor	Adj.OR[±]	95% CI	p-value	Adj.OR	95% CI	p-value
Percentage of smokers	1.071	1.016-1.128	0.01*	1.111	0.982-1.257	0.09*
GP attendance per 1,000 pop.	0.997	0.915-1.086	0.01*	0.984	0.999-1.001	0.32
Population density (Km^2)	1.000	1.000-1.001	0.02*	1.000	0.990-1.008	0.91
IRSAD	0.999	0.998-0.999	0.80	0.999	0.780-1.031	0.12
IRSD	1.000	0.975-1.027	0.94	1.054	0.966-1.150	0.22
IER	1.016	0.999-1.034	0.05	1.028	0.975-1.084	0.29
IEO	0.987	0.963-1.012	0.31	1.017	0.970-1.065	0.46
ARIA+ score	0.342	0.069-1.679	0.17	0.741	0.349-1.570	0.42
GPs per 1,000 population	3.426	0.911-12.877	0.07	1.021	0.253-4.112	0.97
Household income	0.997	0.996-0.999	0.03*	0.995	0.986-1.003	0.26
Unemployment rate	0.983	0.817-1.183	0.85	0.653	0.368-1.158	0.14
Percentage of ATSI population	3.509	0.768-16.035	0.10	0.974	0.461-2.058	0.94
Land use, rural (%)	0.886	0.564-1.391	0.45	1.011	0.793-1.291	0.92
	Males					
	Metropolitan			Rural		
Predictor	Adj.OR	95% CI	p-value	Adj.OR	95% CI	p-value
Percentage of smokers	1.054	1.001-1.110	0.04*	1.181	1.029-1.356	0.02*
GP attendance per 1,000 pop.	0.999	0.999-1.000	0.59	1.000	0.999-1.001	0.13
Population density (Km^2)	1.000	1.000-1.000	0.02*	1.004	0.995-1.013	0.29
IRSAD	1.020	0.969-1.074	0.41	0.946	0.822-1.089	0.43
IRSD	0.982	0.959-1.005	0.12	1.070	0.980-1.168	0.13
IER	1.010	0.995-1.26	0.16	1.038	0.984-1.095	0.16
IEO	0.988	0.966-1.011	0.29	1.001	0.955-1.049	0.96
ARIA+ score	1.316	0.314-5.516	0.69	1.949	0.914-4.154	0.08
GPs per 1,000 population	3.753	1.139-12.366	0.03*	1.908	0.469-7.764	0.36
Household income	0.996	0.995-0.998	0.01*	0.987	0.978-0.995	0.01*
Unemployment rate	0.903	0.764-1.067	0.22	1.342	0.754-2.390	0.31
Percentage of ATSI population	3.814	0.970-14.984	0.05	0.842	0.396-1.789	0.65
Land use, rural (%)	0.926	0.710-1.207	0.42	1.289	1.008-1.649	0.04*

* $p < 0.05$; [±]Adj.OR= Adjusted Odds Ratio (After controlling for smoking).