


BMJ Open Existing comorbidities in people with osteoarthritis: a retrospective analysis of a population-based cohort in Alberta, Canada

Deborah A Marshall ,^{1,2,3,4} Xiaoxiao Liu,^{1,3,4} Cheryl Barnabe,^{1,2} Karen Yee,⁵ Peter D Faris,⁵ Claire Barber,^{1,2} Dianne Mosher,² Thomas Noseworthy,¹ Jason Werle,⁶ Lisa Lix⁷

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For numbered affiliations see end of article.

Correspondence to

Dr Deborah A Marshall; damarsha@ucalgary.ca

ABSTRACT

Objectives The purpose of this study is to estimate the prevalence of comorbidities among people with osteoarthritis (OA) using administrative health data.

Design Retrospective cohort analysis.

Setting All residents in the province of Alberta, Canada registered with the Alberta Health Care Insurance Plan population registry.

Participants 497 362 people with OA as defined by 'having at least one OA-related hospitalization, or at least two OA-related physician visits or two ambulatory care visits within two years'.

Primary outcome measures We selected eight comorbidities based on literature review, clinical consultation and the availability of validated case definitions to estimate their frequencies at the time of diagnosis of OA. Sex-stratified age-standardised prevalence rates per 1000 population of eight clinically relevant comorbidities were calculated using direct standardisation with 95% CIs. We applied χ^2 tests of independence with a Bonferroni correction to compare the percentage of comorbid conditions in each age group.

Results 54.6% (n=271 794) of people meeting the OA case definition had at least one of the eight selected comorbidities. Females had a significantly higher rate of comorbidities compared with males (standardised rates ratio=1.26, 95% CI 1.25 to 1.28). Depression, chronic obstructive pulmonary disease (COPD) and hypertension were the most prevalent in both females and males after age-standardisation, with 40% of all cases having any combination of these comorbidities. We observed a significant difference in the percentage of comorbidities among age groups, illustrated by the youngest age group (<45 years) having the highest percentage of cases with depression (24.6%), compared with a frequency of 16.1% in those >65 years.

Conclusions Our findings highlight the high frequency of comorbidity in people with OA, with depression having the highest age-standardised prevalence rate. Comorbidities differentially affect females, and vary by age. These factors should inform healthcare programme and delivery.

Strengths and limitations of this study

- Strong methodological approach to identify cases of osteoarthritis (OA) with a validated case definition using five linked population-based administrative databases.
- However, case identification based on administrative data may result in underreporting of cases and comorbidities.
- The age-standardised prevalence of eight comorbidities, selected on their clinical relevance and the availability of validated case definitions for administrative health data, was estimated among people with OA.
- We limited our analysis to eight comorbidities of clinical relevance.
- We stratified the analysis by sex and by age cohorts.

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis, affecting 1 in 8 (13%) Canadians and representing a major cause of pain and disability in society.^{1 2} OA affects people of all ages, but is more prevalent among females and older age groups.^{3 4} Due to an ageing population and an increase in obesity, the prevalence of OA is expected to continue to rise, predicted to affect one in four Canadians by 2040.^{5 6} The high prevalence of OA in Canada has a substantial impact on quality of life and healthcare costs to individuals and healthcare systems. Quality of life was measured to be 10%–25% lower among people with OA relative to the general population⁷ with an associated economic burden of \$C33 billion (direct and indirect costs) in Canada in 2011.³ The annual cost per individual with OA has been estimated to be two to three times higher compared with people without OA,⁷ and are associated with more physician visits and hospitalisations.⁸



More recently, the characterisation of comorbidities among people with OA has been explored due to the potential effect of comorbidities on routine clinical practice, clinical practice guidelines, healthcare utilisation and costs.^{9 10} In people with OA over the age of 50 years in England, the presence of comorbidities resulted in increased physical disability compared with those without OA, with the influence of comorbidities greater than that expected for OA alone or for each comorbidity in isolation.⁴ Knowledge of the prevalence of comorbidities in people with OA raises important considerations for optimal OA treatment and management, to reduce pain and physical disability, enhance the quality of life and decrease the burden of OA. Comorbidities add complexity to the management of patients with OA to provide patient-centred care, ensure appropriate management recommendations for healthcare programme and delivery.

The purpose of this study is to estimate the prevalence of comorbidities at time of diagnosis among people with OA in the province of Alberta, Canada, using administrative health data. Our study fills the gap in knowledge regarding the patterns and burden of comorbidities in people with OA, particularly with regard to the link between OA and comorbidities associated with age. In addition, our study is unique in that we examine all of the commonly reported comorbidities simultaneously in a single study. This information is useful to consider in clinical practice guidelines and to assess the potential impact of comorbidities for clinical practice.

MATERIALS AND METHODS

Data sources

We used five linked Alberta, Canada provincial administrative databases between 1 April 1994 and 31 March 2013 to identify individuals with OA who accessed healthcare services paid for by the provincial healthcare insurance plan, previously described elsewhere in detail.⁶ These databases included the Alberta Health Care Insurance Plan (AHCIP) population registry, the Discharge Abstract Database (DAD), the Physician Claims Database (claims), the Ambulatory Care Classification System (ACCS) and the National Ambulatory Care Reporting System (NACRS).

AHCIP population registry captures individual level demographic data on all insured persons as of the last day of each fiscal year (31 March). All Albertans who are included in the AHCIP have a unique, 9-digit personal health number, which is used when accessing healthcare services, and served to link datasets prior to deidentification. Members of the Armed Forces and the Royal Canadian Mounted Police, federal penitentiary inmates and Albertans who have opted out of the AHCIP are excluded.

DAD captures admission and inpatient care data for all hospitalised patients, including diagnostic codes, interventions, patient age and sex, and administrative information. Among 25 DAD diagnostic code fields extracted

from the hospital record, OA-related records were identified as those with the first 3 digits 715 or M15 to M19 based on the ninth and tenth revisions of the International Classification of Diseases (ICD) codes, respectively.

Claims captures OA-related physician visits, which were identified based on the aforementioned ICD codes in any of the three diagnostic code fields.

ACCS and NACRS contains data on hospital-based and community-based ambulatory care, including day surgery, outpatient and community-based clinics and emergency departments, and publicly funded hospital support services such as physiotherapy and occupational therapy. OA-related records were identified based on the presence of the aforementioned ICD codes in any of the 10 diagnostic code fields. NACRS was used since April 2010.

Patient and public involvement

No patients were involved in setting the research question, the design and conduct of the study. No patients were involved in the interpretation or writing up of results. There are no plans to disseminate the results of the research to study participants because this was administrative health database analysis. We will make the publication available to the relevant patient community.

Case definition of OA

Validated case definitions have been used in previous research related to OA using administrative data.^{11 12} The sensitivity of algorithms based on both physician claims and hospitalisations records within 2–5 years ranged from 24% to 46%, along with specificity and positive predictive value ranging from 92% to 98%, and 39% to 54%, respectively.¹¹ In this study, OA cases were identified as individuals with at least one OA-related hospitalisation (DAD), or at least two OA-related physician visits (claims) within 2 years, or at least two OA-related ambulatory care visits (ACCS/NACRS) within 2 years, assuming none of the physicians or ambulatory care visits had occurred on the same day.¹¹ For our study, the OA cohort refers to those Alberta residents registered with AHCIP who have a specified OA-related diagnostic code in any diagnostic code field position. The cohort inclusion date is the earliest date of the OA-related record identified from either the Claims, DAD or ACCS/NACRS files.

Case definitions of comorbidities

We identified specific comorbidities to explore in this analysis based on three criteria: (1) a high frequency of reported comorbidities in the published literature on OA; (2) the availability of validated case definitions for each comorbid condition; and (3) expert input from our clinical coinvestigators. We first conducted a scoping review of the literature,¹³ aiming to examine the extent and range of comorbidities research among people with OA. We identified 20 studies from a range of countries (9 in North America, 8 in Europe, 1 in Asia, 1 in South American, 1 in Netherlands), using different study designs (9 cross-sectional, 5 retrospective cohort, 5

prospective cohort and 1 case control study) with a range of sample sizes (91–85966369 cases of OA). Based on the results of this review, we derived a list of comorbidities and presented it to our clinical coinvestigators. On this basis, we identified eight comorbidities to include in our analysis: hypertension, depression, COPD, diabetes, congestive heart failure (CHF), peripheral vascular disease (PVD), myocardial infarction (MI) and cerebrovascular disease (CEVD). We applied case definitions for each comorbidity to identify those present within 3 years prior to the OA diagnosis. Detailed ICD 9 and ICD 10 diagnostic codes used to identify each comorbidity are provided in online supplementary appendix 1.^{14–23}

Age-standardised comorbidity prevalence rate

The frequency of each comorbid condition in people meeting the case definition for OA was calculated, as was the frequency of the number of comorbidities present per individual: one comorbidity, two comorbidities and three or more comorbidities. We stratified OA cases by sex, and by age at diagnosis (<35, 35–44, 45–54, 55–65, 65–74 and ≥75 years). The crude rate was calculated as the number in each comorbidity group divided by the total number of OA cases. We calculated age-standardised comorbidity prevalence rates using the direct standardisation method.²⁴ We used the 2016 Canadian population reported publicly by Statistics Canada²⁵ to age-standardise the estimates for females and males with 95% CIs calculated using the binomial approximation method.²⁴ To compare differences between females and males, standardised rate ratios (SRR) were estimated as the female age-standardised rate divided by the male age-standardised rate. We calculated 95% CIs for the SRR based on the SE for each sex, to test for a sex difference.²⁴

We calculated the percentage of females and males in each age group and the percentage of OA cases for each age group by sex. The percentage of comorbidities among OA population was calculated as the number of

cases with specific comorbidity divided by the OA population. The percentage of comorbidities among those with comorbidities was calculated using the population with one or more of the eight comorbidities as denominator. We also calculated the frequency of common groupings of these comorbidities in people with OA.

We applied χ^2 tests of independence with a Bonferroni correction²⁶ to compare the percentage of specific comorbid conditions among the population with OA in each age group (<45, 45–64 and ≥65 years). The null hypothesis is that there is no difference in the percentage of comorbidities across age groups, which is rejected when the calculated χ^2 is greater than the critical value for a specific number of df and an altered significance level of 0.005 after Bonferroni correction. All analyses were conducted with R V.3.5.1 and Excel 2013.

RESULTS

We identified 497362 cases of OA, 57.9% of whom were females (table 1). More than half of the OA cases had at least one of the eight comorbidities (54.6%, n=271794) (table 2). A total of 161315 (32.4%) people with OA had only one comorbidity, with 14.6% (n=72567) having two and 7.6% (n=37912) having three or more of the comorbidities. Hypertension was the most frequent comorbidity (29%, n=144453), followed by depression (19.9%, n=99103), COPD (18.6%, n=92273), diabetes (9.5%, n=47102) and CHF (5.6%, n=27905). PVD (3.0%), CEVD (1.2%) and MI (1.0%) were the least frequent comorbidities.

Comorbidity patterns by sex

A similar pattern was observed regarding the number of comorbidities (with most people with OA having one comorbidity) and the ordering of the frequency of each of the comorbidities among females and males based on age-standardised prevalence rates (table 2). Statistically

Table 1 Characteristics of people with OA identified in the population

Population	Age groups (years)	Female			Male			Total
		n	% by age groups	% (Female)	n	% by age groups	% (Male)	
People meeting OA case definition	<35	13975	50.6	4.9	13638	49.4	6.5	27613
	35–44	25616	52.4	8.9	23279	47.6	11.1	48895
	45–54	57574	57.6	20.0	42445	42.4	20.3	100019
	55–64	65528	57.1	22.8	49329	42.9	23.6	114857
	65–74	59346	57.7	20.6	43527	42.3	20.8	102873
	75+	65912	63.9	22.9	37193	36.1	17.8	103105
	Total	287951	57.9	100.0	209411	42.1	100.0	497362

% by age groups was calculated using total population of each specific age group (eg, for OA <35 years), the percentage was calculated using the number of females with OA as the numerator and the total number of people with OA as the denominator (13975+13638=27613). % female <35 years was calculated using the number of females in the age group <35 years as the numerator (13975) and the number of females with OA as the denominator (287951). OA, osteoarthritis.

Table 2 Frequency, percentage and age-standardised rate of comorbidities in people with OA

Comorbidity	n	% of OA cohort	% of the OA cohort with one or more of the eight comorbidities	Age standardised rate (per 1000 population)		SRR (95% CI)
				Female (95% CI)	Male (95% CI)	
Comorbid conditions						
Hypertension	144 453	29.0	53.1	162.2 (160.9 to 163.5)	146.5 (145.1 to 148.0)	1.11 (1.09 to 1.12)
Depression	99 103	19.9	36.5	264.1 (260.9 to 267.3)	152.6 (149.8 to 155.4)	1.73 (1.69 to 1.77)
Chronic obstructive pulmonary disease	92 273	18.6	33.9	195.9 (193.0 to 198.8)	153.6 (150.9 to 156.3)	1.28 (1.25 to 1.30)
Diabetes	47 102	9.5	17.3	53.1 (52.0 to 54.2)	59.4 (58.4 to 60.4)	0.89 (0.87 to 0.92)
Congestive heart failure	27 905	5.6	10.3	24.4 (23.9 to 24.9)	25.4 (24.9 to 26.0)	0.96 (0.93 to 0.99)
Peripheral vascular disease	15 044	3.0	5.5	12.6 (12.1 to 13.0)	17.8 (17.2 to 18.3)	0.71 (0.67 to 0.74)
Myocardial infarction	4969	1.0	1.8	4.3 (4.1 to 4.5)	4.7 (4.4 to 5.0)	0.91 (0.84 to 0.98)
Cerebrovascular disease	5974	1.2	2.2	4.0 (3.8 to 4.2)	7.9 (7.6 to 8.2)	0.51 (0.48 to 0.54)
No of comorbidities						
One comorbidity	161 315	32.4	59.4	329.1 (325.7 to 332.4)	271.5 (268.2 to 274.8)	1.21 (1.19 to 1.23)
Two comorbidities	72 567	14.6	26.7	124.9 (122.8 to 127.1)	84.6 (82.9 to 86.2)	1.48 (1.44 to 1.52)
Three or more comorbidities	37 912	7.6	13.9	42.3 (41.4 to 43.2)	36.9 (36.2 to 37.7)	1.15 (1.11 to 1.18)
OA with comorbidities	271 794	54.6		496.3 (492.8 to 499.8)	392.9 (389.4 to 396.4)	1.26 (1.25 to 1.28)
None of the 8 comorbidities	225 568	45.4		503.7 (500.17 to 507.22)	607.1 (603.56 to 610.56)	0.83 (0.82 to 0.84)

% of OA cohort was calculated using OA population (271 794+225 568 = 497 362) as denominator and the population of each comorbidity as numerator. % of the OA cohort with one or more of the eight comorbidities was calculated using population with at least one comorbidity (n=271 794) as denominator. SRR denotes standardised rate ratio between females and males (females/males). The eight comorbidities are those with validated case definitions for administrative health data. OA, osteoarthritis.

Table 3 Frequency of top 10 common groupings of comorbidities

Combinations of comorbidity	n	% of OA cohort	% of OA with comorbidities
Hypertension only	63 520	12.8	23.4
Depression only	46 226	9.3	17.0
Chronic obstructive pulmonary disease only	34 464	6.9	12.7
Hypertension, depression	14 609	2.9	5.4
Hypertension, chronic obstructive pulmonary disease	13 653	2.7	5.0
Depression, chronic obstructive pulmonary disease	13 584	2.7	5.0
Hypertension, diabetes	11 784	2.4	4.3
Diabetes	11 054	2.2	4.1
Hypertension, depression, chronic obstructive pulmonary disease	5 262	1.1	1.9
Hypertension, congestive heart failure	3 946	0.8	1.5

% of OA cohort was calculated using OA population (271 794+225 568 = 497 362) as denominator and the population of each comorbidity as numerator. % of OA with comorbidities was calculated using population with at least one comorbidity at the diagnosis of OA (n=271 794) as denominator.

OA, osteoarthritis.

significant differences among females and males were observed by the number of comorbidities, with females having higher age-standardised rates overall (SRR=1.26, 95% CI 1.25 to 1.28). The number of comorbidities was also higher for females compared with males with SRR ranging from 1.15 (95% CI 1.11 to 1.18) for three or more comorbidities to 1.48 (95% CI 1.44 to 1.52) for two comorbidities (table 2).

Depression, COPD and hypertension remained as the three most prevalent comorbidities in both females and males after age standardisation. However, the prevalence of each of these comorbidities was higher in females compared to males (table 2). Females had significantly higher prevalence rates than males for depression (SRR=1.73, 95% CI 1.69 to 1.77), COPD (SRR=1.28, 95% CI 1.25 to 1.30) and hypertension (SRR=1.11, 95% CI 1.09 to 1.12).

The prevalence of each of these three comorbidities differed significantly in females. For example, the age-standardised prevalence of depression in females was 264 cases per 1000 population, 35% higher and statistically higher than for COPD (196 cases per 1000 population) (SRR=1.35, 95% CI 1.32 to 1.37). In contrast, the prevalence of these three comorbidities among males were not significantly different.

Common groupings of comorbidities in people with OA

As shown in table 3, of the eight comorbidities in people with OA, the most frequent comorbidity was hypertension as a single comorbidity, found in 12.8% of people with OA (n=63 520). The most common grouping of two comorbidities was the coexistence of hypertension and depression (2.9%, n=14 609). The most common grouping with three comorbidities was depression, COPD and hypertension (1.1%, n=5 262). People with OA having any combination of the top three comorbidities accounted for ~40% of people with OA.

Comorbidity patterns by age group

As shown in figure 1, each of the eight comorbidities, with the exception of depression, was most common in people with OA over 65 years old. Hypertension was found in 44.3% of people with OA over 65 years of age (n=91 153 cases) compared with 5.3% (n=4040 cases) in those <44 years old. The largest number of people with OA and depression were in the 45–64 years age cohort (n=47 061 cases), with the youngest age group (<44 years) having the highest percentage of cases with depression (24.6% compared with 21.9% in the middle age group (45–64 years) and 16.1% in the older age group (≥65 years)). The difference in the percentage of each of the eight comorbidities among the three age groups was statistically significant (p<0.0001). The detailed age-sex stratified crude rates per 1000 population is provided in online supplementary appendix 2.

The number of comorbidities in people with OA increased with increasing age. The percentage of people with three or more comorbidities increased significantly from 1.5% in youngest age group (<44 years), to 4.7% in the middle age group (45–64 years) and to 13% in the older age group (≥65 years) (p<0.0001).

DISCUSSION

We estimated the prevalence of comorbid conditions in people with OA using provincial administrative health data. Using validated case and comorbidity definitions, we found that 54.6% of people with OA had at least one of the eight comorbidities, and 22.2% had at least two. Depression, COPD and hypertension were the three most prevalent comorbidities in both females and males after age standardisation. However, the prevalence of each of these comorbidities was significantly higher in females compared with males. People with any combination of these three comorbidities represented about 40% of the

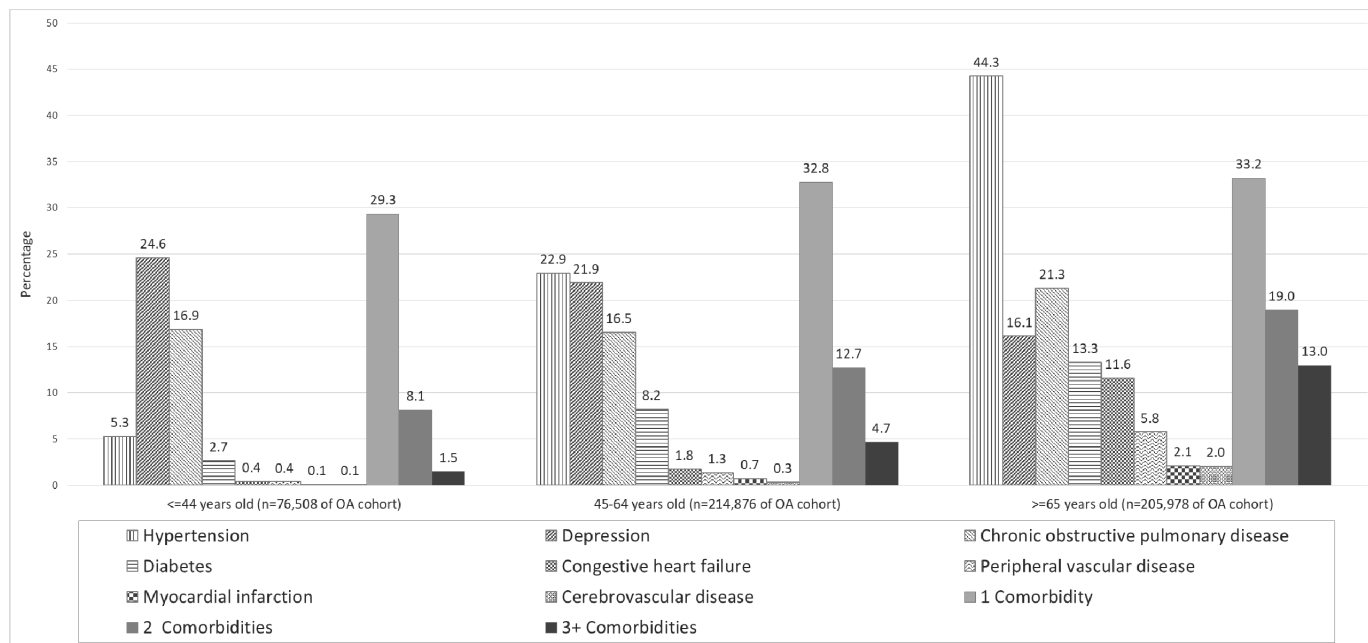


Figure 1 Percentage of specific comorbid conditions among the population with OA in each age group (<45, 45–64 and ≥65 years). The difference by age group was statistically significant for each comorbid conditions ($p<0.0001$), as was the frequency of the number of comorbidities present per individual ($p<0.0001$). OA, osteoarthritis

people with OA. In general, the number of comorbidities in people with OA increased with increasing age. Each of the eight comorbidities, except depression, was most common in people with OA ≥65 years. The largest number of people with OA and depression are in the middle age group (45–64 years), with the youngest age group (<44 years) having the highest percentage of cases with depression.

The estimated prevalence of comorbidities varies among studies due to differences in case definitions, the list of included chronic conditions, data sources and study population. We estimated that the prevalence of comorbidity among people with OA was 54.6% for one or more of the eight comorbid chronic conditions and 22.2% for two or more comorbid chronic conditions with OA. Our estimates of the prevalence of comorbidities in people with OA are higher than the prevalence of two or more and three or more chronic conditions among the general Canadian population (26.5% and 10.2%, respectively) as reported by Feely *et al*,²⁷ and higher than the prevalence of 12.9% (two or more chronic diseases) and 3.9% (three or more chronic diseases) reported by Roberts *et al*.²⁸ In our study, among 205 978 OA cases in the age group over 65 years old, the prevalence of one or more comorbid chronic conditions was 33.2% ($n=68\,418$) and the prevalence of two or more comorbid chronic conditions with OA was 19.0% ($n=39\,044$). The estimated prevalence of comorbid chronic conditions in people with OA is higher than the estimates reported by Roberts *et al*, which showed that the prevalence of two or more chronic diseases in the general population over 65 years old was 31.3% and the prevalence of three or more chronic diseases was 11.3%. It has been reported previously that the prevalence of one

or more comorbid condition among people with musculoskeletal conditions was more than twice than those without a musculoskeletal condition but with another chronic condition.²⁹

We identified depression, COPD and hypertension as frequent comorbid conditions among the people with OA. This was consistent with findings reported from the Canadian Primary Care Sentinel Surveillance Network showing that the prevalence of OA has significant association with depression, COPD and hypertension.² Depression is emerging as a significant comorbidity in OA. Previous findings have reported that depression was highly prevalent in people with OA.^{10,30} A systemic review of depressive symptoms in people with OA, including 49 studies worldwide and representing 15 855 individuals, reported a frequency of depression of 19.9% among people with OA,³¹ which was similar to our estimates.

Depressed individuals are more likely to report chronic or more severe pain, and more than half of the patients with chronic pain are depressed. People living with OA are known to have fewer social contacts, limited physical activity, increased pain and disability,^{32,33} worse surgical outcomes and reduced effectiveness of pain interventions,³⁴ which are all important predictors of depression.³⁵ However, current clinical practice guidelines for non-surgical management of OA do not include recommendations regarding mental health management.^{36–39} This emphasises the need for treatments and management for depression to improve outcomes for people with OA.⁴⁰ It has been suggested that educating physicians about timely identification of psychological factors may be helpful to improve outcomes. In addition, self-care management could be integrated into OA management

strategies as a way to reduce anxiety and depression, as well as resulting emotional and physical pain. Guidelines suggest that OA management should also integrate pharmacotherapy carefully and be cautious about the drug interactions and adverse side effects when treating OA, depression, anxiety and pain holistically.³⁰ Two or more of the comorbidities that we examined coexist in a substantial proportion of people with OA—approximately 22% in total. Obesity, which we were unable to study using administrative data, is also prevalent among people with OA and a risk factor for developing OA.^{41 42} From a clinical practice perspective, a physician has to consider the implications of prescribing non-steroidal anti-inflammatory medications for pain management, but this may worsen hypertension and have an associated increased risk of cardiovascular disease. However, without good pain management, it is difficult for patients with OA to engage in exercise programme which can help improve their muscular condition and potentially reduce obesity and hypertension. This is further complicated by the relationship of lower socioeconomic status with an increased risk of developing OA as demonstrated in the project for an Ontario Women's Health Evidence-based Report.²⁹

Furthermore, our analyses showed that depression not only was the most prevalent comorbidity after age standardisation in people with OA, but that rates of depression were significantly higher for females and younger people (<44 years old). The study by Dibonaventura *et al* reported that people under 65 years of age were still participating in the workforce; however, OA pain resulted in significantly lower productivity and higher costs compared with those without OA pain.⁸ They identified unique treatment gaps for patients younger than 60 years old because the non-operative treatment options were ineffective in long-term management of OA symptoms, but young patients were too young or maybe unwilling to undergo definitive treatment such as total joint replacement.⁴³ Even for those patients who undergo total joint replacement, they were more likely to be dissatisfied about the treatment than older patients, and reported poorer outcomes including residual pain and stiffness.^{44 45} A survey of orthopaedic surgeons found that 84% perceived a need for better treatment for younger (<60 years old) physically active OA patients, and 68.4% perceived that there is a treatment gap for these patients.⁴³ Due to the different presentations of comorbidities and treatment options among young and old age groups, it is imperative to examine the impact of comorbidities on management strategies in an age-stratified OA cohort.

Most clinical practice guidelines focus on single conditions.⁴⁶ Fortin *et al* concluded that even though the quality of the Canadian guidelines was good, their relevance for patients with two or more chronic conditions was limited.⁴⁷ Boyd *et al* highlighted the lack of consideration of comorbidities in clinical practice guidelines may result in poor quality of care because the healthcare some patients received was not optimal.⁴⁸ Sharma *et al* pointed

out that the present literature fails to fully address the management strategies when dealing with comorbidities seen in people with OA.³⁰ Patient-centred care has been recommended in clinical practice guidelines with the aim of improving quality of care by focusing on the patient as a whole rather than on a single disease.⁴⁹ From a system perspective, patients with several comorbidities were also the main users of healthcare resources and services.⁵⁰ Patient-centred and coordinated care for these patients may decrease related healthcare use.⁵¹ It was recommended that physicians consider these comorbidities in the management of people with OA.

A strength of our study is the large population-based number of people with OA (n=497 362) and the investigation of a group of eight comorbidities that are clinically relevant to the management of people with OA. These eight comorbidities among people with OA has been reported in previous studies, but only on an individual basis or in groups of a subset of these comorbidities. Our study is the first one to include all of these comorbidities, which is necessary to understand the clinical context for managing these patients. Furthermore, our analysis also delineates the patterns of occurrence and co-occurrence of these comorbidities regarding the prevalence of comorbidities that is relevant for planning and delivery of health services for this growing population of people with OA. We applied case definitions for administrative health data to identify cases of OA and each of the comorbidities at the diagnosis of OA. A limitation of our study is that case identification based on administrative data may result in underreporting of cases and comorbidities. The case definitions for OA in administrative data research,⁵ based on the physician claims and hospitalisations records, have been applied and validated with a sensitivity of 24%, high specificity of 98% and a positive predictive value of 54%.¹¹ In our study, we also included ACCS/NACRS to mitigate the issue of underestimations.⁶ Nonetheless, the estimated number of OA cases using this approach is almost certainly an underestimate. Similarly, the algorithms for comorbidities may underestimate the prevalence of these comorbidities; the sensitivity for identifying depression is from 36% to 51%,¹⁹ for PVD is 39%¹⁸ and for COPD is 53%²¹ in administrative data (online supplementary appendix 2). More importantly, the reported levels of comorbidity in patients with OA were measured at the time of OA diagnosis. New cases of comorbidity diagnosed after the OA diagnosis were not identified. Further, we limited our analysis to eight comorbidities of clinical relevance and for which there were case definitions in administrative data.

CONCLUSIONS

We found that depression, COPD and hypertension were the three most prevalent comorbidities in people with OA, with rates significantly higher in females compared with males. Of particular note is that the largest number of people with OA and depression are in the age group

between 45 and 64 years old, with the highest percentage of cases occurring in the younger age groups (<44 years). Our findings highlight the need to recognise that people with OA have high rates of comorbidities and this may affect optimal healthcare management of these patients.

Author affiliations

¹Department of Community Health Sciences, University of Calgary, Cumming School of Medicine, Calgary, Alberta, Canada

²Department of Medicine, University of Calgary, Cumming School of Medicine, Calgary, Alberta, Canada

³McCaig Bone and Joint Health Institute, Calgary, Alberta, Canada

⁴O'Brien Institute for Public Health, Calgary, Alberta, Canada

⁵Research Facilitation, Alberta Health Services, Calgary, Alberta, Canada

⁶Department of Surgery, University of Calgary Cumming School of Medicine, Calgary, Alberta, Canada

⁷Department of Community Health Sciences, University of Manitoba, Winnipeg, Manitoba, Canada

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Contributors DAM, PDF and KY were responsible for the conception and design of the research, acquisition of the data, analysis and interpretation of data, drafting the article and revision of the article for important intellectual content. XL was responsible for the analysis and interpretation of data, drafting the article and revision of the article for important intellectual content. ChB, CIB, DM, TN, JW and LL were responsible for the conception and design of the research, interpreting results of the research and revision of the article for important intellectual content. All authors approved the final version of the manuscript to be submitted. DAM (damarsha@ucalgary.ca) and XL (xiaoxili@ucalgary.ca) take responsibility for the integrity of the work as a whole.

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ORCID iD

Deborah A Marshall <http://orcid.org/0000-0002-8467-8008>

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