



Exploratory spatial analysis of comorbidities prevalence in people with osteoarthritis

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ABSTRACT

There is limited evidence on the geographical variation in the prevalence of comorbidities in people with osteoarthritis in Alberta. Our study explores the spatial pattern of osteoarthritis comorbidities along the rural-urban continuum. The results showed a pattern of higher age-sex standardized prevalence rate of osteoarthritis comorbidities in the north and rural areas compared to the south and urban areas, respectively. Hot spots were identified in the north remote area for osteoarthritis with two or more comorbidities, and osteoarthritis with chronic obstructive pulmonary disease. This study provides information for health care planning to support access to health care services.

1. Introduction

Osteoarthritis (OA) is the most common form of arthritis affecting 10% to 15% of Canadian population and is the leading cause of hip and knee joint replacement surgery (Birtwhistle et al., 2015). The

prevalence of OA is expected to continue rising due to an aging population and increasing rates of obesity, a leading risk factor for OA (Kopec et al., 2008; Rahman et al., 2014). Comorbidities are commonly associated with musculoskeletal conditions (Briggs et al., 2018), especially among the elderly (Guisado-Clavero et al., 2018), which greatly increases the disease burden of OA (Briggs et al., 2018). Comorbidities have the potential to influence routine clinical practice, healthcare utilization and costs of OA patients (Duffield et al., 2017; Cimmino et al., 2013; Kim et al., 2011).

The Canadian Medical Association (CMA) and Alberta Health Services (AHS) have a goal to achieve equitable access to OA care, with a focus on patients in rural and remote areas (Canadian Medical Association, 2013; Government of Alberta, 2008). Albertans live across urban, rural and remote areas, creating potential difference in access to health care. It is of great importance to examine the geographic variation of comorbidities among people with OA. Our study aims to explore the spatial pattern of comorbidities along the rural-urban continuum, and identify the areas with hot spots of comorbidities.

2. Methods and Data

2.1 Data sources and case definition

Records were extracted from five administrative health databases - Alberta Health Care Insurance Plan (AHCIP) population registry, Discharge Abstract Database (DAD), Physician Claims Database (claims), Ambulatory Care Classification System (ACCS), and Alberta National Ambulatory Care Reporting System (NACRS) (Marshall et al., 2015). Records across the five databases were linked using a unique patient identifier. The ninth and tenth revisions of the International Classification of Disease (ICD) codes were used to identify OA-related visits. We defined OA cases by applying a validated OA case definition - at least one OA hospitalization (DAD), or at least two OA physician visits (claims) within two years, or at least two OA-related ambulatory care visits (ACCS/NACRS) within two years, assuming none of the physicians or ambulatory care visits had occurred on the same day (Lix et al., 2006; Widdifield et al., 2013; Kopec et al., 2008; Felson et al., 2000).

2.2 Definitions of comorbidities in people with OA

Based on the literature and expert guidance from clinicians, we included a list of 8 chronic conditions for analysis: hypertension (HTN), depression (DEP), chronic obstructive pulmonary disease (COPD), diabetes (DIAB), peripheral vascular disease (PVD), cerebrovascular disease (stroke) (CEVD), myocardial infarction (MI), and congestive heart failure (CHF). Validated algorithms for each of the selected comorbid conditions were applied to identify comorbidities (Tonelli et al., 2015).

The OA cases were grouped by the number of comorbidities: OA with none of these comorbidities, OA with one of these comorbidities, OA with two or more of these comorbidities. With respect to the OA cases

with only one comorbidity, we further categorized this group by the type of comorbidity: OA with only HTN, OA with only DEP, OA with only COPD, OA with only DIAB, OA with only CHF, OA with only PVD, OA with only MI, and OA with only CEVD.

2.3 Age-sex standardized OA-comorbidity rate

The OA cases were stratified by sex and age group (18-35, 35-44, 45-54, 55-65, 65-74, 75-85, and ≥ 85 years of age). Direct standardization method was applied to calculate the age-sex standardized OA comorbidity rates (Boyle & Parkin, 1991). The Alberta OA prevalence population in 2013 were selected as standard population.

2.3 Geographic area

Alberta Health Services created 5 geographic zones for directing operational issues, and 7 rural-urban continuum for the purposes of analysis and planning. The rural-urban continuum were created based on population density and distance from urban centres, including Metro (Calgary and Edmonton), Moderate Metro influence, Urban (Grand Prairie, Fort McMurray, Red Deer, Lethbridge and Medicine Hat), Moderate Urban influence, Rural Centre (Brooks, Canmore et al.), Rural, and Rural Remote. By stratifying the rural-urban continuum by the 5 geographic zones, we identified 20 geographic sub-areas (Figure 1) in order to capture potential variation associated with both zone and rural-urban continuum (Alberta Health Services and Alberta Health, 2017). The six-digit postal codes reflecting patient residence were extracted for spatial analysis.

2.4 Spatial analysis

The latitude and longitude of each postal code was obtained by linking the OA data and the Postal Code Translator Files (Alberta Health, 2013). Spatial analysis in this study included global Moran's I (Moran, 1950)(Cliff & Ord, 1973), incremental spatial autocorrelation (Esri, 2017), and hot spot analysis (Getis & Ord,

1992; Anselin, 1995). Moran's I is a basic measure of spatial autocorrelation, which produces a spatial autocorrelation index ranging from 1 (positive spatial autocorrelation) to -1 (negative spatial autocorrelation). Incremental spatial autocorrelation measures the strength of spatial autocorrelation by different distance band. Hot spot analysis based on the Getis-Ord G_i^* statistic detects spatial patterns of hot spots. The conceptualization of spatial relationship between postal codes in both urban and rural areas were captured by spatial weight matrix with a fixed distance band and a minimum number of nearest neighbors. The critical value of plus or minus 1.96 for Z scores and a p value =0.05 were applied to make decisions regarding accepting or rejecting the null hypothesis. The hot spot maps were generated by interpolating Z scores with the Inverse Distance Weighting Interpolation.

3. Results

We identified 359,638 OA cases in Alberta in 2013 (Table 1), of which 52% had at least one comorbidity (n=186,350), and 18% had two or more comorbidities (n=120,936). Comorbidities were more frequent in females in all comorbidity groups, compared to males (23% vs 20% for OA with at least one of these comorbidities; 8% vs 7% for OA with two or more comorbidities).

Among OA cases with only one comorbidity, HTN was the most frequent comorbid condition, accounting for 13% (n=46,871) of total OA cases, followed by DEP (10.6%, n=38,248), COPD (7%, n=25,495) and diabetes (2%, n=7,794). CHF, PVD, MI and CEVD were identified to be the least frequent comorbid conditions in OA cases, with the percentage of OA cases ranging from 0.3% for CHF to 0.04% for CEVD. Comorbidities with a frequency lower than 3% were excluded from spatial analysis due to limited number of cases.

By rural-urban continuum, the age-sex standardized prevalence rate for OA with

one comorbidity ranged from 321 per 1,000 (Urban-North) to 269 per 1,000 (Rural-Centre-North) and for OA with two or more comorbidities from 152 per 1,000 (Moderate Urban-North) to 263 per 1,000 (Rural Centre-South). For OA with HTN only, rates ranged from 101 per 1,000 (Rural-Centre-Calgary) to 142 per 1,000 (Moderate-Metro-Calgary), for DEP only 81 per 1,000 (Rural-Remote-North) to 143 per 1,000 (Rural-Centre-Calgary), and for COPD 61 per 1,000 (Rural-Centre-South) to 126 per 1,000 (Rural-Centre-North). In general, the prevalence rates for OA with comorbidities tend to be higher in the north, compared to OA without comorbidities (Figure 2). The rate of OA with HTN and OA with DEP was higher in the south. OA with COPD only was observed to be higher in the north.

Global Moran's I suggested a statistically significant spatial autocorrelation for all comorbidity groups. A spatial weight matrix with a fixed distance of 6 km and at least 8 nearest neighbors was generated to model the spatial relationship of postal codes in both rural and urban areas. Hot spots analysis identified hot spots of OA with one comorbidity in both Rural-North and Rural-South (Figure 3). OA with HTN showed hot spots in the Moderate Urban area, in both south and north, and Rural Remote – Northwest. While for OA with COPD only, we identified hot spots mostly in Rural Centre-North, Rural Remote –North, and Rural Remote –Northwest.

4. Conclusion

We explored the geographic variation in OA comorbidities and showed that higher rates of comorbidities in people with OA tend to be observed in the north rural areas. The findings provide valuable information for planning healthcare delivery and informing equitable access to health care. Further research will explore the driving factors influencing this observed variation.

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Table 1 Summary of OA comorbidities

Comorbidity Type	OA Cases (2013)					
	Female	Male	All	Female	Male	All
	n			% of OA Cases (2013)		
Hypertension (HPTN)	28,186	18,685	46,871	5.7%	5.2%	13.0%
Depression (DEP)	26,695	11,553	38,248	5.4%	3.2%	10.6%
Chronic Obstructive Pulmonary Disease (COPD)	14,812	10,683	25,495	3.0%	3.0%	7.1%
Diabetes (DIAB)	3,655	4,139	7,794	0.7%	1.2%	2.2%
Congestive Heart Failure (CHF)	554	499	1,053	0.1%	0.1%	0.3%
Peripheral Vascular Disease (PVD)	464	550	1,014	0.1%	0.2%	0.3%
Myocardial Infarction (MI)	73	250	323	0.0%	0.1%	0.1%
Cerebrovascular Disease (CEVD)	78	60	138	0.02%	0.02%	0.04%
OA with One Type of Comorbidity	74,517	46,419	120,936	15.0%	12.9%	33.6%
OA with Multi-morbid Condition*	41,166	24,248	65,414	8.3%	6.7%	18.2%
OA with Comorbidities	115,683	70,667	186,350	23.3%	19.6%	51.8%
OA with No Comorbidities	93,853	79,435	173,288	18.9%	16.0%	48.2%
Total - OA in Alberta	209,536	150,102	359,638	58.3%	41.7%	100.0%

* Combination of any comorbidity types.

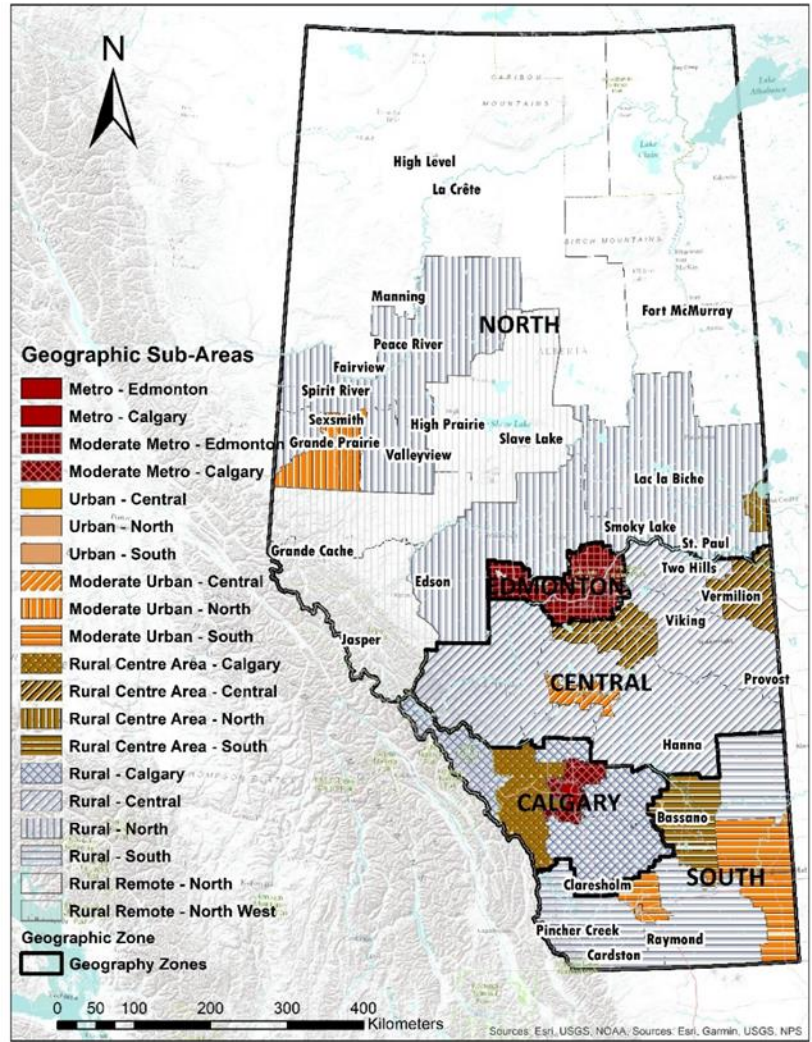


Figure 1 Geographic areas in Alberta

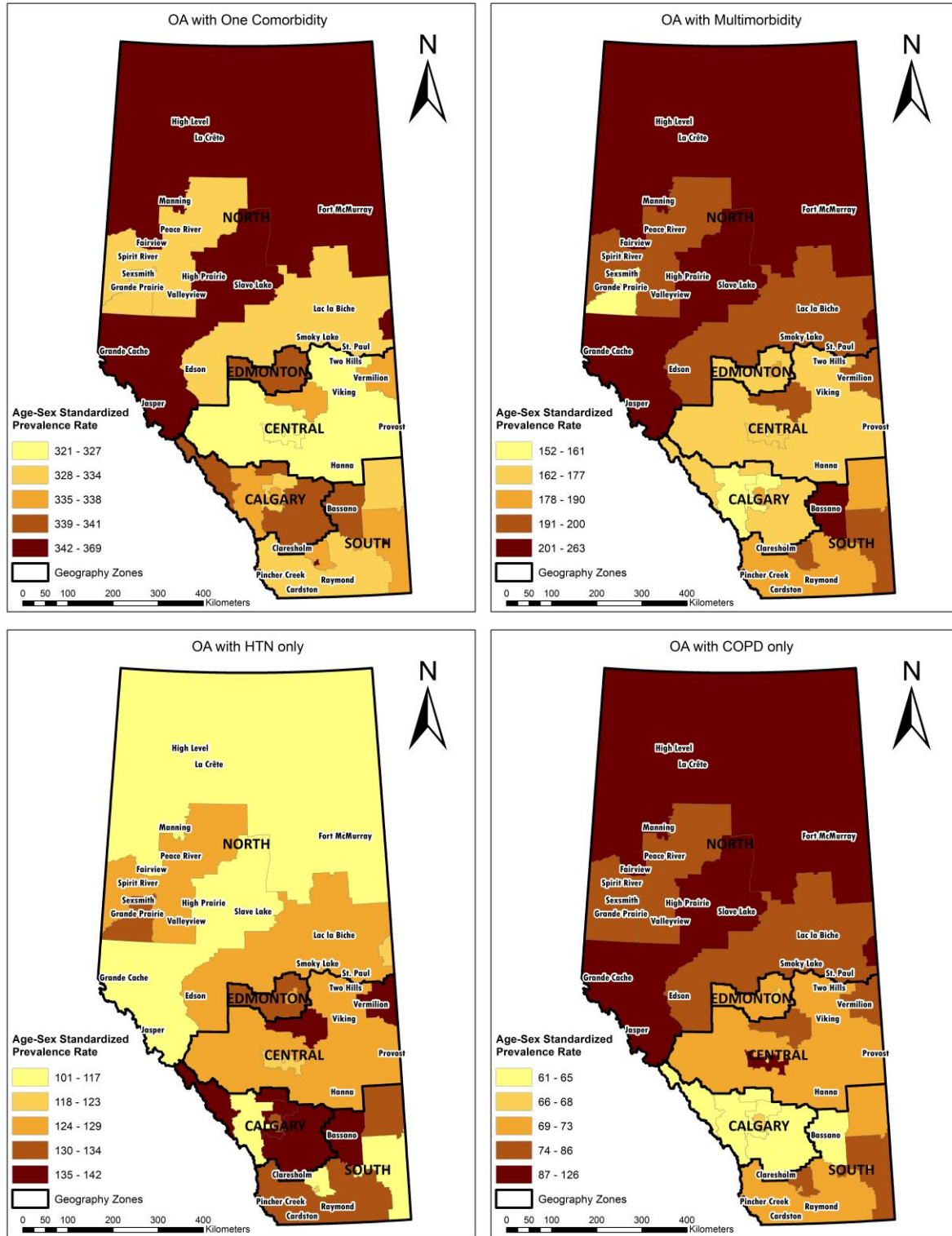


Figure 2 Distribution of age-sex standardized rate for OA with one comorbidity, OA with multimorbidity, OA with HTN only and OA with COPD only, along the rural-urban continuum.

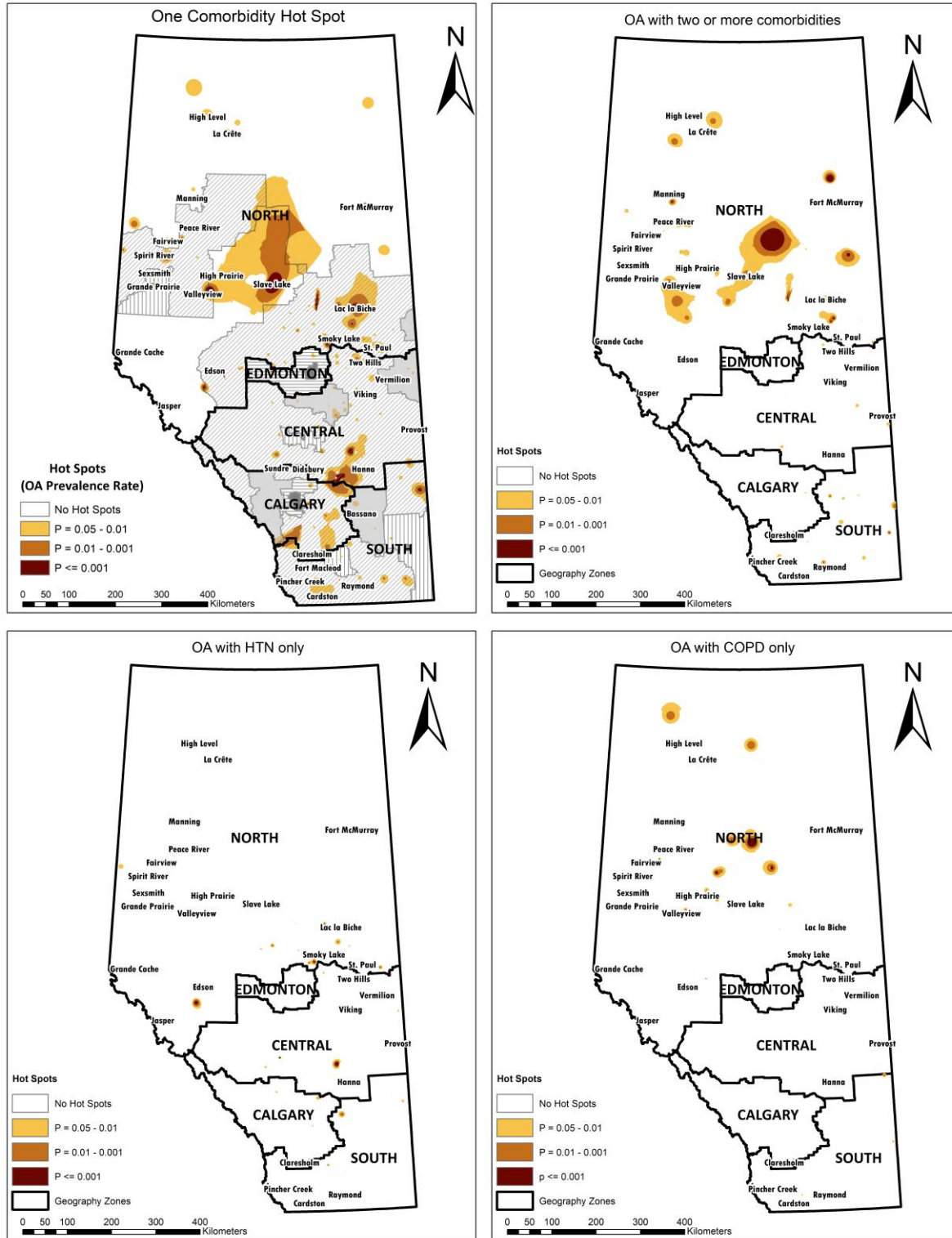


Figure 3 Hot spots of OA with one comorbidity, OA with multimorbidity, OA with HTN only, and OA with COPD only.