ACR Open Rheumatology
Vol. 3, No. 5, May 2021, pp 324–332
DOI 10.1002/acr2.11251

AMERICAN COLLEGE of RHEUMATOLOGY
Empowering Rheumatology Professionals

Geographic Variation in the Prevalence of Rheumatoid Arthritis in Alberta, Canada

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Objectives. Timely access to rheumatologists remains a challenge in Alberta, a Canadian province with vast rural areas, whereas rheumatologists are primarily clustered in metro areas. To address the goal of timely and equitable access to rheumatoid arthritis (RA) care, health planners require information at the regional and local level to determine the RA prevalence and the associated health care needs.

Methods. Using Alberta Health administrative databases, we identified RA-prevalent cases (April 1, 2015-March 31, 2016) on the basis of a validated case definition. Age- and sex-standardized prevalence rates per 1000 population members and the standardized rates ratio (SRR) were calculated. We applied Global Moran's *I* and Gi* hotspot analysis using three different weight matrices to explore the geospatial pattern of RA prevalence in Alberta.

Results. Among 38 350 RA cases (68% female; n = 26 236), the prevalence rate was 11.81 cases per 1000 population members (95% confidence interval [CI] 11.80-11.81) after age and sex standardization. Approximately 60% of RA cases resided in metro (Calgary and Edmonton) and moderate metro areas. The highest rate was observed in rural areas (14.46; 95% CI 14.45-14.47; SRR 1.28), compared with the lowest in metro areas (10.69; 95% CI 10.68-10.69; SRR 0.82). The RA prevalence across local geographic areas ranged from 4.7 to 30.6 cases. The Global Moran's *I* index was 0.15 using three different matrices (*z*-score 3.96-4.24). We identified 10 hotspots in the south and north rural areas and 18 cold spots in metro and moderate metro Calgary.

Conclusion. The findings highlight notable rural–urban variation in RA prevalence in Alberta. Our findings can inform strategies aimed at reducing geographic disparities by targeting areas with high health care needs.

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic autoimmune disease affecting approximately 1% of Canadians and is a leading cause of work disability (1). Close to 40 000 people in Alberta, Canada, are living with RA (2). Timely access to rheumatologists, the specialists providing health care for patients with RA, is associated with better quality of care and is critical for early diagnosis and targeted management of patients with RA (3). However, access remains a challenge, especially in the province of Alberta, which has vast rural areas, whereas most rheumatologists are primarily clustered in metro areas (4). In 2015/2016, 63% of new patients with RA in Alberta experienced excessive wait times to see a rheumatologist (5). Addressing wait times to see specialists remains a provincial priority (6). Of all patient visits to rheumatologists, 14% of visits were with new patients, who were often symptomatic, compared with 86% of visits for patients with established RA (5,7). These follow-up visits to a rheumatologist by established patients may further limit access for new consultations and increase wait times.

Estimates of the number of rheumatologists per capita as a system-level performance measure, as recommended by the

Supported by grant funding from the Canadian Initiative for Outcomes in Rheumatology Care grant competition (CIORA) and the Arthur J. E. Child Chair in Rheumatology Research. Dr. Marshall was supported by the Arthur J. E. Child Chair in Rheumatology Research and a Canada Research Chair in Health Systems and Services Research (2008-18). Dr. Liu was supported by the Arthur J. E. Child Chair in Rheumatology Research, the Cumming School of Medicine postdoctoral scholarship, and a postdoctoral scholarship funded by the O'Brien Institute of Public Health and the McCaig Institute for Bone and Joint Health.

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No potential conflicts of interest relevant to this article were reported.

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Submitted for publication January 28, 2021; accepted in revised form February 22, 2021.

SIGNIFICANCE & INNOVATIONS

- RA prevalence rates were significantly higher in rural and remote areas compared with urban areas.
- Local geographic areas have a fivefold difference in RA prevalence, ranging from 4.7 to 30.6/1000 population members, with hotspots in rural areas and cold spots in urban metro areas.
- The findings provide information for health services planners making decisions regarding resource allocation and care delivery.

Arthritis Alliance of Canada, do not provide enough information for determining gaps in rheumatology services because of the wide geographic variation in the distribution of patients with RA (8). A previous epidemiologic study in Alberta showed that the RA prevalence in rural areas was 20% higher compared with that in urban areas (9), but further geospatial analysis of RA prevalence has not, to date, been completed in the province. The Canadian Medical Association and Alberta Health Services (AHS) have set goals to achieve equitable access to care, with a focus on reducing health disparities for patients in rural and remote areas (10,11). Further, in 2020, Alberta Health (AH) initiated the Alberta Surgical Initiative to "improve and standardize the entire surgical system from the time patients seek advice from their family doctor, to when they are referred to a specialist..." (12). To help address the goal of timely and equitable access to RA care, health planners require information at the regional and local level to determine the prevalence of RA and the associated needs for health services.

This study aims to assess the geographic variation in RA prevalence across the rural–urban continuum by applying geospatial analysis using AH provincial administrative health data sets. Evidence on the geographic variation in RA prevalence is critical for identifying possible gaps in access to RA specialty care to better inform health care planning and programs that are responsive to local needs.

MATERIALS AND METHODS

Standard geographic areas. The AHS, the single health authority in Alberta, is organized into the following five geographic zones: south, Calgary, Central, Edmonton, and north, providing decision-making at regional levels (Figure 1). To compare population health according to rural–urban status, the province is stratified into seven distinct categories (metro, moderate metro, urban, moderate urban, rural center, rural, and rural remote) based on population density, distance from urban centers, and local knowledge of populations, industry type, municipalities, resources, and infrastructure (13,14). To capture detailed local information, the province is stratified into 132 local geographic areas (LGAs), the smallest geographic areas used by AHS to examine the local health outcomes and use of health services (13,15).

RA-prevalent cases in 2015/2016. AH administrative health records between April 1, 2002, and March 31, 2017, were obtained from three administrative health databases, including the Discharge Abstract Database (DAD), physician claims, and the Alberta Health Care Insurance Plan (AHCIP) (2). These databases were linked using a unique patient identifier, which ensures that each patient is used only once in the estimation of RA rates. The DAD captures inpatient services for all hospitalized patients and 25 diagnostic code fields based on the ninth and tenth revisions of the International Classification of Diseases (ICD) codes. Physician claims contain information on physician billing for services and three diagnostic code fields. The AHCIP captures all insured persons as of the last day of each fiscal year (March 31) and their individual demographic data, including age, sex, residential postcode, and vital status.

Patients with RA were defined using a validated case definition as those Albertans aged 16 years of age or older at the time of incidence having at least one hospitalization or two physician claims (at least 8 weeks apart) within 2 years (2,9,16). RA-related records were identified as those with the ICD, Ninth Revision, Clinical Modification (ICD-9-CM) codes of 714.x or the ICD, Tenth Revision, Canada (ICD-10-CA) codes of M05.X or M06.X (2,16). Patients were excluded from the cohort if they were subsequently diagnosed with a non-RA inflammatory arthritis, defined as those with two physician visits within 2 years with a diagnostic code for systemic autoimmune rheumatic diseases (710.x), polyarteritis nodosa and allied conditions (446.x), polymyalgia rheumatic (725.x), psoriatic arthritis (696.x), or ankylosing spondylitis and/or other spondylarthritides (713.x and 720.x). The RA-prevalent cases in the fiscal year 2015/2016 (April 1, 2015, to March 31, 2016) were included for this analysis.

Descriptive statistics. The population with RA was stratified by sex and by age groups (16-44 years, 45-64 years, and ≥65 years) and compared with the general population estimated from the AHCIP data set. The crude RA rate per 1000 general population members was calculated as the number of people with RA divided by the population registered in the AHCIP in the fiscal year 2015/2016. As we have the age- and sex- specific rates available for each geographic population, direct standardization is preferred to the indirect standardization (17). We adjusted for age and sex using the 2011 Canada census national population as the standard population to make the rates comparable among geographic areas and also consistent with the previous study (2). Confidence intervals (CIs) of the standardized rates were calculated using the binomial approximation at the 95% level (17). The standardized rate ratios (SRRs) were calculated as the rate of each geographic area divided by the rate in the rest of Alberta. The CI for the SRR at the 5% significance level was calculated with an approximation method to test whether the difference between each geographic area and the rest of Alberta was statistically significant (17). All the rate calculations were done at both the rural–urban

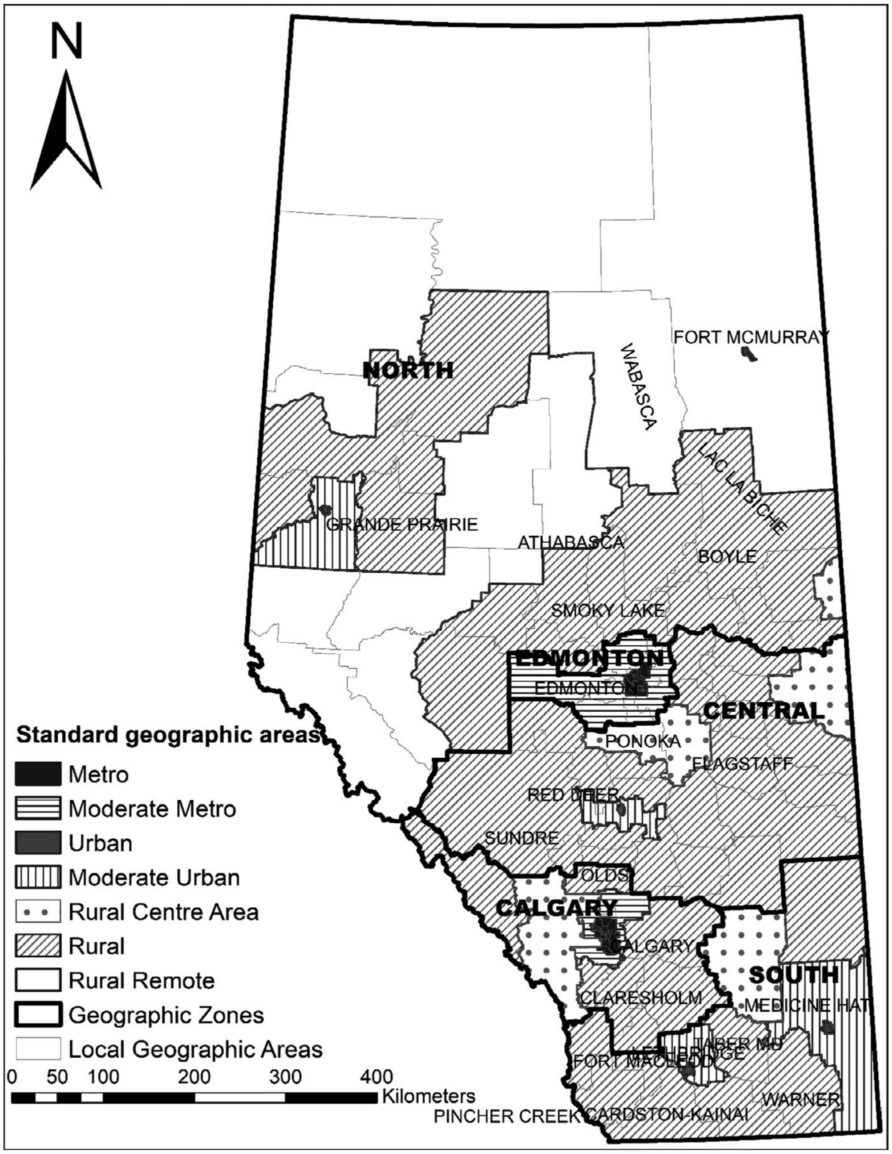

Figure 1. Standard geographic areas in Alberta.

continuum and the LGA level. Box maps of RA rates at the LGA level were produced to display the statistical distribution of RA rates (18,19). Outliers were identified as those 1.5 times of the interquartile range (IQR) above the third quartile and 1.5 times the IQR below the first quartile (18).

Spatial analysis. The complete six-digit postal code of a patient's residential location was obtained from the AHCIP population registry dataset. Each postal code was geocoded using the AH Postal Code Translator File (20) and aggregated at the LGA level.

We conducted the Global Moran's *I* (21,22) and Gi* hotspot analysis (22-24) on different neighborhood specifications to examine the spatial pattern of RA prevalence rates. Global Moran's *I* measures the degree of spatial autocorrelation of RA rates across LGAs (ie, their similarity) as a function of their distance (22). It addresses the following question: Are the LGAs with similar RA rates located nearby, located far apart, or distributed randomly across the province? Moran's *I* index ranges from −1 to 1, with positive values suggesting spatial autocorrelation, negative values suggesting similar rates located far from each other, and values close to 0 indicating that the location of similar rates is independent of their distance. Although Global Moran's *I* provides information on the spatial interaction over the study area, it does not locate the clusters. We applied Gi* hotspot analysis to identify local hotspots of RA rates. Gi* hotspot analysis is a spatial statistical tool to identify the spatial pattern of age- and sex-standardized rates. Gi* hotspot analysis is different from traditional statistics by accounting for the spatial interaction/spatial dependence between geographic areas within a local neighborhood that is defined by the spatial interaction structure (spatial weight matrix). It compares the local sum of RA rates in the defined neighborhood with

Table 1. Age and sex-standardized rates of RA prevalence by rural–urban continuum

Rural–Urban Continuum	RA-Prevalent Cases (in 2015)		Alberta Registry (in 2015)		Crude Rate per 1000 Population Members	Age- and Sex-Standardized Rate per 1000 Population Members (95% CI)	Standardized Rate Ratio (95% CI)
	Count	Percentage	Count	Percentage			
Metro	18 223	47.5	2 413 203	53.8	7.6	10.69 (10.68-10.69)	0.82 (0.82-0.82)
Moderate metro	4893	12.8	584 462	13.0	8.4	11.10 (11.09-11.11)	0.93 (0.93-0.93)
Urban	4120	10.7	448 357	10.0	9.2	13.58 (13.57-13.60)	1.17 (1.17-1.17)
Moderate urban	853	2.2	102 600	2.3	8.3	12.41 (12.38-12.44)	1.05 (1.05-1.05)
Rural center	1745	4.6	187 238	4.2	9.3	12.61 (12.59-12.63)	1.07 (1.07-1.07)
Rural	7625	19.9	646 806	14.4	11.8	14.46 (14.45-14.47)	1.28 (1.28-1.28)
Rural remote	891	2.3	104 013	2.3	8.6	14.17 (14.14-14.20)	1.20 (1.20-1.21)
Alberta	38 350	100	4 486 679	100	8.5	11.81 (11.80-11.81)	-

CI, confidence interval; RA, rheumatoid arthritis.

the expected sum of RA rates in the whole of Alberta (22,23). A hotspot refers to an LGA that has a high RA rate and is also surrounded by LGAs with high RA rates, with the RA rate in the neighborhood being significantly higher than the expected. Conversely, a cold spot refers to an LGA that has a low RA rate and is surrounded by neighboring LGAs with low RA rates, and the neighborhood RA rate is significantly lower than the expected. Both indices are tested statistically with respect to a normal standard distribution. We reported *z*-scores and used $P = 0.05$ as the threshold for rejecting or not rejecting the null hypothesis that RA rates are distributed randomly across the province (25).

The neighborhood defined by eight nearest neighbors (8NN) was chosen as the most appropriate spatial weight matrix conceptualizing the spatial interactions with regards to RA rates of LGAs on the basis of *1*) exploratory analysis on the geographic characteristics of LGAs (15); *2*) comparison of connectivity structures (26) of three weight matrices (supplemental Appendix 1), including 8NN (25,26), 40-km distance band with at least 8NN (40km_8NN) (27) (supplemental Appendix 2), and the first-order queen contiguity with at least 8NN (Queen_8NN) (28); and *3*) the cluster of rheumatologists in Calgary and Edmonton and higher percentage of rural residents seeking health care beyond their own local LGA and their contiguous LGAs (29). We applied a binary specification with row standardization (23) for the weight matrix, assuming that all the neighbors likely interact with the LGA of interest equally, whereas those outside the neighborhood do not.

Descriptive statistics were conducted using R 3.6.1 and Geoda 1.14 (18). Spatial analysis was conducted using ArcMap10.8. Ethics approval for this project was provided by the Conjoint Health Research Ethics Board at the University of Calgary (REB16-1683).

RESULTS

Among 38 350 people with RA, 44% (n = 16 792) were older than 65 years and 68% (n = 26 236) were female compared with 12% and 50% in the general Alberta Registry population, respectively. The number of people with RA in the older population (≥65 years) was three times that in the younger group (aged 16-44 years). The crude prevalence rate of RA was approximately 8.5 cases/1000 population members at the provincial level, which increased to 11.8 cases/1000 population members after age and sex standardization (95% CI 11.80-11.81) (Table 1). This increase is to be expected given that RA has a higher rate in women and the older population, and the Canadian population has a higher percentage of women (Canada 51% versus Alberta 49%) and an older age structure (≥65 years old, Canada 18% versus Alberta 11.7%) compared with the Alberta Registry population. Approximately 60% of people with RA resided in the metro (Calgary and Edmonton) and moderate metro areas (eg, Airdrie, Cochrane, and Okotoks).

Descriptive statistics. *RA prevalence rates at the rural–urban continuum level.* We found a notable rural–urban variation in the RA prevalence along the rural–urban continuum. The crude rate of RA prevalence ranged from 11.8/1000 population members in rural areas to 7.6/1000 population members in metro areas (Table 1). After age and sex standardization, the RA prevalence presented the same pattern, with the highest rate in rural areas (14.46 cases; 95% CI 14.45-14.47;SRR = 1.28) compared with the lowest rate in metro areas (10.69 cases; 95% CI 10.68-10.69; SRR = 0.82). Rural and rural remote areas were observed to have RA prevalence rates 28% and 20% higher than the RA rates in the rest of Alberta, respectively (rural: 14.46 cases; 95% CI 14.45-14.47; SRR = 1.28; rural remote: 14.17 cases; 95% CI 14.14-14.20; SRR = 1.20).

RA prevalence rates at the LGA level. The population of people with RA across LGAs ranged from 16 to 995 cases (median 213; IQR 285). As shown in Figure 2, after age and sex standardization, we found a fivefold difference in RA prevalence ranging from 4.7 to 30.6/1000 population, with a median of 11.8. We identified 11 upper outliers that were beyond the distance of 1.5 times the IQR above the third quartile of RA rates. These outliers were located mostly in the rural and rural remote areas. The RA rates in metro Calgary were less than the first quartile (10.4/1000 population), whereas in metro Edmonton, the RA rates were more than the first quartile. Of the latter, nine were located within the third quartile (11.88-14.50 cases) (Figure 2).

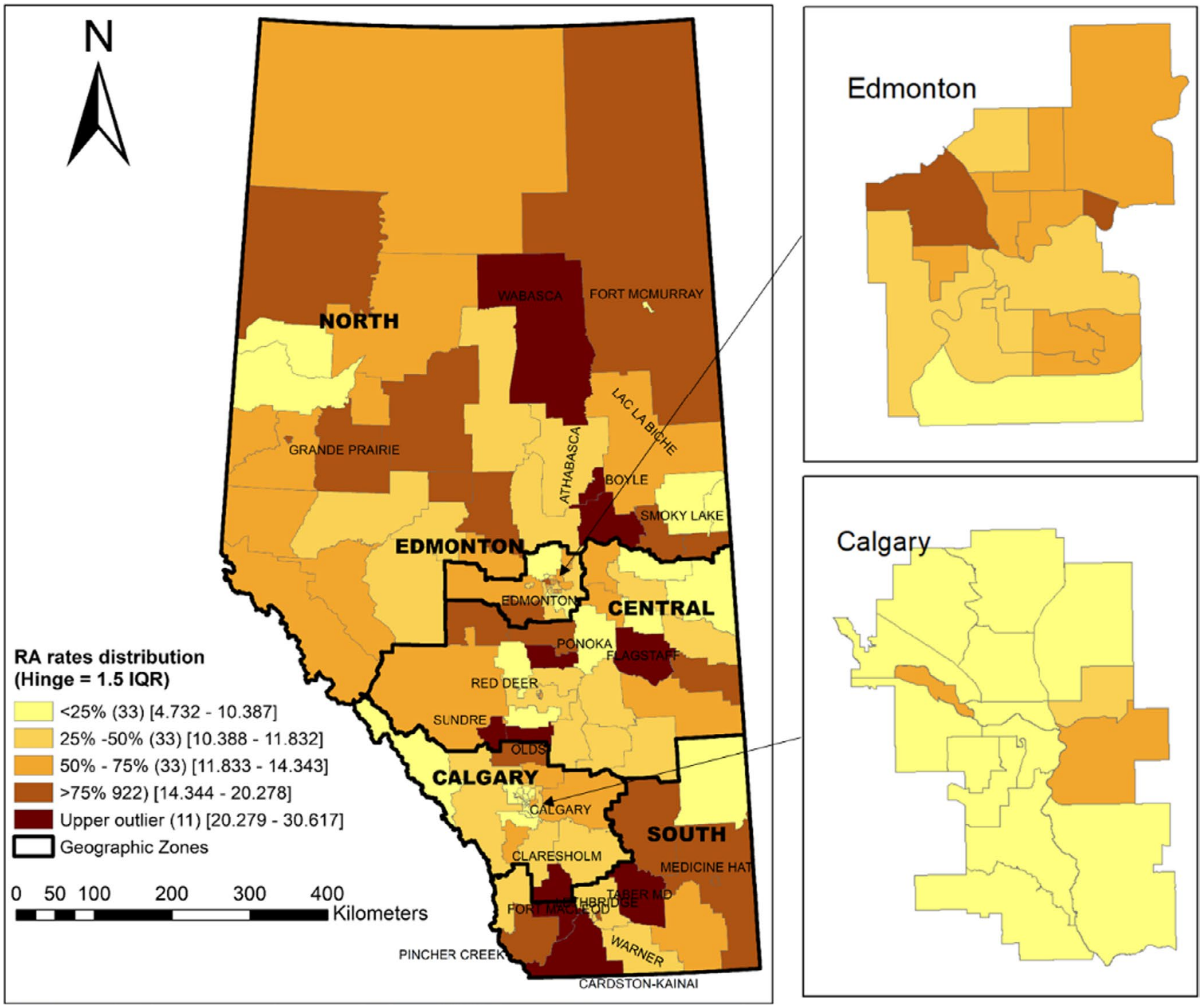

Figure 2. Distribution of rheumatoid arthritis (RA) rates at the local geographic area (LGA) level. The map displays the spatial distribution of RA rates based on the quartiles and includes information on quartiles, count of LGAs within this quartile, and the range of RA rates. Lighter color represents lower RA rates, and darker color represents higher RA rates. Upper outlier ranges between 1.5 times the interquartile range (IQR) above the third quartile (14.34) and the maximum (30.62).

Spatial analysis at the LGA level. Global Moran's *I* produced values of 0.15 for the 8NN spatial weights matrix (8NN; *z*-score = 4.24; P = 0.000022), 0.15 for the distance-band spatial weights matrix (40km_8NN; *z*-score = 4.74; P = 0.000002), and 0.146 for the queen contiguity spatial weights matrix (Queen_8NN; *z*-score = 3.96; P = 0.000075]), respectively. This indicates that RA prevalence is significantly different from a random distribution, and it exhibited a tendency for similar values to occur in proximity (ie, positive spatial autocorrelation).

Gi* hotspot analysis with 8NN spatial weight matrix identified 18 cold spots and 10 hotspots. As shown in Figure 3, all 18 cold spots were in the metro and moderate metro Calgary areas. Among the 10 hot spots, nine were primarily located in the west rural areas of the south zone, including Cardston-Kainai (30.62 cases/1000 population members), Claresholm (29.88 cases), Fort Macleod (28.00 cases), and Pincher Creek (18.34 cases), with one in the north rural remote area (Wabasca 24.11 cases).

Sensitivity analyses were conducted using different spatial weight matrices, as follows: fixed distance band (40km_8NN) and queen contiguity (Queen_8NN). As shown in Figure 3, the three different weight matrices identified the same set of nine hotspots in the south zone. Whereas in the north, hotspot analysis using Queen_8NN identified two rural hotspots (Lac La Biche 13.08 cases; Athabasca 11.49 cases), which was different from the hotspot identified by 8NN and 40km_8NN spatial weight matrices (Wabasca 24.11 cases). By investigating the connectivity of the three hotspots in the north (supplemental Appendix 3), neighborhoods defined by 8NN showed a better capture of people's health

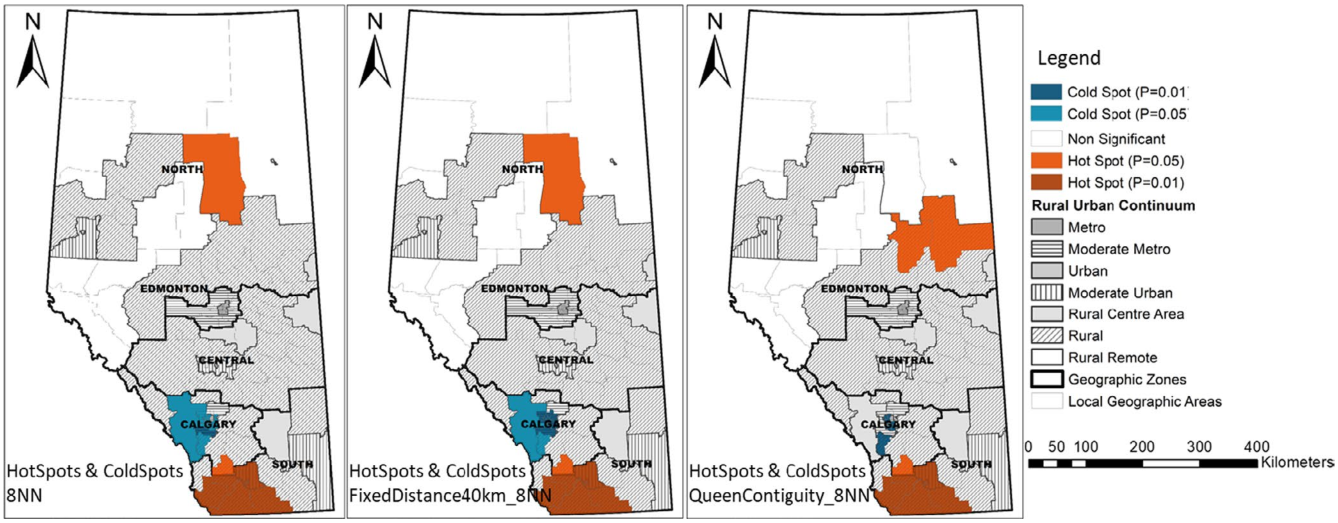

Figure 3. Hotspots and cold spots of rheumatoid arthritis (RA) prevalence rates at the local geographic area (LGA) level by using three different spatial weight matrices. 8NN, eight nearest neighbors.

care–seeking behavior pattern compared with neighborhoods defined by 40km_8NN and Queen_8NN.

DISCUSSION

Using AH administrative health data sets and applying geospatial analysis, our study assessed the geographic variation in RA prevalence across the rural–urban continuum. Although the crude prevalence rate of RA was approximately 8.5/1000 population members for the province, we found a notable rural–urban variation between geographic areas from 7.6 cases/1000 population members to 11.8 cases/1000 population members. RA prevalence rates were significantly higher in rural and remote areas. When analyzed at the LGA level, we found a fivefold difference in RA prevalence ranging from 4.7/1000 population members to 30.6/1000 population members. We identified 10 hotspots located in the south/north rural and remote areas. Cold spots were located in metro and moderate metro Calgary. These variations have the potential to create disparities in access to RA care, which should be considered when designing evidence-based interventions and planning programs to improve access to health care services and reduce inequities. Our findings highlight the need for regional approaches to the planning and delivery of RA care.

Our results are similar to RA prevalence estimates reported in British Columbia (7.6/1000) (30), Ontario (9/1000) (31), and Quebec (9.9/1000) (32). We found a notable rural–urban variation in RA prevalence across the rural–urban continuum, with the lowest RA burden in metro areas and the highest in rural and rural remote areas. Though beyond the scope of this analysis, the rural–urban variation in RA prevalence rate may be explained by systematic differences leading to overdiagnosis or underdiagnosis of RA in rural and urban areas. In Alberta, 54% of RA visits (primary diagnostic code 714) in metro areas were seen by family physicians, compared with 46% with a specialist, including rheumatologists, internists, and orthopedic surgeons. Given the lack of rheumatologists in rural areas, 75% of the RA visits (primary diagnostic code: 714) were associated with a family physician, compared with 25% with specialists. The difference in care delivery may bring up the issue of the accuracy of RA diagnoses, which may further contribute to the rural–urban differences in RA prevalence that was estimated using administrative health data.

In addition, factors such as obesity, socioeconomic factors, and aboriginal and immigrant status may partially explain these variations. Obesity and low socioeconomic status may contribute to the increased risk of developing RA (33,34). The prevalence of RA is higher among the First Nation population compared with non–First Nation populations (9). Recent immigrants have a higher prevalence of arthritis than the nonimmigrant population (35). In Alberta, rural residents have a higher percentage of individuals in the overweight (body mass index [BMI] = 25-29.9 kg/m^2) and obese (BMI = 30-39.9 kg/m^2 and BMI ≥ 40 kg/m^2) ranges compared with urban residents (36). Patients with obesity have more musculoskeletal complaints (37) and might be mistakenly diagnosed with RA, which would increase the prevalence estimates. The average percentage of aboriginal population in rural remote LGAs is nine times the percentage of metro LGAs (20.5% versus 2.3%). Conversely, the percentage of recent immigrants in rural remote LGAs is 86% lower than it is in the metro LGAs (0.7% versus 5%). The rural–urban difference in the distribution of aboriginal and immigrant populations may partially contribute to the RA variation.

These findings of rural–urban variation are in agreement with a previous study that found that the RA prevalence was 20% higher among people residing in rural areas compared with their urban counterparts in Alberta (9). Our findings highlight a common issue of rural–urban disparities in health outcomes and health care access in Alberta and other provincial health systems in Canada (38). Rural Canadians have greater health care needs but less access to health (10,38). In general, 21% of the Canadian population resides in the rural areas, whereas the percentages of family physicians and specialists considered rural are only 9.4% and 3%, respectively (39). In Alberta, people with RA who live in rural areas face challenges in accessing care because rheumatologists are located primarily in metro Calgary and Edmonton. Rural and rural remote areas in Alberta have disproportionately higher rates of ambulatory care–sensitive condition separation rates (40), a valid proxy indicator for the robustness of a primary care system (940 and 1302/1000 population members, respectively) compared with the provincial level of 664, suggesting a problem in obtaining access to appropriate primary health care in the rural and rural remote areas (41,42). Both the Canadian Medical Association and the AHS have a goal to achieve equitable access to care, with a focus on patients in rural and remote areas (10,11). Understanding the rural–urban variation in the prevalence of RA and identifying RA hotspots will provide evidence for health care providers and policy makers to design regional planning of health care services that will improve timely access to RA care (40).

The local difference in RA rates between Calgary and Edmonton is interesting given their similarity in their population sizes, availability of rheumatologists, and access to health care. Metro Calgary has 16 LGAs with an RA standardized prevalence rate of 9.8/1000 population members on average (7.8-13.7 cases; median 9.4 cases), which is 20% lower than the average rate of 12.3 cases in metro Edmonton (15 LGAs; 9.6-14.5 cases; median 12). According to the Community Profile published by AH, the Calgary zone has a lower percentage of individuals with obesity and individuals belonging to the aboriginal population and a higher percentage of immigrants compared with the Edmonton zone (43,44), which could explain this difference through mechanisms suggested above. Statistics Canada reported that Calgary has a higher median household income than Edmonton ($97 334 versus $90 874) (45). Research on the risk factors at both the individual and neighborhood levels at the two cities may contribute a better understanding of this disparity.

To improve patients' access to speciality care, especially those in the rural and rural remote areas, ensuring highly coordinated care between primary care and specialists is central to facilitating timely diagnosis and treatment of new patients and management of established patients, especially those with disease flares. The government of Alberta initiated the Alberta Surgical Initiative in 2020 (12), emphasizing the importance of expanding telephone and electronic advice programs through which primary care providers can receive timely advice from specialists for patients under care. Across the province, several efforts are ongoing to improve access to specialty care for patients. Telehealth has been used for more than decade in a limited capacity by urban rheumatologists to provide care to specific rural communities (37). Additionally, some Alberta rheumatologists provide travelling clinics to indigenous and remote communities in the province (46). More recently, the province has developed a program in Calgary area to increase primary care access to specialist physicians through Specialist Link, a telephone consultation service, along with online clinical pathways to better direct timely care (47,48). Identifying hotspots may further inform targeted evaluation of the impacts of these new and existing services and assist in planning additional community-level approaches to high-quality care. Especially at this time of the coronavirus disease 2019 pandemic, virtual care for established patients with RA is increasingly practiced across the country. It is intriguing to think that we already have the tools to help provide RA care to the patients residing in the hotspots identified, although it is also possible that virtual care might further drive inequities in access, especially if not provided in a culturally sensitive way.

This study has strengths and limitations. First, we applied spatial analysis to explore the geographic variation of RA prevalence at the LGA level, which may fill the gap in knowledge of RA prevalence at local levels, providing important information for health care planning. We conducted spatial analysis using three different spatial weight matrices to examine the sensitivity of results to different weight matrix settings. We had 15 years of longitudinal data, ensuring stable estimates of RA prevalence. We used provincial administrative databases as the source for estimating the RA prevalence using a validated RA case definition. Previous studies suggest that the RA case definition using health administrative databases that we applied has excellent sensitivity when multiple physician claims are included. The RA case definition algorithm of "at least one hospitalization or two physician claims (at least 8 weeks apart) within 2 years" had a sensitivity of 97%, specificity of 77%, positive predictive value of 67%, and negative predictive value of 98% (49). The Public Health Agency of Canada applies this case definition in their surveillance definitions and across all provinces to provide reasonable and stable estimates of disease prevalence (50). However, these estimates are based on administrative data that have inherent limitations and should be interpreted with caution. The data reflect only people seeking medical care who were given an RA diagnosis on billing or hospitalization data. The case ascertainment in rural and rural remote areas may be even lower because of reduced access to primary care (30,32). In addition, research has highlighted the importance of accounting for imperfect sensitivity and specificity by combining more than one case definition (32). In our study, we did not apply multiple case definitions to estimate RA prevalence; instead, we chose the case definition on the basis of previous publications (2,9,51).

In conclusion, we analyzed RA prevalence rates at the LGA level across the rural–urban continuum using spatial analysis. The findings highlight notable rural–urban variation, with RA prevalence rates significantly higher in rural (SRR = 1.28) and remote areas

(SRR = 1.20) than the rest of Alberta. These variations can inform strategies aimed at reducing geographic disparities by targeting areas with high health care needs. Future work will examine geographic accessibility and the association of socioeconomic factors with health care utilization and health outcomes, which may reveal further insights about rural–urban disparities.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting or revising the article for important intellectual content, and all authors have read and approved the final version to be published. Dr. Marshall had full access to all the data in study and takes responsibility for the integrity of the data and accuracy of the data analysis.

Study conception and design. Liu, Barber, Katz, Homik, Bertazzon, Patel, Mosher, Marshall.

Acquisition of data. Liu, Barber, Robert, Smith, Marshall.

Analysis and interpretation of data. Liu, Barber, Katz, Homik, Bertazzon, Patel, Robert, Smith, Mosher, Marshall.

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