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RESEARCH

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Informing equitable access to care: a cross-sectional study of travel burden to primary and rheumatology care for people with rheumatoid arthritis

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Abstract

Background Achieving equity in access to care is a priority at both national and provincial levels in Canada to address health disparities. However, equitable access remains a challenge due to significantly higher rheumatoid arthritis (RA) prevalence in vast rural areas, whereas the RA care providers are primarily concentrated in the two largest cities. Rural-urban disparities in access may be partially attributed to geographic barriers. It is important to measure travel burden of people with RA for developing targeted interventions and policies to mitigate identified geographic barriers and informing equitable access to health care.

Methods A cross-sectional study was conducted between April 1, 2019 and March 31, 2020 for people with RA in Alberta, Canada. RA cohort was identified using a validated RA case definition based on administrative health data. Travel time between patients' postal codes and providers' clinic postal codes was calculated using network analysis. Median travel time was reported at geographic area level. Wilcoxon Rank Sum Test was applied to test the statistical significance between rural-urban categories. The distance decay effect of travel time on health care utilizaton was modelled using a reverse cumulative probability approach.

Results RA patients took a median of 13 min (IQR: 5–28) to visit general practitioners (GPs) and 34 min (IQR: 21–51) to visit rheumatologists. There were significant rural-urban disparities in access to GP and rheumatology care. The results showed a 4-fold difference in GP travel time (remote areas:5 min, IQR 5–79; moderate metro:20 min, IQR 7–34) and 8.7-fold difference to rheumatologist visit (remote: 226 min, IQR 165–331; metro: 26 min, IQR 17–36) across the rural-urban continuum. Remote patients experienced the longest travel time to rheumatology care but the shortest median travel time to GP care. In remote areas, travel time showed the weakest impact on health care utilization compared to other rural-urban continuum.

Conclusions Measuring the travel burden for people with RA to access care reveals patterns about the differences in how far patients travelled to seek RA care based on their residential geographic location. These findings will provide

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evidence to inform health care planning and address observed disparities towards the goal of achieving equitable care.

Keywords Rheumatoid arthritis, Primary care, Rheumatology care, Equitable access, Travel time, Rural-urban disparities

Background

Rheumatoid arthritis (RA) is one of the most common forms of autoimmune arthritis in Canada, affecting approximately 1% of the Canadian population [1]. As a chronic condition requiring ongoing medical care, RA significantly impacts patients' quality of life and poses substantial economic burden on individuals and society. Currently, health care access for RA is suboptimal given the significant gaps between anticipated demand of RA care and supply for rheumatology providers [2–4]. Studies reported rheumatology workforce shortages worldwide, which is expected to be exacerbated by anticipated baby boomer retirement of nearly 50% of the current workforce, the increasing number of women, millennials, and part-time providers entering RA practice, and fewer providers anticipating entering into community practice [3, 5]. At the same time, greater demands on rheumatology services are anticipated due to the rapidly rising RA prevalence and aging populations [1, 3]. The mismatch between demands of RA care and the supply of rheumatologists is further worsened by the maldistribution of RA populations and RA care providers [6], especially in rural and remote areas, leading to delayed access to appropriate care. Timely access to rheumatology care is crucial for optimal health outcomes with early diagnosis, optimal disease management, multidisciplinary care coordination, and prevention of long-term complications [7–9].

Achieving equity in access to care is a priority at both national and provincial levels in Canada to address health disparities in rural and remote areas [10, 11]. However, equitable access remains a challenge, especially in the province of Alberta, which has a significantly higher RA prevalence in its vast rural areas, whereas the majority of RA care providers are primarily concentrated in the two largest cities [3, 6]. Rural-urban disparity in health outcomes and health care access is a common issue in Alberta and other provincial health systems in Canada. Only 9.4% of general practitioners (GPs) and 3% of specialists [10, 12] practice in rural areas, providing care to 19% of rural Canadians. In Alberta, a number of studies have identified significant rural-urban disparities in the prevalence of osteoarthritis [13] and associated comorbidities [14], health care utilization for osteoarthritis [15], as well as prevalence of rheumatoid arthritis across the rural-urban continuum [6]. It is reported that the RA prevalence in rural and remote areas was 20-30% higher than their urban and metro counterparts in Alberta [6, 16]. Rural-urban disparities in health outcomes and access may be partially attributed to geographic barriers, long travel distances, and limited transportation options. Geography was more frequently reported as a barrier to health care in Canada compared to other countries including Australia, New Zealand, and Switzerland according to an international comparative study [17]. The presence of geographical obstacles to achieving equitable health care results in a significant travel burden for patients who must journey longer distances to access services that are unavailable within their local communities [12].

It is important to measure travel burden of people with RA for developing targeted interventions and policies in order to mitigate identified geographic barriers and ensure equitable access to health care. However, there is limited evidence on travel burden to RA care. It was reported that increased travel distances to RA care was associated with decreased probabilities of RA diagnosis and the disease-modifying antirheumatic drugs (DMARDs) treatment [18, 19]. Timely rheumatology consultation is negatively associated with remote patient residence [20]. By reducing travel burden, health care providers can facilitate timely diagnosis, treatment initiation, and regular follow-up care, leading to improved health outcomes for individuals in rural areas. Measuring travel burden allows policymakers to identify areas with high travel burden and inadequate health care services, facilitating targeted allocation of health care resources. This information can guide decisions on the implementation of alternative health care delivery models, such as telemedicine or specialist outreach programs, which can be more cost-effective and efficient for patients in rural areas.

This study aims to measure travel burden to GPs and rheumatologists for people with RA and to examine the impact of travel burden on healthcare utilization in Alberta across the rural-urban continuum. By considering travel burden measurement, policymakers can develop strategies to address geographic barriers, reduce travel burden and promote equitable access to RA care for all patients, regardless of their geographic location.

Methods

Standard geographic areas in Alberta

Covering 661,848 km^2, Alberta is the 4th largest province in Canada with approximately 4.3 million people. Over half of residents live in the two largest cities – Edmonton and Calgary. Urban population represents 81% of the provincial population, while rural is 19%. Alberta Health Services (AHS), is the province's sole health care authority, delivering medical care on behalf of the Alberta government – Alberta Health (AH). AHS and AH jointly created a set of standard geographic areas in Alberta for the purpose of surveillance, planning, monitoring, and reporting of population health, health outcomes, and health services across Alberta (Fig. 1) [21]. Five zones were formed in 2009 to deliver health services, consisting of Edmonton, Calgary, North, Central, and South zones. Based on rurality and population density, a rural-urban continuum was further developed, including seven distinct categories (metro, moderate metro, urban, moderate urban, rural centre, rural, and rural remote). Calgary and Edmonton are the two metro centres. Metro influenced area refers to those areas immediately surrounding Calgary and Edmonton, having commuters living outside of Calgary/Edmonton but commuting to Calgary/Edmonton for work and business. Urban centres are defined as having populations > 25,000 but less than 500,000, including five urban centres - Grand Prairie, Fort McMurray, Red Deer, Lethbridge, and Medicine Hat. Areas immediately surrounding the urban centers are classified as moderate urban influenced areas. Rural centers are defined as having populations between 10,000 and 25,000. Rural areas have populations less than 10,000 and within 200 km from a metro or urban centre. Remote areas are located greated than 200 km away from a metro or urban centre.

Study design, RA case definition and data sources

A cross-sectional observational study was conducted on the RA prevalence cohort between April 1, 2019 and March 31, 2020 in Alberta Canada. This study utilized administrative health data and employed a validated RA case definition established by the Public Health Agency of Canada for the Canadian Chronic Disease Surveillance System to identify cases of prevalent RA [22, 23]. RA cases were defined as individuals who had either one hospitalization separation or two physician claims (> = 8 weeks apart) within a 2-year period. The case date was defined as the date of the second physician claims visit or the discharge date of hospitalization with RA diagnosis code (ICD-9-CM codes of 714.x or ICD-10-CA codes of M05.x, M06.x), whichever occurred first. Administrative health records spanning from April 1, 2007 to March 31, 2020 were obtained from three administrative health databases: the Discharge Abstract Databases, physician claims, and the Alberta Health Care Insurance Plan (AHCIP). RA cases were identified among patients aged 16 years and older by applying the defined case criteria to linked health administrative data utilizing a unique personal identifier. A long run-in period (2009/10–2019/20) was applied to capture all prevalent RA cases and avoid misclassifications of prevalent cases as incident [23]. Patients were excluded for a specific fiscal year if they moved out of Alberta or died during the fiscal year.

Definition of primary care physicians and rheumatologists

GPs were identified if a physician was listed as "GP" under the specialty group in the physician claims records. In Alberta's provincial administrative datasets, distinguishing between rheumatologists and internists is challenging as there is no dedicated identifier for rheumatologists [3]. To compile a list of rheumatologists, we followed two criteria: (1) Inclusion of rheumatologists who explicitly gave consent for their personal physician identifiers to be included in the analysis; (2) Identification of internists who had more than 20% of their claims related to RA visits between 2007/2008 and 2019/20 [7]. While this method might not encompass the entire list of rheumatologists in Alberta, it correctly identified 93% of the known rheumatologists [7].

Health care visits

All visits to GPs and rheumatologists due to any diagnosis between April 1, 2019 and March 31, 2020 were included. Physician claims submitted by the same provider for the same patient on the same day were considered as one unique visit.

Travel time using network analysis

Travel times between patients' residential postal codes and providers' clinic postal codes were calculated as the driving time along a digital road network that was modeled by AHS [24]. Providers' 6-digit postcodes of their practice locations were extracted from the physician claims records. Some providers may practice at multiple clinics. All clinic postal codes were included in the analysis. Patients' 6-digit postal codes were obtained from the AHCIP population registry dataset. Both patients and providers were geocoded using Alberta Health Postal Code Translator File [25].

Using the Route Logistics Road Network File (DMTI) and Alberta Municipality Data Sharing Partnership (AMDSP) road data [24], AHS created a road network dataset with defined speed limits across the whole province. The origin-destination function from the Network Analysis in ArcGIS was applied to calculate the driving time in minutes from patients' postal codes to providers' postal codes [26, 27]. The modeled travel time was calculated with the assumption that patients travelled under optimal conditions with posted speed limits. Given the long winter time in Alberta, we applied a 20% reduction in speed limit for travel distances less than 50 km to account for the impact of winter conditions on travel time [24].

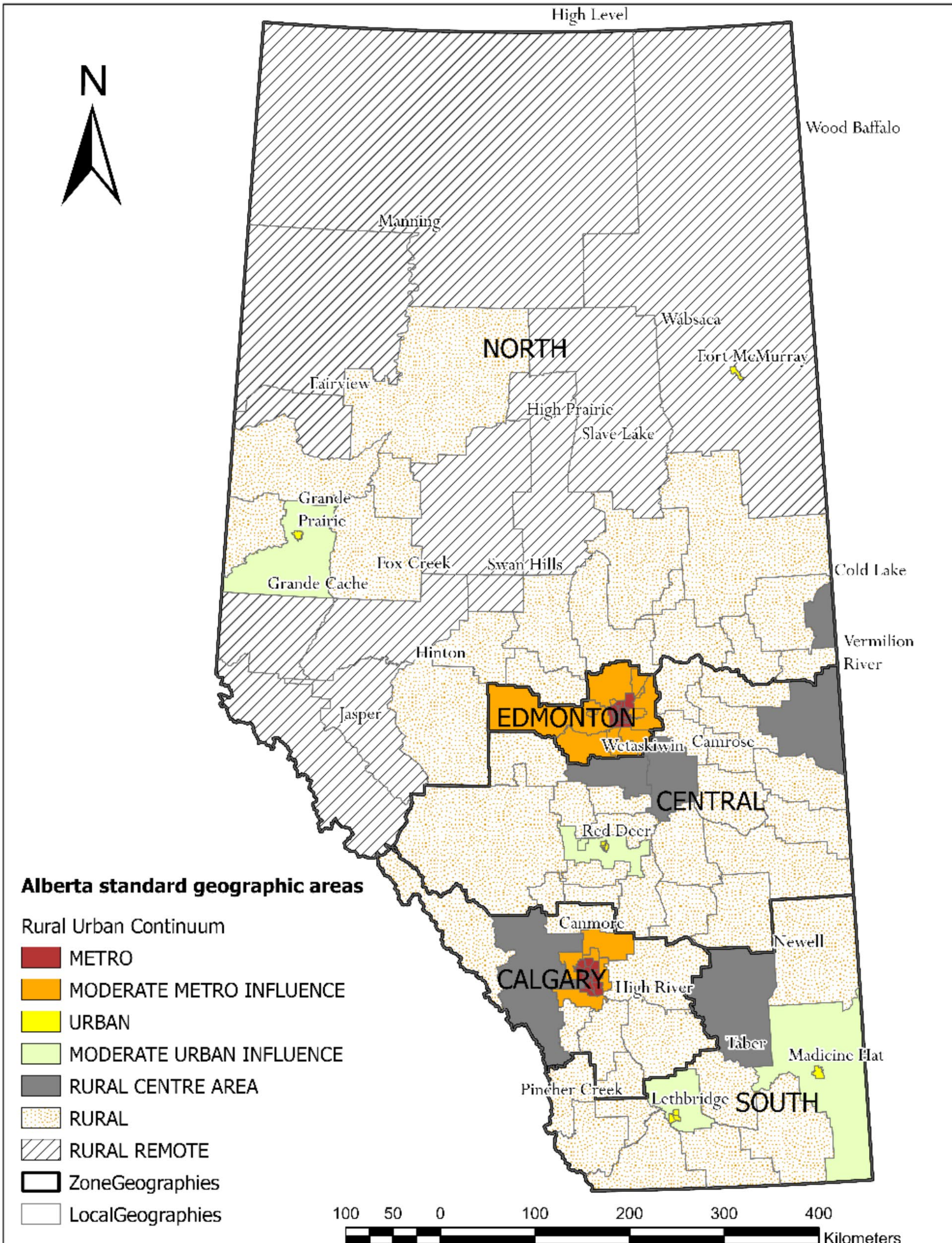

Fig. 1 Standard geographic areas in Alberta

Descriptive analysis

Due to the right skewed distribution of travel times, median and interquartile range (IQR) of travel time per visit were reported to represent travel burden at provincial level as well as the rural-urban continuum level. Count and percentage were reported for number of patients, number of providers, and number of visits for each rural-urban category. We also reported the ratio of travel time within each rural-urban category to the provincial travel burden. The statistical significance between rural-urban category and the provincial level was tested using the Wilcoxon Rank Sum Test, a nonparametric test to compare outcomes between two independent groups [28].

Distance decay effect of travel time on health care utilizations.

We adopted the cumulative probability approach to capture the effect of travel times on the interaction between people with RA and two types of health care providers, respectively, along the rural-urban continuum [15, 29, 30]. This is also called the distance decay effect, which is a geographical term describing that the interaction between two locations declines as the distance / time between them increases. Number of health care visits were calculated as a measure of interaction between patients and providers. We reversely aggregated the number of GP / rheumatologist visits and corresponding cumulative probabilities at defined travel time points for each rural-urban category. It tells us the probability that people with RA travelled beyond a specific distance. For example, at travel time 0, the probability is 1 as all people with RA travelled more than 0 min to seek health care. We calculated the cumulative probabilities at 68 travel time points, including 31 points for every minute for the range 0–30 min, 18 points for every 5 min from 31 to 120 min, 12 points for every 10 min from 121 to 240 min, 6 points for every 60 min from 241 min to 480 min, and 1 point for the maximum travel time. We conducted sensitivity analysis to decide the best-fitting distance decay model, including 5 commonly used decay functions: exponential function, log-logistic function, power function, logistic function, and Gaussian function [15, 30, 31]. The model results showed that log-logistic function works better than the other functions, which is consistent with literature (appendix A). For consistency and comparison across rural-urban categories, log-logistic model was chosen as the best-fitting model for subsequent results reporting and discussion.

Descriptive analyses were conducted using R 4.2.2. Network analyses were conducted using ArcGIS Pro 3.0.3. Ethics approval for this project was provided by the Conjoint Health Research Ethics Board at the University of Calgary (REB22-0658).

Table 1 Characteristics of RA prevalent cohort in fiscal year 2019/20

Characteristics	***n* (%)**
Age	
Age at incidence (median)	55 (IQR: 44–65)
Age at fiscal year (median)	64 (IQR: 53–74)
Sex	
Male	14,082 (32.1%)
Female	29,745 (67.9%)
Status	
Prevalent RA	40,520 (92.5%)
New RA	3,307 (7.5%)
Zone	
CALGARY	14,756 (33.7%)
CENTRAL	5,729 (13.1%)
EDMONTON	14,079 (32.1%)
NORTH	4,972 (11.3%)
SOUTH	4,291 (9.8%)
Rural-urban Continuum	
METRO	21,210 (48.4%)
MODERATE METRO INFLUENCE	5,838 (13.3%)
URBAN	4,455 (10.2%)
MODERATE URBAN INFLUENCE	943 (2.2%)
RURAL CENTRE AREA	2,048 (4.7%)
RURAL	8,331 (19.0%)
RURAL REMOTE	1,002 (2.3%)
Having >= 1 GP visit	41,788 (95.3%)
Having >= 1 rheumatologist	16,001 (36.5%)
Alberta	43,827 (100.0%)

Results

We identified 43,827 RA prevalent cases in the fiscal year 2019/20, with a median age of 64 years old (IQR: 53–74). Females accounted for 67.9% of the RA cohort (29,745), twice the number of males (14,082, 32.1%). Among the RA cohort, 3,307 (7.5%) incident RA cases were identified, compared to 40,520 established RA cases (92.5%). Half of the RA cohort resided in metro Calgary and metro Edmonton Zone (48.4%), compared to 26% in rural and remote areas. Majority RA cases (41,788, 95.3%) had at least one GP visit. One third of RA cases (16,001, 36.5%) had at least one visit to a rheumatologist during the fiscal year 2019/20 (Table 1).

We identified 5,203 GPs practicing at 2,721 postal codes, among which 8 GPs were excluded due to missing clinic postal codes in the physician claims records. As physicians were billing from more than one location, the number of postal codes linked to a GP ranged from 1 to 48 with a median of 2 postal codes (IQR: 1–3). We identified 59 flagged rheumatologists in 2019/20 practicing in 53 postal codes. Number of postal codes linked to a rheumatologist ranged from 1 to 12 with a median of 2 postal codes (IQR: 2–3).

Travel time of primary care visit

Median travel time to GPs was 13 min (IQR: 5–28) in Alberta (Table 2). The travel burden in rural (6 min, IQR: 5–38) and remote areas (5 min, IQR: 5–79) was 50-60% lower than the provincial level. Metro area had similar travel burden (14 min, IQR: 7–25) as the provincial median, while moderate metro (20 min, IQR: 7–34) and moderate urban (20, IQR: 12–29) areas had the longest travel time to GP – 1.5 times the provincial level. Notably, as shown by appendix B, though remote area had the shortest median travel time to GPs, it had the longest mean travel time (82 min) due to a wide range (1–883 min) and right skewed distribution. As shown by Table 3, about 90% of metro patients visited GPs in their metro city within 15 min. Among patients living in the moderate metro areas, over half of them sought GP care in local communities (7–8 min), while 30-40% of them travelled about 30 min to metro centres for GP care. About 60% remote RA patients visited GP care within in 5 min, comparing to 9% of remote patients taking up to 375 min to seek GP care.

Travel time of rheumatologist visit

Median travel time to rheumatologists was 34 min (IQR: 21–51) in Alberta. Metro had the shortest travel time to rheumatologist (26 min, IQR 17–36), 20% lower than the provincial level. Remote areas had the longest travel time (226 min, IQR: 165–331) to rheumatologist, 6.6 times the provincial level, followed by urban areas (105 min, IQR: 11–150) (Table 2). We observed an 8.7-fold difference in travel time across the rural-urban continuum. Most urban patients visited rheumatologists in the closest metro area (Table 4) – Calgary or Edmonton, due to limited availability of rheumatologists in the urban areas, leading to heavy travel burden to RA care.

Distance decay effect of travel time on health care utilization

As shown by Fig. 2, we observed that primary care utilization decreased at a similar rate when travel times increased across all rural-urban continuum within 30 min travel time, accounting for about 65% primary care visits. Rural remote had the slowest decreasing utilization beyond 30 min. Approximately 25% of people with RA in remote areas visited GPs beyond 60 min, comparing to 10% in the rest of Alberta. For rheumatologist utilization, the interaction between RA patients and rheumatologists decreased fastest in metro and moderate metro area (90% rheumatologists visits within 60 min), followed by rural and rural centre area (90% rheumatologists visits within 180 min), urban and moderate urban areas (90% rheumatologists visits within 300 min), and remote areas (90% rheumatologist visits within 500 min).

Discussion

We conducted a cross-sectional analysis to examine rural-urban disparities in travel burden to primary care and rheumatology care for people with RA using administrative health data within the fiscal year 2019/20. In summary, people with RA in Alberta took a median travel time of 13 min to visit a GP and 34 min to visit a rheumatologist. However, there were significant rural-urban

Table 2 Travel time to primary care and rheumatologists

Travel time of GP visits by rural urban continuum (minutes)							
Rural-Urban Continuum	nPatient (%)	nGP (%)	nVisit (%)	Median	Min	Max	Ratio to AB
METRO	20,194 (48.3%)	3,347 (52.7%)	225,283 (48.7%)	14 (IQR:7–25)	2	595	1.1
MODERATE METRO INFLUENCE	5,587 (13.4%)	884 (13.9%)	55,300 (12.0%)	20 (IQR:7–34)	2	565	1.5
URBAN	4,221 (10.1%)	580 (9.1%)	46,116 (10.0%)	9 (IQR:5–14)	2	682	0.7
MODERATE URBAN INFLUENCE	897 (2.1%)	108 (1.7%)	8,389 (1.8%)	20 (IQR:12–29)	2	502	1.5
RURAL CENTRE AREA	1,954 (4.7%)	281 (4.4%)	21,513 (4.7%)	10 (IQR:5–35)	2	583	0.8
RURAL	7,981 (19.1%)	993 (15.6%)	93,832 (20.3%)	6 (IQR:5–38)	2	685	0.5
RURAL REMOTE	954 (2.3%)	162 (2.5%)	12,050 (2.6%)	5 (IQR:5–79)	2	883	0.4
Alberta	41,788 (100.0%)	6,355 (100.0%)	462,483 (100.0%)	13 (IQR:5–28)	2	883	1.0
Travel time of rheumatologist visits by rural urban continuum (minutes)							
Rural-Urban Continuum	nPatient (%)	nRheumatologist (%)	nVisit (%)	Median	Min	Max	Ratio to AB
METRO	8,282 (51.8%)	57 (72.2%)	12,052 (54.6%)	26 (IQR:17–36)	2	312	0.8
MODERATE METRO INFLUENCE	2,346 (14.7%)	5 (6.3%)	3,287 (14.9%)	36 (IQR:30–44)	2	373	1.1
URBAN	1,363 (8.5%)	10 (12.7%)	1,725 (7.8%)	105 (IQR:11–150)	2	527	3.1
MODERATE URBAN INFLUENCE	326 (2.0%)	0	444 (2.0%)	108 (IQR:27–141)	10	330	3.2
RURAL CENTRE AREA	669 (4.2%)	3 (3.8%)	732 (3.3%)	65 (IQR:52–114)	2	315	1.9
RURAL	2,695 (16.8%)	4 (5.1%)	3,473 (15.7%)	81 (IQR:51–131)	2	524	2.4
RURAL REMOTE	320 (2.0%)	0	379 (1.7%)	226 (IQR:165–331)	28	775	6.6
Alberta	16,001 (100.0%)	79 (100.0%)	22,092 (100.0%)	34 (IQR:21–51)	2	775	1.0

Note: the number of rheumatologists and GPs may be double counted as a provider may practice within multiple areas. All the ratios to Alberta level were statistically significant ($p < 0.05$)

Table 3 Most frequently visited GP destinations at zone and rural level

Patient Zone_Rural	Favourite Destinations (GP Providers Zone_rural)			
	1st	2nd	3rd	4th
Metro-Calgary	**Metro-Calgary**	**Moderate Metro-Calgary**	**Metro-Edmonton**	**Rural-Calgary**
n(%) RA patients	10,160 (91.2%)	390 (3.5%)	160 (1.4%)	114 (1.0%)
Median Travel time	15	29	212	48
Metro-Edmonton	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**	**Rural-North**
n(%) RA patients	8698 (83.0%)	1266 (12.1%)	159 (1.5%)	92 (0.9%)
Median Travel time	12	28	210	160
Moderate Metro-Calgary	**Moderate Metro-Calgary**	**Metro-Calgary**	**Rural-Calgary**	**Rural Centre-Calgary**
n(%) RA patients	1075 (49.4%)	858 (39.4%)	145 (6.7%)	25 (1.1%)
Median Travel time	7	33	29	54
Moderate Metro-Edmonton	**Moderate Metro-Edmonton**	**Metro-Edmonton**	**Rural-Central**	**Metro-Calgary**
n(%) RA patients	3123 (61.4%)	1579 (31.0%)	107 (2.1%)	96 (1.9%)
Median Travel time	8	34	42	225
Moderate Urban-Central	**Urban-Red Deer**	**Moderate Urban-Central**	**Rural-Central**	**Metro-Calgary**
n(%) RA patients	184 (39.0%)	159 (33.7%)	79 (16.7%)	20 (4.2%)
Median Travel time	24	6	41	105
Moderate Urban-North	**Urban-Grand Prairie**	**Moderate Urban-North**	**Rural-North**	**Metro-Edmonton**
n(%) RA patients	175 (70.9%)	35 (14.2%)	13 (5.3%)	11 (4.5%)
Median Travel time	19	5	42	292
Moderate Urban-South	**Urban-Medicine Hat**	**Urban-Lethbridge**	**Moderate Urban-South**	**Rural-South**
n(%) RA patients	135 (30.9%)	132 (30.2%)	117 (26.8%)	22 (5.0%)
Median Travel time	19	23	5	30
Rural-Calgary	**Rural-Calgary**	**Metro-Calgary**	**Moderate Metro-Calgary**	**Rural-Central**
n(%) RA patients	1078 (52.7%)	417 (20.4%)	276 (13.5%)	113 (5.5%)
Median Travel time	5	48	29	22
Rural-Central	**Rural-Central**	**Urban-Red Deer**	**Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	2569 (68.3%)	323 (8.6%)	184 (4.9%)	163 (4.3%)
Median Travel time	5	45	87	95
Rural-North	**Rural-North**	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Urban-Grand Prairie**
n(%) RA patients	2010 (65.9%)	397 (13.0%)	258 (8.5%)	122 (4.0%)
Median Travel time	5	103	47	41
Rural-South	**Rural-South**	**Urban-Lethbridge**	**Metro-Calgary**	**Urban-Medicine Hat**
n(%) RA patients	1003 (68.8%)	242 (16.6%)	65 (4.5%)	36 (2.5%)
Median Travel time	5	42	150	65
Rural Centre-Calgary	**Rural Centre-Calgary**	**Metro-Calgary**	**Moderate Metro-Calgary**	**Rural-Calgary**
n(%) RA patients	205 (56.6%)	102 (28.2%)	38 (10.5%)	11 (3.0%)
Median Travel time	5	41	34	31
Rural Centre-Central	**Rural Centre-Central**	**Rural-Central**	**Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	939 (56.7%)	213 (12.9%)	177 (10.7%)	20 (1.2%)
Median Travel time	5	22	66	207
Rural Centre-North	**RURAL CENTRE AREA - NORTH**	**Metro-Edmonton**	**Rural-North**	
n(%) RA patients	149 (63.1%)	36 (15.3%)	34 (14.4%)	
Median Travel time	4	221	41	
Rural Centre-South	**Rural Centre-South**	**Metro-Calgary**	**Urban-Medicine Hat**	
n(%) RA patients	294 (79.9%)	26 (7.1%)	21 (5.7%)	
Median Travel time	5	124.5	55	
Rural Remote-North (North)	**Rural Remote-North (North)**	**Rural-North**	**Metro-Edmonton**	**Urban-Fort McMurray**
n(%) RA patients	322 (56.3%)	59 (10.3%)	51 (8.9%)	45 (7.9%)
Median Travel time	5	130	375	96
Rural Remote-North (West)	**Rural Remote-North (West)**	**Metro-Edmonton**	**Rural-North**	**Urban-Grand Prairie**

Table 3 (continued)

Patient Zone_Rural	Favourite Destinations (GP Providers Zone_rural)			
	1st	**2nd**	**3rd**	**4th**
n(%) RA patients	499 (66.6%)	76 (10.1%)	65 (8.7%)	43 (5.7%)
Median Travel time	5	208	54	131
Urban-Fort McMurray	**Urban-Fort McMurray**	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	333 (69.2%)	65 (13.5%)	33 (6.9%)	17 (3.5%)
Median Travel time	12	312	512	310
Urban-Grand Prairie	**Urban-Grand Prairie**	**Rural-North**	**Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	556 (80.3%)	37 (5.3%)	21 (3.0%)	17 (2.5%)
Median Travel time	7	41	295	473
Urban-Lethbridge	**Urban-Lethbridge**	**Rural-South**	**Metro-Calgary**	**Moderate Urban-South**
n(%) RA patients	1094 (77.8%)	107 (7.6%)	70 (5.0%)	63 (4.5%)
Median Travel time	8	41	145	22
Urban-Medicine Hat	**Urban-Medicine Hat**	**Metro-Calgary**	**Moderate Urban-South**	**Urban-Lethbridge**
n(%) RA patients	1010 (88.4%)	47 (4.1%)	22 (1.9%)	15 (1.3%)
Median Travel time	8	200	17	124
Urban-Red Deer	**Urban-Red Deer**	**Rural-Central**	**Moderate Urban-Central**	**Metro-Edmonton**
n(%) RA patients	863 (77.7%)	97 (8.7%)	46 (4.1%)	38 (3.4%)
Median Travel time	9	38	32	104

disparities in access to both primary and rheumatology care. The results showed a 4-fold difference in travel time to GP visits and an 8.7-fold difference in travel time to visit a rheumatologist. Rural remote patients had the longest median travel time for rheumatology care but the shortest median travel time to primary care. Health care utilization decreased along with increased travel time, whereas in remote areas, travel time showed the weakest impact on health care utilization comparing to other rural-urban continuum.

We observed consistent travel burdens to primary care and specialty care for people with RA and osteoarthritis (OA) in Alberta. At provincial level, people with RA travelled 13 min (IQR: 5–28) to primary care and 34 min (IQR: 21–51) to rheumatology care, which was consistent with the reported travel burden among people with OA [15] – 12 min to GPs (IQR: 4–26) and 29 min to orthopedic surgeons (IQR: 15–65). At the rural-urban continuum level, the results showed consistent rural-urban disparities in travels times to both primary care and specialty care. Metro patients took about 14 min for primary care (OA: 13 min, IQR: 7–21; RA: 14 min, IQR: 7–25), compared to 5 min among remote patients (OA: 3 min, IQR: 0–92; RA: 5 min, IQR: 5–79). Travel time to specialty services was about 30 min for metro patients (OA: 21 min, IQR: 14–30; RA: 26 min, IQR: 17–36) and close to four hours for remote patients (OA: 234 min, IQR: 171–363; RA: 226 min, IQR: 165–331). The concordance of travel pattern between OA and RA patients suggests that there may be a potential to apply the findings to specialty health care services to inform health resource allocation and health care planning in Alberta. However, we have to generalize findings with caution because generally health care utilization patterns vary depending on population groups, health care providers, and the spectrum of diseases [23, 32].

In this study, we focused on examining how far patients travelled to seek GP and rheumatology care in Alberta. We identified significant rural-urban disparities in travel burden across the rural-urban continuum, which can partially provide information on the determination of travel time thresholds and catchment areas for primary and rheumatology care. A maximum of 30 min travel time for GP care is used to designate Health Professional Shortage Areas in USA [32]. Australia determined a threshold of 10 min travel time to GPs and 30 min to specialists. Netherland also defined a 10-minutes travel time by car to measure access to GPs [33]. The Office for National Statistics in England used a maximum catchment size of 60 min by car for GP care [34]. Numerous studies on spatial accessibility assumed a 30-minutes catchment size for primary care in urban and metro areas [35–37], which was extended to 60 min to account for the long travel distances in rural and remote areas [38–40]. There are limited studies on rheumatology care compared to primary care. It is reported that the mean time travelled for face-to face rheumatology consultation is 2 h in Spain [41]. In Canada, about 27% of study participants in rural and northern Saskatchewan travelled four hours or more to see their rheumatologist, while in this study, about 50% of remote people with RA travelled about four hours or more. Besides observed travel burden to health care, it is critical to consider patient preferences to gather information on individuals' willingness

Table 4 Most frequently visited rheumatologists destinations at zone and rural level

Patient Zone_Rural	Favourite Destinations (Rheumatologist Zone_rural)			
	1st	**2nd**	**3rd**	**4th**
Metro-Calgary	**Metro-Calgary**	**Metro-Edmonton**	**Rural Centre-Calgary**	**Moderate Metro-Edmonton**
n(%) RA patients	5034 (98.9%)	44 (0.9%)	5 (0.1%)	4 (0.1%)
Median Travel time	27	207	9	228
Metro-Edmonton	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**	**Urban-Grand Prairie**
n(%) RA patients	3023 (92.9%)	199 (6.1%)	28 (0.9%)	2 (0.1%)
Median Travel time	21	30	207	304
Moderate Metro-Calgary	**Metro-Calgary**	**Metro-Edmonton**	**Urban-Lethbridge**	**Urban-Red Deer**
n(%) RA patients	820 (97.9%)	12 (1.4%)	2 (0.2%)	2 (0.2%)
Median Travel time	38	180	161	67
Moderate Metro-Edmonton	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**	**Urban-Lethbridge**
n(%) RA patients	1223 (78.0%)	330 (21.1%)	13 (0.8%)	1 (0.1%)
Median Travel time	37	15	220	373
Moderate Urban-Central	**Metro-Edmonton**	**Metro-Calgary**	**Urban-Red Deer**	**Moderate Metro-Edmonton**
n(%) RA patients	84 (53.8%)	50 (32.1%)	19 (12.2%)	3 (1.9%)
Median Travel time	105	110	34	108
Moderate Urban-North	**Urban-Grand Prairie**	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	41 (50.6%)	36 (44.4%)	3 (3.7%)	1 (1.2%)
Median Travel time	20	309	288	NA
Moderate Urban-South	**Metro-Calgary**	**Urban-Lethbridge**	**Metro-Edmonton**	
n(%) RA patients	88 (71.5%)	34 (27.6%)	1 (0.8%)	
Median Travel time	154	23	330	
Rural-Calgary	**Metro-Calgary**	**Rural-Calgary**	**Urban-Lethbridge**	**Metro-Edmonton**
n(%) RA patients	553 (93.1%)	18 (3.0%)	16 (2.7%)	4 (0.7%)
Median Travel time	49	20	59	241
Rural-Central	**Metro-Edmonton**	**Metro-Calgary**	**Urban-Red Deer**	**Moderate Metro-Edmonton**
n(%) RA patients	536 (54.3%)	355 (35.9%)	50 (5.1%)	44 (4.5%)
Median Travel time	97	92	58	107
Rural-North	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Urban-Grand Prairie**	**Rural-North**
n(%) RA patients	572 (71.5%)	114 (14.3%)	63 (7.9%)	36 (4.5%)
Median Travel time	139	103	97	5
Rural-South	**Metro-Calgary**	**Urban-Lethbridge**	**Rural-South**	**Metro-Edmonton**
n(%) RA patients	285 (66.4%)	100 (23.3%)	38 (8.9%)	4 (0.9%)
Median Travel time	161	39	24	367
Rural Centre-Calgary	**Metro-Calgary**	**Rural Centre-Calgary**	**Metro-Edmonton**	
n(%) RA patients	89 (74.8%)	29 (24.4%)	1 (0.8%)	
Median Travel time	56	5	275	
Rural Centre-Central	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Rural Centre-Central**	**Metro-Calgary**
n(%) RA patients	379 (92.7%)	10 (2.4%)	10 (2.4%)	8 (2.0%)
Median Travel time	64	80	5	159
Rural Centre-North	**Metro-Edmonton**	**Moderate Metro-Edmonton**		
n(%) RA patients	58 (95.1%)	3 (4.9%)		
Median Travel time	221	215		
Rural Centre-South	**Metro-Calgary**	**Urban-Lethbridge**	**Metro-Edmonton**	
n(%) RA patients	93 (93.0%)	4 (4.0%)	3 (3.0%)	
Median Travel time	133	108	273	
Rural Remote-North (North)	**Metro-Edmonton**	**Urban-Grand Prairie**	**Moderate Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	80 (66.7%)	31 (25.8%)	5 (4.2%)	2 (1.7%)
Median Travel time	516	137	297	655
Rural Remote-North (West)	**Metro-Edmonton**	**Rural-North**	**Moderate Metro-Edmonton**	**Urban-Grand Prairie**
n(%) RA patients	156 (68.4%)	26 (11.4%)	25 (11.0%)	17 (7.5%)
Median Travel time	230	61	193	119
Urban-Fort McMurray	**Metro-Edmonton**	**Urban-Fort McMurray**	**Metro-Calgary**	**Moderate Metro-Edmonton**

Table 4 (continued)

Patient Zone_Rural	Favourite Destinations (Rheumatologist Zone_rural)			
	1st	**2nd**	**3rd**	**4th**
n(%) RA patients	125 (66.1%)	52 (27.5%)	7 (3.7%)	5 (2.6%)
Median Travel time	315	15	512	315
Urban-Grand Prairie	**Urban-Grand Prairie**	**Metro-Edmonton**	**Moderate Metro-Edmonton**	**Metro-Calgary**
n(%) RA patients	93 (47.4%)	91 (46.4%)	7 (3.6%)	4 (2.0%)
Median Travel time	7	304	285	475
Urban-Lethbridge	**Metro-Calgary**	**Urban-Lethbridge**	**Rural-South**	**Metro-Edmonton**
n(%) RA patients	288 (57.8%)	202 (40.6%)	5 (1.0%)	3 (0.6%)
Median Travel time	143	10	42	368
Urban-Medicine Hat	**Metro-Calgary**	**Urban-Lethbridge**	**Metro-Edmonton**	
n(%) RA patients	218 (85.2%)	34 (13.3%)	4 (1.6%)	
Median Travel time	198	124	348	
Urban-Red Deer	**Metro-Edmonton**	**Metro-Calgary**	**Urban-Red Deer**	**Moderate Metro-Edmonton**
n(%) RA patients	176 (46.7%)	129 (34.2%)	62 (16.4%)	10 (2.7%)
Median Travel time	103	104	10	128

to travel for health services. McGrail et al. tested the distance tolerance of rural residents for non-emergency care in Australia, which demonstrated that the accepted travel time to primary care (54.1–31.9 min, $p < 0.001$) in rural and remote residents was 20–30 min longer than their observed travel time (26.3–16.9 min, $p < 0.001$) [42]. Weinhold et al. examined patients' acceptable and realized distances to determine accessibility standards for the size of catchment areas in outpatient care in Germany [43]. It also reported that patient acceptable distance thresholds were higher than the realised observed distance limits [43]. Though the findings of the Germany study may be not applicable to Alberta due to their distinct geographic context, the method may be generalized to other regions or countries to help determine the travel time threshold that aligns with patient expectations and ensures patient-centered care. Further work may be conducted to examine patient acceptable travel time to health care in Alberta. Together with the observed travel pattern, the findings may provide guidance on health care planning, resource allocation, and the establishment of health service locations to ensure that patients have reasonable access to care within the defined travel time threshold.

This study examined the distance decay effect of travel time on health care primary care and rheumatology care utilization across rural-urban continuum. Rural and remote areas had sparsely distributed RA population with limited availability of GP / rheumatologists and limited transportation options, leading to pronounced distance decay effects and decreased accessibility to primary and rheumatology care. While in urban and metro areas, high population density, availability of service providers concentrating within a small geographic area, and adequate transportation options help reduce the impact of distance decay, allowing patients to access health care more conveniently and with shorter travel times. It is important to note the distance decay effect varies depending on the disease, type of health care services, and geographic locations [15, 30, 43]. It is a key component for the spatial accessibility model, e.g. three-step floating catchment area method, which had limitations in the choice of reasonable distance decay function without real-world data [15, 39, 40]. Using realized utilization data, this study will provide empirical evidence to support decisions on the determination of distance decay effects of travel time on health care utilizations.

The results showed that rural remote patients had the shortest median travel time to GP care (5 min) in Alberta, but we can not simply conclude that rural and remote RA patients had better access to care than urban and metro patients. Caution is needed when interpreting these findings due to heterogeneous travel patterns. In remote areas, the mean travel time to a GP visit was 82 min (Std: 146, median:5 min, IQR: 5–79), four times higher than the metro average. While approximately 60% of GP visits occurred within 5 min, the remaining GP visits took up to 468 min (95th percentile). It is consistent with previous research which concluded that travel behavior is not constant among rural populations due to significant differences in patients' acceptable travel time to primary care between closely-settled rural communities and sparsely-settled rural communities [42]. In rural and northern Saskatchewan, over half (53%) of participants reported having to travel outside their community to see their primary care providers [44]. Though it is beyond our analysis in this study, systemic barriers, such as the lack of local GPs and required health services in remote communities, may explain the substantial travel burden for this subgroup of patients. Factors such as quality of care, clinic hours, provider characteristics, and patient preferences may also play a role. Further research

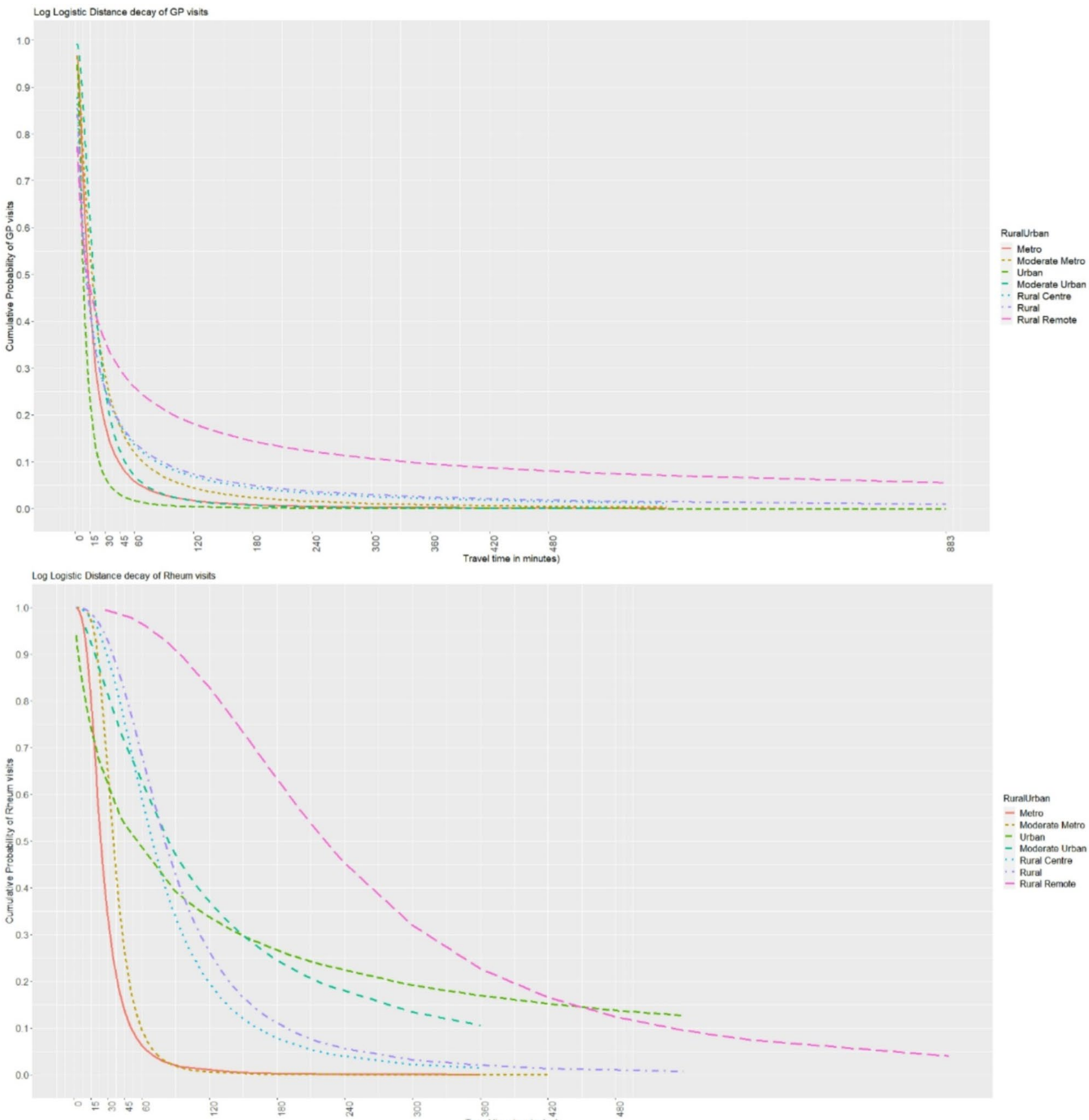

Fig. 2 Distance decay effects of travel time on health care utilizations (Upper: GPs; Bottom: Rheumatologists)

using mixed methods may be important to understand the accessibility challenges they face, which will provide information for service planning.

To reduce rural-urban disparities in access to RA care and facilitate/ move towards equitable access, a multi-faceted approach at various levels is required to address the gap between increasing demands for RA care and rheumatology workforce shortage, especially in rural and remote areas [5, 45]. While rheumatologists play a crucial role in managing RA, primary care physicians, nurse practitioners, pharmacists, and other health care providers also play a significant role in providing initial assessments, monitoring disease progression, and prescribing appropriate treatments [5]. Collaborative models of care can help alleviate the workload burden on rheumatologists, ensuring that specialized care is still accessible to patients in rural and remote communities [46]. At the same time, it is important to expand the use of telemedicine and digital health technologies to enhance access to

RA services, particularly in remote or underserved areas, thereby mitigate the impact of geographic barriers [47].

This study has several strengths. First, we collected patient and provider location at the most detailed spatial scale available for spatial analysis in Alberta - the six-digit postal code level, using administrative data. This level of granularity enables us to gather the most precise information regarding travel times and distances, enhancing the accuracy of our study. Second, we relied on utilization data to investigate the actual travel time of RA patients when seeking various health care across the rural-urban spectrum. It provided valuable insights that can aid health care planning. Additionally, our research provides critical evidence on the determination of travel time threshold and choice of distance decay function in modeling spatial accessibility to RA care, which varies by rural-urban status, health care services, and types of diseases.

This study also has limitations. First, we used 6-digit postal code instead of home address to calculate travel time between patients and providers, which may lead to underestimation of travel burden in rural and remote areas due to vast size of rural postal codes. However, due to privacy and confidentiality, six-digit postal code is the most detailed spatial information we can obtain in Canada for spatial analysis. Second, this study only included patients who sought either primary care or rheumatology care in the fiscal year 2019/20. Exclusion of patients who were not captured in the utilization dataset may underestimate the travel burden. Further work focusing on the excluded patients will be helpful to shed light on the estimation of overall travel burden to RA care. Third, access to specialists require GP access and referral. Further travel to GPs compounds overall travel burdens required to attend a rheumatology appointment. The compound effect of travel burden to GP on travel burden to rheumatologist was not accounted for in this study. Fourth, rural physicians tend to have different practice scopes comparing to urban physicians, which were not included in analysis. Finally, this study coincided with the onset of the COVID-19 pandemic, which may have affected patient behaviors due to disruptions such as cancellations, rescheduling, and the shift to virtual care. These factors could have impacted the travel burden measurement in the final months of the study period, and therefore caution is advised when interpreting the results.

Conclusion

Measuring the travel burden for people with RA to access care reveals patterns about the differences in how far patients travelled to seek RA care based on their residential geographic location. These findings offer essential empirical insights into the understanding of travel time thresholds and catchment areas for primary and RA care. Further studies on the factors driving these travel patterns are of interest to elucidate approaches to address these differences. It is also important to evaluate the acceptable travel time to health care, which will provide complimentary evidence to inform health care planning and address observed disparities towards the goal of achieving equitable care.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-025-02439-w.

Supplementary Material 1

Author contributions

X.L., A.P., J.S., and D.A.M. have made substantial contributions to the conception and design of the work. X.L., A.P., J.S., D.A.M., D.P. M., and J.H. have made substantial contribution to the acquisition, analysis, and interpretation of data. X.L. have drafted the work. A.P., J.S., D.A.M., D.P. M., and J.H. have substantively revised it. All authors have approved the submitted version. All authors have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work.

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Data availability

The data that support the findings of this study are available from Alberta Health Services, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Alberta Health Services.

Declarations

Ethics approval and consent to participate

Ethics approval for this project was provided by the Conjoint Health Research Ethics Board at the University of Calgary (REB22-0658).

Competing interests

The authors declare no competing interests.

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References

1. Al Maini M, Adelowo F, Al Saleh J, Al Weshahi Y, Burmester G-R, Cutolo M, Flood J, March L, McDonald-Blumer H, Pile K, et al. The global challenges

and opportunities in the practice of rheumatology: white paper by the world forum on rheumatic and musculoskeletal diseases. Clin Rheumatol. 2015;34:819–29. https://doi.org/10.1007/s10067-014-2841-6.
2. Lacaille D, Anis AH, Guh DP, Esdaile JM. Gaps in care for rheumatoid arthritis: A population study. Arthritis Care Res. 2005;53:241–8. https://doi.org/10.1002/art.21077.
3. Widdifield J, Barber CEH, Bernatsky S, Eder L, Ahluwalia V, Pope JE, Ling V, Gozdyra P, Kuriya B, Hofstetter C, et al. Evaluation of rheumatology workforce supply changes in Ontario, Canada, from 2000 to 2030. Healthc Policy. 2021;16. https://doi.org/10.12927/HCPOL.2021.26428.
4. Widdifield J, Paterson JM, Bernatsky S, Tu K, Thorne JC, Ahluwalia V, Ivers N, Butt D, Jaakkimainen RL, Tomlinson G, et al. The rising burden of rheumatoid arthritis surpasses rheumatology supply in Ontario. Can J Public Health. 2013;104:e450–5. https://doi.org/10.17269/cjph.104.4115.
5. Miloslavsky EM, Bolster MB. Addressing the rheumatology workforce shortage: A multifaceted approach. Semin Arthritis Rheum 2020, 791–6.
6. Liu X, Barber CEH, Katz S, Homik J, Bertazzon S, Patel AB, Robert J, Smith C, Mosher D, Marshall DA. Geographic variation in the prevalence of rheumatoid arthritis in Alberta, Canada. ACR Open Rheumatol. 2021;0:1–9. https://doi.org/10.1002/acr2.11251.
7. Barber CEH, Lacaille D, Faris P, Mosher D, Katz S, Patel JN, Zhang S, Yee K, Barnabe C, Hazlewood GS, et al. Evaluating quality of care for rheumatoid arthritis for the population of Alberta using System-Level performance measures. J Rheumatol. 2021;48:482–5. https://doi.org/10.3899/JRHEUM.200420.
8. Keeling SO, Alabdurubalnabi Z, Avina-Zubieta A, Barr S, Bergeron L, Bernatsky S, Bourre-Tessier J, Clarke A, Baril-Dionne A, Dutz J, et al. Canadian rheumatology association recommendations for the assessment and monitoring of systemic lupus erythematosus. J Rhuematol. 2018;45:1426–39. https://doi.org/10.3899/jrheum.171459.
9. Monti S, Montecucco C, Bugatti S, Caporali R. Rheumatoid arthritis treatment: the earlier the better to prevent joint damage. RMD Open. 2015;1:e000057. https://doi.org/10.1136/rmdopen-2015-000057.
10. Canadian Medical Association. *CMA Position Statement: Ensuring Equitable Access to Care: Strategies for Governments, Health System Planners, and the Medical Profession*; 2013.
11. Starke R, Spenceley S, Cafffaro M, Sansregret B, Garbutt A, Dupres K, Robbins C. *Rural Health Services Review Final Report: Understanding the Concerns and Challenges of Albertans Who Live in Rural and Remote Communities.*; 2015.
12. Pong RW, Pitblado JR. Geographic distribution of physicians in Canada: beyond how many and where. Ontario: Ottawa; 2005.
13. Marshall DA, Liu X, Shahid R, Bertazzon S, Seidel JE, Patel AB, Nasr M, Barber CEH, McDonald T, Sharma R, et al. Geographic variation in osteoarthritis prevalence in Alberta: A Spatial analysis approach. Appl Geogr. 2019;103:112–21. https://doi.org/10.1016/j.apgeog.2019.01.004.
14. Liu X, Shahid R, Patel AB, McDonald T, Bertazzon S, Waters N, Seidel JE, Marshall DA. Geospatial patterns of comorbidity prevalence among people with osteoarthritis in Alberta Canada. BMC Public Health. 2020;20:1551. https://doi.org/10.1186/s12889-020-09599-0.
15. Liu X, Seidel JE, McDonald T, Waters N, Patel AB, Bertazzon S, Shahid R, Marshall. DA Rural-Urban disparities in realized access to general practitioners, orthopedic surgeons, and physiotherapists among people with osteoarthritis. Int J Environ Res Public Res. 2022;19:1–20.
16. Barnabe C, Jones CA, Bernatsky S, Peschken CA, Voaklander D, Homik J, Crowshoe LF, Esdaile JM, El-Gabalawy H, Hemmelgarn B. Inflammatory arthritis prevalence and health services use in the first nations and Non-First nations populations of Alberta, Canada. Arthritis Care Res. 2017;69:467–74. https://doi.org/10.1002/acr.22959.
17. Senn N, Cohidon C, Breton M, Levesque JF, Zuchuat JC. Patterns of patient experience with primary care access in Australia, Canada, new Zealand and Switzerland: A comparative study. Int J Qual Health Care. 2019;31:G126–32. https://doi.org/10.1093/intqhc/mzz092.
18. Polinski JM, Brookhart MA, Ayanian JZ, Katz JN, Kim SC, Lii J, Tonner C, Yelin E, Solomon DH. Relationships between driving distance, rheumatoid arthritis diagnosis, and Disease-Modifying antirheumatic drug receipt. Arthritis Care Res. 2014;66:1634–43. https://doi.org/10.1002/acr.22333.
19. Lennep DS, Crout T, Majithia V. Rural health issues in rheumatology: A review. Curr Opin Rheumatol. 2020;32:119–25. https://doi.org/10.1097/BOR.0000000000000694.
20. Widdifield J, Paterson JM, Bernatsky S, Tu K, Thorne JC, Ivers N, Butt D, Jaakkimainen RL, Gunraj N, Ahluwalia V, et al. Access to rheumatologists among patients with newly diagnosed rheumatoid arthritis in a Canadian universal public healthcare system. BMJ Open. 2014;4:1–8. https://doi.org/10.1136/bmjopen-2013-003888.
21. Alberta Health Services and Alberta Health. *Official Standard Geographic Areas*; Alberta Canada, 2017.
22. Public Health Agency of Canada. *Canadian Chronic Disease Surveillance System (CCDSS) 2021*; 2021.
23. Marshall DA, Pham T, Faris P, Chen G, O'Donnell S, Barber CEH, LeClercq S, Katz S, Homik J, Patel JN, et al. Determination of rheumatoid arthritis incidence and prevalence in Alberta using administrative health data. ACR Open Rheumatol. 2020;2:424–9. https://doi.org/10.1002/acr2.11158.
24. Alberta Health Servcies Applied Research and Evaluation Services Primary Health Care Alberta Facilities Distance /. Time Look Up Tables 2016, 1–12.
25. Alberta Health *Postal Code Translator File (PCTF)*; 2013.
26. Higgs G. *A Literature Review of the Use of GIS-Based Measures of Access to Health Care Services*; 2004; Vol. 5.
27. Fischer MM. GIS and Network Analysis. In *Spatial Analysis and GeoComputation*; Springer Berlin Heidelberg, 2006; pp. 1–336 ISBN 3540357297.
28. Kim H-Y. Statistical notes for clinical researchers: nonparametric statistical methods: 1. nonparametric methods for comparing two groups. Restor Dentistry Endodontics. 2014;39:235–9. https://doi.org/10.5395/rde.2014.39.3.235.
29. Delamater PL, Messina JP, Grady SC, WinklerPrins V, Shortridge AM. Do more hospital beds lead to higher hospitalization rates?? A Spatial examination of Roemer's law. PLoS ONE. 2013;8. https://doi.org/10.1371/journal.pone.0054900.
30. Jia P, Wang F, Xierali IM. Differential effects of distance decay on hospital inpatient visits among subpopulations in Florida, USA. Environ Monit Assess. 2019;191:1–16. https://doi.org/10.1007/s10661-019-7468-2.
31. Wan N, Zhan FB, Zou B, Chow EA. Relative Spatial access assessment approach for analyzing potential Spatial access to colorectal Cancer services in Texas. Appl Geogr. 2012;32:291–9. https://doi.org/10.1016/j.apgeog.2011.05.001.
32. Lee RC. Current approaches to shortage area designation**. J Rural Health. 1991;7:437–50. https://doi.org/10.1111/J.1748-0361.1991.TB01029.X.
33. The State of Public Health and Care. N. *General Practitioner: Travel Time Longer than 10 Minutes*; 2022.
34. Bauer J, Groneberg DA. Measuring Spatial accessibility of health care Providers-Introduction of a variable distance decay function within the floating catchment area (FCA) method. PLoS ONE. 2016;11:1–17. https://doi.org/10.1371/journal.pone.0159148.
35. Luo J. Analyzing potential Spatial access to primary care services with an enhanced floating catchment area method. Cartographica. 2016;51:12–24. https://doi.org/10.3138/cart.51.1.3230.
36. Luo W, Qi Y. An enhanced Two-Step floating catchment area (E2SFCA) method for measuring Spatial accessibility to primary care physicians. Health Place. 2009;15:1100–7. https://doi.org/10.1016/j.healthplace.2009.06.002.
37. Shah TI, Bell S, Wilson K. Spatial accessibility to health care services: identifying under-Serviced neighbourhoods in Canadian urban areas. PLoS ONE. 2016;11:1–22. https://doi.org/10.1371/journal.pone.0168208.
38. McGrail MR, Humphreys JS. Measuring Spatial accessibility to primary health care services: utilising dynamic catchment sizes. Appl Geogr. 2014;54:182–8. https://doi.org/10.1016/j.apgeog.2014.08.005.
39. McGrail MR. Spatial accessibility of primary health care utilising the two step floating catchment area method: an assessment of recent improvements. Int J Health Geogr. 2012;11:1–12. https://doi.org/10.1186/1476-072X-11-50.
40. Mcgrail MR, Humphreys JS. The index of rural access: an innovative integrated approach for measuring primary care access. BMC Health Serv Res. 2009;9. https://doi.org/10.1186/1472-6963-9-124.
41. Tornero-Molina J, Sánchez-Alonso F, Fernández-Prada M, Bris-Ochaita M-L, Sifuentes-Giraldo A, Vidal-Fuentes J. Tele-Rheumatology during the COVID-19 pandemic. Reumatologia Clin. 2022;18:157–63. https://doi.org/10.1016/j.reumae.2020.10.002.
42. McGrail MR, Humphreys JS, Ward B. Accessing Doctors at times of Need-Measuring the distance tolerance of rural residents for Health-Related travel. BMC Health Serv Res. 2015;15:1–9. https://doi.org/10.1186/s12913-015-0880-6.
43. Weinhold I, Wende D, Schrey C, Militzer-Horstmann C, Schang L, Sundmacher L. Assessing patients' acceptable and realised distances to determine accessibility standards for the size of catchment areas in outpatient care. Health Policy. 2022;126:1180–6. https://doi.org/10.1016/j.healthpol.2022.08.011.
44. Nair BV, Schuler R, Stewart S, Taylor-Gjevre RM. Self-Reported barriers to healthcare access for rheumatoid arthritis patients in rural and Northern

Saskatchewan: A mixed methods study. Musculoskelet Care. 2016;14:243–51. https://doi.org/10.1002/msc.1146.
45. Goldenberg DL, Perspective. Where have all the rheumatologists gone? Practical Pain Manage. 2021;21:1–17.
46. Garner S, Lopatina E, Rankin JA, Marshall DA. Nurse-Led care for patients with rheumatoid arthritis: A systematic review of the effect on quality of care. J Rhuematol. 2017;44:757–65. https://doi.org/10.3899/jrheum.160535.
47. Devadula S, Langbecker D, Vecchio P, Tesiram J, Meiklejohn J, Benham H. Tele-Rheumatology to regional hospital outpatient clinics: patient perspectives on a new model of care. https://home Liebertpub Com/tmj. 2020;26:912–9. https://doi.org/10.1089/TMJ.2019.0111.

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