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Title:

Encounters with Rheumatologists in a Publicly-Funded Canadian Healthcare System: A Population-Based Study

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ABSTRACT

Objective:

To quantify population-level and practice-level encounters with rheumatologists over time.

Methods:

We conducted a population-based study from 2000 to 2015 in Ontario, Canada, where all residents are covered by a single-payer healthcare system. Annual total number of unique patients seen by rheumatologists, the number of new patients seen, and total number of encounters with rheumatologists were identified.

Results:

From 2000 to 2015, the percentage of the population seen by rheumatologists was constant over time (2.7%). During this time, Ontario had a stable rheumatology supply (0.8 Full Time Equivalents (FTEs)/75,000). From 2000 to 2015, the number of annual rheumatology encounters increased from 561,452 to 742,952, but the adjusted encounter rates remained stable over time (at 62 encounters per 1000 population). New patient assessment rates declined over time from 10 new patient assessments per 1000 in 2000 to 6 per 1000 in 2015. The crude volume of new patients seen annually decreased and an increasing proportion of rheumatology encounters were with established patients. We observed a shift in patient case-mix over time, with more assessments for systemic inflammatory conditions. Rheumatologists' practice volumes, practice sizes, and the annual number of days providing clinical care decreased over time.

Conclusion:

Over a 15-year period, the annual percentage of the population seen by a rheumatologist remained constant and the volume of new patients decreased, while follow up patient encounters increased. Patient encounters per rheumatologist decreased over time. Our findings provide novel information for rheumatology workforce planning. Factors affecting clinical activity warrant further research.

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INTRODUCTION

In Canada and throughout the world rheumatic and musculoskeletal diseases (RMDs) are some of the most prevalent conditions affecting population health(1). The aging demographic, increasing prevalence of RMDs, and complexity of care management involved with comorbid illnesses in aging populations is expected to place greater demands on rheumatology services(2).

Rheumatology workforces are increasingly challenged by too few physicians(3-6). Physician surveys have identified major demographic changes of rheumatology workforces including baby boomer retirements, a millennial predominance, and an increase of female and part-time providers(3, 4). These changes, coupled with an increased demand for adult rheumatology care due to the growing and aging populations and rise of the burden of RMDs are likely to negatively impact clinical activity and reduce supply of rheumatology services.

In Canada, rheumatologists are currently among the most frequent non-surgical specialty referrals(7) and they also are among the longest specialist wait times(8-11). A better understanding of longitudinal trends in rates of rheumatology encounters with new and existing patients is needed to help identify why patients have such long waits for rheumatology care.

To better document the issues facing rheumatology care, more detailed information is needed regarding populations accessing rheumatology services and the clinical activity of the workforce in a population-based sample. Thus, we sought to describe population-level trends in patient encounters with rheumatologists between 2000 and 2015 in Ontario, Canada. In addition, we assessed trends in practice-level clinical activity of rheumatologists over time.

PATIENTS AND METHODS

Setting. Ontario is a large, diverse, multicultural province that constitutes approximately 40% of Canada's population, with a population of 11 million adults in 2015(12, 13). Approximately 40% of the Canadian rheumatology workforce resides in Ontario(4). All residents are covered by a universal, single-payer, public health insurance that includes hospital care and physicians' services, and in which access to rheumatologists requires referral from a physician or nurse practitioner.

Study Design. We conducted a retrospective study using population-based health administrative databases in Ontario from 2000 to 2015.

Data sources. Annual population denominators (all residents 18 years and older) were ascertained from the Primary Care Population Database (PCPOP) derived from the Ontario Health Insurance Plan (OHIP) Registered Persons Database (RPDB), which includes all OHIP beneficiaries alive and who have had accessed the healthcare system. Residents are eligible for OHIP if they are Canadian citizens, landed immigrants or refugees, make their permanent and principal home in Ontario, and are physically present in Ontario 153 days in any 12-month period. Physicians are reimbursed by submitting claims to OHIP for medical services provided.

We identified all patients 18 years and older with rheumatology encounters within the OHIP Claims History Database, which provides diagnoses, dates and types of services, associated with each rheumatology encounter. One diagnosis is provided with each claim, which represents the main 'reason for the visit'. These diagnoses are coded in a modification of the 8th revision of the International Classification of Diseases (ICD). Claims also include fee codes reflecting the types of services provided, and where the service was rendered (inpatient or outpatient setting)(14).

Rheumatologists were identified using the ICES Physician Database (IPDB), which is constructed and routinely validated using the OHIP Corporate Provider Database, the Ontario Physician Human Resources Data Centre Database, and physicians' OHIP billings. We included only

active rheumatologists, defined as those with fee-for-service claims during each year (excluding paediatric rheumatologists).

These datasets are linked using unique, encoded patient and physician identifiers and are securely held and analyzed at ICES (www.ices.on.ca). ICES is a prescribed entity under section 45 of Ontario's Personal Health Information Protection Act (PHIPA). The use of data in this study was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Analysis.

Population-level Measures. Contacts with rheumatologists were separately defined as any type of patient encounter (including inpatient, outpatient assessments, and other interactions which may include non-face-to-face encounters such as telemedicine, or review of laboratory test reports or bone densitometry reports), and outpatient assessments only (reflecting only face-to-face visits). Multiple fee codes billed by the same physician on the same patient on the same day were counted as one encounter (such as performing a consult and injecting a joint). We separately identified the annual total number of unique patients with at least one rheumatology encounter (including both inpatient and outpatient), only outpatient assessments, as well as the total number of rheumatology encounters and outpatient assessments (as patients may have multiple contacts throughout the year). Using annual population denominators, we determined the percentage of Ontario residents with encounters and assessments annually, as well as rates of total encounters and assessments expressed as per 1,000 population.

To identify new patients seen by rheumatologists each year, we applied a 3-year washout period ensuring patients had no prior rheumatology contacts. Annual new patient encounter and assessment rates, as well the percentage of new patients out of all rheumatology patients, and out of

the total volume of rheumatology contacts were also stratified by any type of patient encounter and outpatient assessments only.

Diagnosis codes assigned at each outpatient assessment were used to assess for changes in the case-mix of patients under outpatient rheumatology care over time. Among annual total outpatient assessments, we assessed the frequency of diagnosis codes for osteoarthritis (OA), rheumatoid arthritis (RA), Ankylosing Spondylitis (AS), other inflammatory arthritis (IA) such as seronegative or psoriatic arthritis, gout, connective tissue diseases (such as lupus, scleroderma), other systemic autoimmune rheumatic diseases (SARDs, such as polymyalgia rheumatica, vasculitis, sarcoidosis), regional musculoskeletal (MSK) conditions, osteoporosis, bone and spinal conditions, trauma and related conditions/injuries, and other conditions with diagnosis codes not defined in Online Supplementary Table 1 (which represent non-MSK related conditions such as hypertension, infection). Using the yearly population denominators, we assessed crude and age-and-sex standardized rates (directly standardized to the 2000 population).

Practice-level Measures. We assessed the annual number, and clinical activity, of all active rheumatologists overall, and by clinical full-time equivalent (FTE) classification. Using annual fee-for-service billing claims, rheumatologists below the 40th percentile of total billings each year were classified as providing less clinical activity (<1 FTE); rheumatologists within the 40-60th percentile were classified as 1 FTE; and >60th percentile as >1 FTE(15). As this FTE measure does not take into account the annual total number days providing clinical care, we also determined the number of days with patient encounters and patient assessments per year. This alternative FTE measure identifies the number of rheumatologists who worked on at least 209 days out of the year (365 days in the year – 102 days (weekends) – 12 days (statutory holidays) – 30 days (vacations) – 9 days (attending conferences/CME activities/meetings) = 209 days).

Annual practice volumes (defined as the median number of patient encounters per year) and practice sizes (defined as the median number of unique patients seen per year) were assessed according to clinical FTE classification. As rheumatologists may enter the workforce, die, move out of the province, retire, or take leaves of absence throughout the study period, rheumatologists were removed from the annual denominator of active rheumatologists if any physician had no claim for 365 days and their last claim date was assigned the date they exited the workforce. Rheumatologists were permitted to re-enter the workforce if they subsequently became active.

All analyses were performed using linked, encoded data held at ICES using SAS, version 9.2.

RESULTS

Population-level contacts with rheumatologists. Despite an increase in the population of Ontario during the study period, the percentage of the population seen by a rheumatologist annually remained constant over time at 2.7%, Table 1. The percentage of patients seen by a rheumatologist for an outpatient assessment also remained fairly constant (2%).

The total number of rheumatology encounters increased from 561,452 annual patient encounters (382,074 outpatient assessments) in 2000 to 786,061 annual patient encounters (500,831 outpatient assessments) in 2015, Table 1. The number of new patients seen annually decreased over time as well as the percentage of new patients out of the total patients under rheumatology care.

A breakdown of the types of rheumatology encounters is provided in Online Supplementary Figure 1 illustrating that the volume of inpatient encounters declined over time whereas the volume of other patient interactions (such as non-face-to-face encounters e.g. laboratory review) increased over time.

From 2000 to 2015, the total crude patient encounter rate increased 15% from 61.7 to 70.8

encounters per 1,000 population, Figure 1. The annual total outpatient assessment rate was fairly constant over time (42-45 assessments per 1000). New patient encounter rates declined over time (9.8 new patient assessments per 1000 in 2000 to 6.2 new patient assessments per 1000 in 2015).

We observed a shift in the diagnostic case-mix of patients over time with rheumatologists seeing more systemic inflammatory conditions and a declining proportion of patients with regional musculoskeletal conditions (Table 2). The volume of rheumatoid arthritis (RA) encounters increased the most, with 21% of all assessments related to RA in 2000 versus 27% in 2015. Crude patient assessment rates for systemic inflammatory conditions significantly increased over time and encounter rates for non-systemic conditions (osteoarthritis, regional musculoskeletal conditions) decreased (Online Supplementary Table 2).

Both the age-and-sex standardized rates for total encounters and outpatient assessments were fairly stable across years (Online Supplementary Table 3). Adjusted rates for systemic inflammatory conditions increased over time whereas non-systemic inflammatory conditions rates decreased.

Provider-level activity. In 2000, there were 146 adult rheumatologists in Ontario (57 of whom worked <1 clinical FTE; 31 worked as at least 1 clinical FTE; and 58 as >1 clinical FTE); this increased to 194 rheumatologists (74 <1 FTE; 41 FTEs; 79 > 1 FTEs) in 2015, corresponding to an overall provincial per capita supply of 0.8 FTEs per 75,000 (Online Supplementary Figure 2). As of 2000, the total rheumatology workforce was predominantly male (66%), a mean (standard deviation, SD) age of 48.5 (10.6) years, and 16% of rheumatologists were aged 60 and older. By 2015, 51% of the workforce was male, a mean (SD) age of 51.7 (11.6) years, and 26% were over 60 years of age. More male rheumatologists were consistently identified as >1 clinical FTEs each year (Online Supplementary Figure 2), with male rheumatologists providing more patient assessments than female rheumatologists, across all age groups (data not shown).

The annual median (interquartile range) number of days in which rheumatologists had patient encounters decreased from 231 (193, 257) days in 2000 to 205.5 (159, 253) days in 2015, Table 3. When we assessed assessments only, rheumatologists had even fewer days of clinical activity (180 days/year in 2015). The percentage of rheumatologists with patient encounters on at least 209 days/year (an alternative FTE benchmark) showed a downward trend over time. When we restricted the analysis to patient assessments, and varied the criteria of the number of patient assessments within each day, a similar downward trend over time was observed (Online Supplementary Figure 3).

Within each FTE category, annual rheumatology practice volumes and practice sizes also decreased over time (Table 4). In 2015, the average rheumatologist practicing as <1 clinical FTE saw 670 patients, rheumatologists practicing as 1 clinical FTE saw 1219 patients and those providing more clinical service (>1 clinical FTE) saw 2050 patients. Monthly and daily practice volumes are provided in Online Supplementary Table 3. The median numbers of new patients seen annually and monthly significantly decreased over time within each FTE classification (Online Supplementary Table 5).

DISCUSSION

We conducted a large population-based study of all contacts with rheumatologists in a universal healthcare system and quantified changes in clinical activity of rheumatologists over a 15-year period. Our study reveals that while the crude volume of rheumatology contacts increased annually over time, the proportion of the population under rheumatology care remained constant and the adjusted total encounter and assessment rates remained relatively stable over time. The annual new patient consultation rate significantly declined over time as fewer new patients were seen annually. During the study period, Ontario held a constant ratio of 0.8 clinical FTEs rheumatologists per 75,000 population (Online Supplementary Figure 2). Without an increase in the per capita supply of

rheumatologists, the proportional increase of rheumatology encounters occurring with established patients may also be limiting access for new consultations and increasing wait times. We also observed a shift in patient case-mix over time with rheumatologists seeing more systemic inflammatory conditions. Our practice-level findings of the decline of clinical activity of rheumatologists over time provide important information for rheumatology workforce planning.

Across Canada, including Ontario, there is a lower per capita supply of rheumatologists than in the U.S.(4). A comprehensive U.S. workforce study reported a provider/population ratio of 3.1 per 100,000 in the Northeast to 1.3 per 100,000 in the Southwest in 2015(3). Within the U.S, there was an estimated deficit of 700 FTE rheumatologists in 2015 and by 2030 the projected demand will exceed the supply by 4,133 clinical FTEs(3). Moreover, studies have projected a significant increase in patient demand for rheumatologists(3, 16).

In Canada, there were approximately 400 rheumatologists as of 2015 (4, 17) with an estimated deficit of 200 rheumatologists(4). The current shortage is further compounded by one-third of the workforce nearing retirement(4), which is raising concerns over whether there are sufficient numbers of positions in rheumatology training programs to replace rheumatologists who retire, in addition to expanding workforce requirements needed to meet the increasing demands for rheumatology care associated with the growing and aging population. We also observed changes in clinical activity over time with a decreasing number of patient encounters per rheumatologist per year and fewer days providing clinical care annually. Previous studies have suggested that the clinical activity of rheumatologists may be declining(3, 16). Evidence from rheumatologist surveys suggests that the average number of visits provided annually by a rheumatologist varies depending on the age and sex of the rheumatologist(16, 18), with the average male rheumatologist providing approximately 35 percent more visits annually than the average female(16). A recent Canadian survey reported that

although female rheumatologists saw fewer patients, they worked equivalent hours compared to their male counterparts(18). Our study also revealed that more male rheumatologists practice as a clinical FTE compared to female rheumatologists (Online Supplementary Figure 2). This has implications for planning and managing services. With the increasing feminization of rheumatology workforces, longer consultations by female rheumatologists will limit the number of consultations they can provide to the population. In addition, generational differences (including millennials who place more emphasis on the value of both leisure time and earnings(19)), and increasing age of the workforce is likely to influence workforce capacity, which has been demonstrated in other specialties(20-22). Additional factors affecting rheumatology clinical activity may include clinic saturation, increasing care complexity, different practice models of care (e.g. differential access to allied health providers), greater demands for continuing medical education (CME), and research activity. More research of the effects of these factors on rheumatology workforces is warranted.

Our study also suggests that Ontario rheumatologists may be managing this imbalance of supply and demand by changing how they practice and following more inflammatory conditions (who require ongoing follow-up care). Additionally, the volume of rheumatology inpatient encounters declined over time, which is likely reflective of the declining number of rheumatologists with hospital affiliations (data not shown) in order to prioritize outpatient care, as opposed to fewer hospitalizations for patients with RMDs.

We used population-based data from a large single-payer healthcare system, which has the strength of being relatively complete for rheumatology billing claims and population coverage. However, we acknowledge some potential limitations of our study. First, we observed an increase in the crude total patient encounter rate but not the outpatient assessment rate over time, therefore the total patient encounter rate needs to be interpreted with caution, as this may be a reflection of an

increase in the availability of additional fee-for-service billing fee codes over time (such as billing claims to review laboratory test reports). Yet, the total patient encounter rate (which captures non-face-to-face interactions) may better capture the totality of patient interactions as a recent time and motion study found that for every office hour spent on direct clinical face time with patients, physicians spent nearly an additional 2 hours on EHR and desk work(23). Thus, while health administrative data represents an advantage of this study, we are unable to assess the totality of physician activity (e.g. time spent with patients and in completion of forms and review of health records before and after direct patient interactions). Another potential caveat is that our data only allowed us to assess patients who were seen by rheumatologists and not all patients referred to rheumatologists. In our study, we observed fewer patients being seen with non-systemic inflammatory conditions (e.g. osteoarthritis and regional self-limiting musculoskeletal conditions) over time, which may be a reflection of rheumatologists declining these types of referrals in more recent years in order to prioritize patients with systemic inflammatory conditions and/or less referrals to rheumatologists for these non-inflammatory conditions. Indeed, in a study of 2,430 patients referred to a rheumatologist in Ontario, 17% did not result in a rheumatology consultation(10). Our data is also limited in that physician service claims only require one diagnosis code per patient encounter, limiting what is reported for patients who have multiple health problems. Diagnosis codes assigned at patient assessments also may not be accurate, or could be used when a disease is being 'ruled out'. Temporal variation in billing code practices during the study period could influence our results. Changes over time in billing could be attributable to true changes in case mix, improvements in coding (due to provider education and in degree of detail in codes or their definitions, or the use of electronic medical records), or code creep (physicians using codes associated with higher reimbursement)(24). In Ontario, there are additional premiums associated with systemic inflammatory conditions (where

patients require more complex care). However, the increased prevalence of systemic inflammatory conditions within rheumatology practices over time likely reflects that these patients are remaining under rheumatology care rather than physicians attempting to increase their reimbursement. Higher reimbursement is provided as these patients require more complex care (and subsequently more time with the patient). While it is possible that changes to the fee code structure have influenced the increase in follow-up of RA patients, it is also possible that the increase in follow-up of RA patients (and other systemic inflammatory conditions) are aligned with best practice care(25). A significantly larger proportion of patients with systemic inflammatory conditions had follow-up encounters with their rheumatologist compared with non-inflammatory conditions. In 2000 only 58% of patients billed for osteoarthritis on their initial rheumatology visit had a subsequent rheumatology visit within 12 months. The percentage declined steadily over time with only 36% of osteoarthritis patients having a follow-up visit in 2014. Moreover, we found a decline in the percentage of total new patients being accepted into rheumatology practices over time, which likely reflects that practices are becoming saturated with patients requiring continuous care (such as those with systemic inflammatory conditions) and limiting the availability of new consultations. Currently, changes to rheumatology wait times over time are unknown, however wait times exceed established benchmarks(10). An alternative explanation to the reduction in new consultations is that some patients (such as those with regional musculoskeletal conditions) are being referred to other care providers. However, in our study, rheumatology practice sizes and volumes exceed those of family physicians (26, 27), and thus it is likely that clinic saturation is playing a role in reducing the availability of rheumatologists to see new patients.

Finally, there is no perfect methodology or consensus to define a clinical FTE rheumatologist. For physicians in general, hours worked are unknown, apart from self-reported data, which may be

unreliable. Defining FTEs from fee-for-service billings is commonly used as a proxy for time worked. The methodology we employed (which determined total fee-for-service billings for each rheumatologist annually and those below the 40th percentile defined as <1 FTE) was chosen for consistency through time as this methodology removes the effects of different fee levels on physician income. Simulations of alternative percentiles have shown that the FTE counts are relatively insensitive to different benchmark ranges e.g. 60th vs 70th percentile to define high volume providers(15). However, we acknowledge that any definition of FTE is arbitrary, the methodology may be imperfect, and thus we present an alternative definition (annual number of days providing clinical care).

In summary, our findings provide novel insights for rheumatology workforce planning. Access to rheumatologists in Ontario has not increased over time. The significant decline in new patient consultation rates over time helps illustrate the growing supply-demand mismatch in rheumatology care. An increasing fraction of rheumatology encounters are with established patients, which may be limiting access for new consultations and increasing wait times. We observed changes in the volumes of clinical activity and the types of patients being seen by rheumatologists. Our findings have important implications for people with RMDs, care providers, and health policy makers.

List of Tables and Figures

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AUTHOR CONTRIBUTIONS

Widdifield takes responsibility for the integrity of the data and the accuracy of the data analysis. Widdifield drafted the manuscript and all authors were involved in revising and finalizing it for important intellectual content.

Study design. Widdifield, Bernatsky, Pope, Ahluwalia, Barber, Eder, Kuriya, Ling, Paterson, Thorne

Acquisition of data. Widdifield, Ling

Statistical analysis. Ling

Analysis and interpretation of data. Widdifield, Bernatsky, Pope, Ahluwalia, Barber, Eder, Kuriya, Ling, Paterson, Thorne

Manuscript preparation. Widdifield, Bernatsky, Pope, Ahluwalia, Barber, Eder, Kuriya, Ling, Paterson, Thorne

DISCLOSURES

None of the authors have conflicts of interests related to this study.

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Table 1 Annual Number of Patients Seen by Rheumatologists and Total Patient Encounters with Ontario Rheumatologists between 2000 and 2015

		Any Type of Patient Encounter[1]					Outpatient Assessments Only[2]				
Year	Ontario population denominator[3]	Number (%) of patients seen by a rheumatologist[4]	Total Patient Encounters[5]	New Patients[6]	% of New Patients among Total Patients	% of New Patients among Total encounters	Number (%) of patients seen in an Outpatient Rheumatology Clinic[7]	Total Outpatient Assessments[8]	New Patients[6]	% of New Patients among Total Patients	% of New Patients among Total Outpatient Assessments
2000	9,093,486	245,486 (2.7%)	561,452	145,686	59%	26%	172,864 (1.9%)	382,074	89,426	52%	23%
2001	9,241,575	255,289 (2.8%)	588,581	132,490	52%	23%	179,370 (1.9%)	394,532	80,191	45%	20%
2002	9,393,473	263,139 (2.8%)	599,278	126,811	48%	21%	182,111 (1.9%)	400,879	75,081	41%	19%
2003	9,527,281	250,176 (2.6%)	571,366	110,164	44%	19%	180,385 (1.9%)	391,450	71,270	40%	18%
2004	9,651,626	258,751 (2.7%)	599,821	105,906	41%	18%	185,891 (1.9%)	398,768	68,146	37%	17%
2005	9,788,275	273,462 (2.8%)	634,730	109,021	40%	17%	188,297 (1.9%)	404,593	65,469	35%	16%
2006	9,907,932	286,309 (2.9%)	663,302	111,136	39%	17%	195,043 (2.0%)	417,241	66,509	34%	16%
2007	10,125,042	280,072 (2.8%)	652,933	98,586	35%	15%	191,950 (1.9%)	408,219	60,575	32%	15%
2008	10,268,935	282,959 (2.8%)	667,337	95,510	34%	14%	196,687 (1.9%)	421,871	61,333	31%	15%
2009	10,410,050	284,158 (2.7%)	685,195	94,123	33%	14%	201,649 (1.9%)	434,601	63,546	32%	15%
2010	10,528,197	285,103 (2.7%)	693,667	92,435	32%	13%	202,618 (1.9%)	434,304	62,174	31%	14%
2011	10,587,857	288,422 (2.7%)	725,807	89,393	31%	12%	212,479 (2.0%)	460,309	65,151	31%	14%
2012	10,716,779	281,754 (2.6%)	698,384	85,853	31%	12%	219,466 (2.1%)	447,380	67,648	31%	15%
2013	10,881,690	293,704 (2.7%)	742,952	88,895	30%	12%	228,237 (2.1%)	470,367	68,539	30%	15%
2014	11,039,248	292,948 (2.7%)	746,300	86,793	30%	12%	229,026 (2.1%)	473,788	65,214	29%	14%
2015	11,103,150	302,336 (2.7%)	786,061	86,877	29%	11%	242,761 (2.2%)	500,831	68,916	28%	14%

[1] Any Type of Patient Encounter includes inpatient, outpatient assessments, and non-face-to-face encounters; [2] Outpatient Assessments include only face-to-face patient assessments; [3] Population denominator confined to residents ages 18 and older; [4]Number of unique patients seen annually in an outpatient or inpatient setting with the % reflecting the percentage of patients seen by rheumatologists for any type of rheumatology encounter and the denominator being the Ontario population; [5]Total Patient Encounters includes initial and repeat encounters; [6]Number of New Patients seen by a rheumatologist; [7]% reflecting the proportion of patients seen by a rheumatologist in an outpatient setting and the denominator being the Ontario population;[8] Total Outpatient Assessments includes initial and repeat encounters

Table 2 Annual Number and Distribution (%) of Patient Assessments According to Diagnosis Category (Outpatient Setting)

Year	Total[1]	OA	Systemic Inflammatory Conditions						Regional MSK Conditions	Osteoporosis	Bone & spinal conditions	Trauma & related conditions	Other[2]
			RA	AS	IA	CTD	SARDs	Gout					
2000	382,123	59,217 (15.5%)	79,697 (20.9%)	8,178 (2.1%)	***	21,900 (5.7%)	7,114 (1.9%)	5,275 (1.4%)	120,856 (31.6%)	15,452 (4.0%)	13,015 (3.4%)	5,733 (1.5%)	45,686 (12.0%)
2001	394,560	60,439 (15.3%)	82,114 (20.8%)	8,617 (2.2%)	***	22831 (5.8%)	7,428 (1.9%)	5,641 (1.4%)	122,813 (31.1%)	15,763 (4.0%)	12,910 (3.3%)	6,022 (1.5%)	49,982 (12.7%)
2002	400,906	60,915 (15.2%)	84,480 (21.1%)	8,792 (2.2%)	***	23358 (5.8%)	8,181 (2.0%)	6,019 (1.5%)	125494 (31.3%)	16,173 (4.0%)	12,564 (3.1%)	6,104 (1.52%)	48,826 (12.2%)
2003	391,477	65,356 (16.7%)	85,153 (21.8%)	9,101 (2.3%)	***	23,575 (6.0%)	8,242 (2.1%)	6,244 (1.6%)	124261 (31.7%)	14,598 (3.7%)	11,945 (3.1%)	5,630 (1.4%)	37,372 (9.6%)
2004	398,807	66,855 (16.8%)	88,077 (22.1%)	10,101 (2.5%)	278 (0.1%)	25,763 (6.5%)	8,708 (2.2%)	6,841 (1.7%)	125,148 (31.4%)	14,650 (3.7%)	12,322 (3.1%)	5,266 (1.3%)	34,798 (8.7%)
2005	404,710	66,939 (16.5%)	92,118 (22.8%)	11,166 (2.8%)	10,017 (2.5%)	31,263 (7.7%)	7,962 (2.0%)	7,016 (1.7%)	115,199 (28.5%)	15,164 (3.8%)	12,203 (3.0%)	4,442 (1.1%)	31,221 (7.7%)
2006	417,331	67,375 (16.1%)	99,699 (23.9%)	12,498 (3.0%)	20,963 (5.0%)	35,410 (8.5%)	7,789 (1.9%)	7,387 (1.8%)	106,845 (25.6%)	14,998 (3.6%)	11,593 (2.8%)	4,584 (1.1%)	28,190 (6.8%)
2007	408,315	63,604 (15.6%)	102,462 (25.1%)	12,214 (3.0%)	22,612 (5.5%)	36,105 (8.8%)	7,818 (1.9%)	7,090 (1.7%)	101,148 (24.8%)	13,943 (3.4%)	11,932 (2.9%)	4,077 (1.0%)	25,310 (6.2%)
2008	421,945	62,555 (14.8%)	105,522 (25.0%)	13,339 (3.2%)	24,121 (5.7%)	37,769 (9.0%)	7,981 (1.9%)	6,963 (1.7%)	103,618 (24.6%)	14,245 (3.4%)	15,631 (3.7%)	3,671 (0.9%)	26,530 (6.3%)
2009	434,692	62,808 (14.5%)	110,412 (25.4%)	13,236 (3.0%)	26,284 (6.1%)	39,858 (9.2%)	8,906 (2.1%)	7,514 (1.7%)	104,654 (24.1%)	14,626 (3.4%)	15,482 (3.6%)	3,952 (0.9%)	26,960 (6.2%)
2010	434,436	61274 (14.1%)	113,770 (26.2%)	14,842 (3.4%)	26,716 (6.2%)	40,351 (9.3%)	10,893 (2.5%)	8,152 (1.9%)	102,396 (23.6%)	13,768 (3.2%)	9,396 (2.2%)	3,918 (0.9%)	28,960 (6.7%)
2011	460,457	63699 (13.83%)	121034 (26.3%)	16,387 (3.6%)	28,866 (6.27%)	41,113 (8.9%)	16,744 (3.6%)	9,207 (2.0%)	104,009 (22.6%)	15,468 (3.4%)	8,613 (1.9%)	3,889 (0.8%)	31,428 (6.8%)
2012	447,514	62640 (14%)	120,479 (26.9%)	16,767 (3.8%)	29,047 (6.5%)	39,369 (8.8%)	19,385 (4.3%)	9,854 (2.2%)	85,156 (19.0%)	16,267 (3.6%)	8,356 (1.9%)	3,184 (0.7%)	37,010 (8.3%)
2013	470,502	63675 (13.53%)	127,418 (27.1%)	18140 (3.86%)	32,897 (7.0%)	42,629 (9.1%)	21,706 (4.6%)	10,918 (2.3%)	86,508 (18.4%)	17,223 (3.7%)	7,749 (1.7%)	3,382 (0.7%)	38,257 (8.1%)
2014	473,902	61835 (13.05%)	130,340 (27.5%)	19396 (4.09%)	34,033 (7.2%)	43,893 (9.2%)	22,421 (4.7%)	11,254 (2.4%)	83,652 (17.7%)	17,801 (3.8%)	6,622 (1.4%)	3,503 (0.7%)	39,152 (8.3%)
2015	500,914	65175 (13.0%)	137,271 (27.4%)	22381 (4.5%)	37,859 (7.6%)	47,568 (9.5%)	24,575 (4.9%)	12,188 (2.4%)	86,923 (17.4%)	18,955 (3.8%)	6,165 (1.2%)	3,515 (0.7%)	38,339 (7.7%)

[1]Only outpatient assessments; Denominator for % is the total outpatient assessments for each year; [2]All other conditions with diagnosis codes not defined Online Supplementary Table 1 Diagnosis Codes and Descriptions (e.g non-MSK related conditions such as hypertension, infection); ***Diagnosis code not in use until 2004; Abbreviations: OA = Osteoarthritis; RA = rheumatoid arthritis; AS = Ankylosing spondylitis; IA = inflammatory arthritis; CTD = connective tissue disease (lupus erythematosus, scleroderma); SARDs = systemic autoimmune rheumatic diseases (including PMR, vasculitis, Raynaud's phenomenon, Sarcoidosis); MSK = musculoskeletal.

Table 3 Annual Number of Days Rheumatologists Provided Clinical Activity

Year	Any type of patient encounter[1]		Patient Assessments only[2]	
	Annual number of days with any type of patient encounter Median (IQR)	Number (%) of rheumatologists with at least 3 patient encounters on at least 209 days per year[3]	Annual number of days with patient assessments Median (IQR)	Number (%) of rheumatologists with at least 3 patient assessments on at least 209 days per year[3,4]
2000	231 (193, 257)	78 (53%)	220 (178, 243)	67 (46%)
2001	227 (191.5, 255.5)	75 (49%)	216 (169, 237)	61 (40%)
2002	226 (192, 255)	77 (50%)	210.5 (168, 238)	63 (41%)
2003	224.5 (187, 251)	78 (53%)	209 (165, 233)	66 (45%)
2004	222 (182, 250)	77 (52%)	203.5 (160.5, 229)	62 (42%)
2005	222 (175, 251)	73 (48%)	202 (151, 234)	57 (38%)
2006	218 (171, 251)	72 (47%)	195.5 (157, 231)	53 (34%)
2007	210 (166, 248)	69 (45%)	189 (143, 224)	49 (32%)
2008	209.5 (164, 246.5)	67 (43%)	189.5 (150, 223)	46 (30%)
2009	206.5 (161.5, 244)	64 (40%)	182.5 (142.5, 218)	43 (27%)
2010	206 (161, 244)	68 (42%)	182 (145, 214)	42 (26%)
2011	207.5 (155, 241.5)	73 (42%)	178 (134, 219)	46 (26%)
2012	207 (156, 243)	63 (36%)	175 (137, 209)	34 (19%)
2013	208 (157, 250)	72 (39%)	176 (138, 213)	40 (22%)
2014	204 (165, 248)	71 (39%)	177 (137, 212)	42 (23%)
2015	205.5 (159, 253)	75 (39%)	180 (137, 208)	43 (22%)

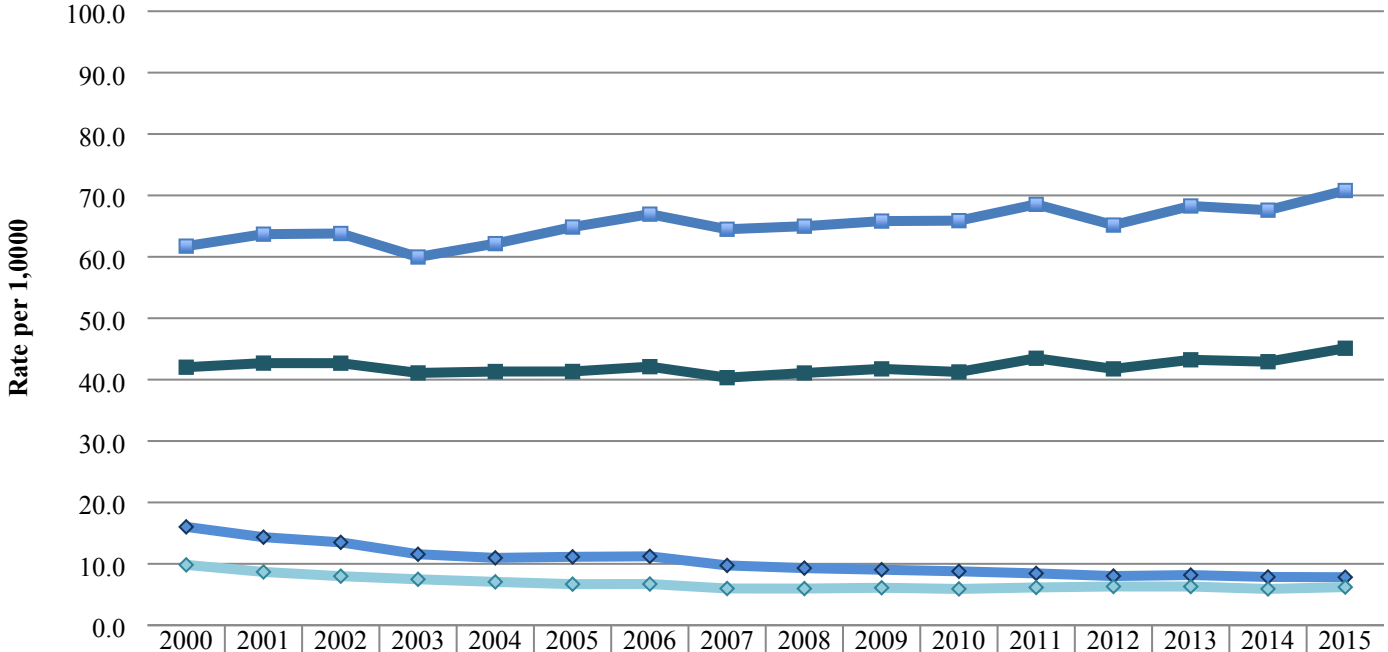
IQR = interquartile range;
[1] Any Type of Patient Encounter includes inpatient, outpatient assessments, and non-face-to-face encounters;
[2] Patient Assessments include only face-to-face patient assessments;
[3]Denominator in the total number of active rheumatologists within each year (see Online Supplementary Figure 1 for denominators);
[4]See Online Supplementary Figure 3 comparing different criteria of the number of daily patient assessments;

Table 4 Median (IQR) Annual Rheumatology Practice Volumes (Number of Patient Encounters per year) and Practice Sizes (Number of Patients Seen per year) by Clinical FTE Classification

	<1 clinical FTE[1]		1 clinical FTE[2]		>1 clinical FTE[3]	
	Practice Volume (# of encounters/ year)	Practice Size (# of patients/year)	Practice Volume (# of encounters/ year)	Practice Size (# of patients/year)	Practice Volume (# of encounters/ year)	Practice Size (# of patients/year)
2000	1730 (879, 2494)	796 (411, 1108)	3467 (2842, 4727)	1418 (1160, 1922)	5752 (4586, 6733)	2396 (1709, 3320)
2001	1768 (933, 2478)	789 (420, 1081)	3381 (2837, 4327)	1398 (1207, 1765)	5763 (4791, 6721)	2507 (2064, 3388)
2002	1804 (797, 2658)	773 (439, 1034)	3487 (2922, 3774)	1416 (1217, 1712)	5552 (4743, 7098)	2385 (1900, 3374)
2003	1697 (827, 2323)	746 (449, 1031)	3365 (2868, 4228)	1375 (1238, 1678)	5632 (4536, 7002)	2432 (1921, 3245)
2004	1823 (867, 2513)	814 (404, 1071)	3734 (3255, 4410)	1497 (1330, 1843)	5820 (4782, 7703)	2367 (1904, 3369)
2005	1772 (600, 2459)	759 (380, 1033)	3625 (2957, 4491)	1456 (1275, 1580)	5961 (4955, 8159)	2380 (1923, 3307)
2006	1866 (743, 2371)	779 (384, 1015)	3584 (2996, 4787)	1373 (1254, 1521)	5971 (4719, 8416)	2406 (1912, 3617)
2007	1722 (730, 2282)	737 (380, 1016)	3561 (2934, 4559)	1347 (1174, 1579)	5776 (4603, 8561)	2476 (1830, 3311)
2008	1738 (676, 2283)	815 (346, 1019)	3405 (2905, 4035)	1335 (1182, 1504)	5911 (4466, 8496)	2199 (1808, 3164)
2009	1662 (679, 2259)	816 (387, 951)	3575 (2970, 4195)	1324 (1116, 1561)	5780 (4471, 8358)	2310 (1801, 3094)
2010	1745 (737, 2323)	798 (376, 975)	3459 (2987, 4370)	1325 (1147, 1554)	5524 (4508, 8289)	2242 (1852, 3082)
2011	1536 (677, 2004)	663 (328, 913)	3485 (2883, 4090)	1229 (1080, 1581)	5533 (4416, 7743)	2092 (1735, 2864)
2012	1525 (892, 2136)	713 (427, 887)	3316 (2996, 3900)	1170 (1061, 1455)	5357 (4362, 7704)	2101 (1750, 2700)
2013	1598 (859, 2187)	687 (349, 869)	3340 (2873, 3832)	1196 (985, 1334)	5215 (4260, 7525)	1988 (1702, 2701)
2014	1739 (915, 2256)	737 (420, 869)	3365 (2863, 3868)	1230 (1030, 1406)	5277 (4342, 7698)	1940 (1655, 2518)
2015	1492 (663, 2234)	670 (409, 890)	3315 (2891, 3763)	1219 (1022, 1337)	5547 (4553, 7658)	2050 (1756, 2563)

FTE = full-time equivalent; IQR = interquartile range; [1]Among rheumatologists identified as those with <40% percentile of total billings; [2] Among rheumatologists identified as those in the 40 to 60th percentile of total billings; [3] Among rheumatologists identified as those >60% percentile of total billings (thus providing more clinical service);

Figure 1 Rates of Encounters with Rheumatologists, per 1,000 population



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Patient Encounters	61.7	63.7	63.8	60.0	62.2	64.9	67.0	64.5	65.0	65.8	65.9	68.6	65.2	68.3	67.6	70.8
New Patient Encounters	16.0	14.3	13.5	11.6	11.0	11.1	11.2	9.7	9.3	9.0	8.8	8.4	8.0	8.2	7.9	7.8
Total Outpatient Assessments	42.0	42.7	42.7	41.1	41.3	41.3	42.1	40.3	41.1	41.8	41.3	43.5	41.8	43.2	42.9	45.1
New Outpatient Assessments	9.8	8.7	8.0	7.5	7.1	6.7	6.7	6.0	6.0	6.1	5.9	6.2	6.3	6.3	5.9	6.2