Determination of Rheumatoid Arthritis Incidence and Prevalence in Alberta Using Administrative Health Data

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INTRODUCTION

Rheumatoid arthritis (RA) is a disabling chronic disorder that affects approximately 1.0% of the Canadian population and, with a growing and aging population, is expected to increase (1). The expected rise in Canadians living with RA will place an increased demand on scarce health care resources, which highlights the urgent need to ensure that those affected have access to health care services, including rheumatologists (2). Access to specialized care and early therapeutic intervention has proven to improve clinical outcomes and reduce disease burden and health care costs (1,3).

Population-based administrative health data offer an efficient way of providing longitudinal epidemiological data to study rheumatic disease burden, treatment outcomes, and quality of care (4,5). However, inconsistencies in case definitions and analytical techniques make study comparisons difficult. To address this problem, the Public Health Agency of Canada (PHAC) in collaboration with the Canadian Rheumatology Administrative Data Network developed best practices and algorithms to

Objective. The objective of the study was to estimate the incidence and prevalence of rheumatoid arthritis (RA) in Alberta using administrative health data.

Methods. We identified RA cases in patients 16 years and older by applying a national case definition to linked administrative health data (ie, hospital discharge abstract records, physician claims, and health insurance registry records) using a unique personal identifier. Incidence and prevalence are reported for the 2015-2016 fiscal year and a trend analysis from 2011-2012 to 2015-2016. Incidence and prevalence estimates were standardized using the 2011 Canadian census population.

Results. In 2015-2016, the overall crude incidence was 0.74 [95% confidence interval (CI): 0.71-0.77] per 1000 and crude prevalence was 1.08% (95% CI: 1.07-1.09). The women-to-men crude incidence and prevalence sex ratios were 2.04 and 2.19, respectively. People aged 65 to 79 years had the highest incidence of RA, and the highest prevalence was observed among those 80 years and older. From 2011-2012 to 2015-2016, the overall age-standardized incidence decreased [0.97 (95% CI: 0.94-1.01) to 0.79 (95% CI: 0.76-0.82) per 1000], whereas age-standardized prevalence remained constant [1.17 (95% CI: 1.15-1.18) to 1.18 (95% CI: 1.17-1.19)].

Conclusion. In Alberta, there was a decreasing trend in RA incidence over the study period, whereas prevalence was stable. These estimates, combined with clinical data, will be used to measure system performance for quality improvement and to inform simulation modeling for planning the expected demand for health services for patients living with RA.
standardize measures for surveillance and to promote the use of administrative health data for rheumatic diseases research and surveillance (4,6).

The study objective was to estimate the incidence and prevalence of RA in Alberta using administrative health data and a national case definition (6). An understanding of the incidence and prevalence of RA will be used to inform the reporting of system performance measures for quality of care monitoring, and to provide a baseline estimate to plan for future health resource needs in the province.

MATERIALS AND METHODS

Ethics approval for this study was obtained from the University of Calgary Conjoint Health Research Ethics Board (Ethics ID: REB13-0822).

Administrative health databases

Administrative health data were acquired from Alberta Health (provincial Ministry of Health) and Alberta Health Services (a province-wide health system responsible for delivering health services to Albertans). Health care services for hospitals and physicians in Canada are publicly funded, and therefore the individuals identified as RA patients include individuals who accessed publicly funded health care services paid for by the Alberta Health Care Insurance Plan (AHCIP). Administrative health data included AHCIP records, hospital discharge abstract records, and physician claims from April 1, 2002, to March 31, 2017. These data were linked using a unique personal health number.

AHCIP Population Registry. The AHCIP covers individuals who have lived in Alberta for at least 3 months and who have registered with Alberta Health (excluding Albertans who opted out of AHCIP and members of the Armed Forces and the Royal Canadian Mounted Police, and federal penitentiary inmates who receive coverage from the federal government). The AHCIP population counts correlate to census population estimates and covers 99.9% of the Alberta population (7). Individual patient-level demographic data (eg, age, sex, and postal code) for all Albertans who are covered by the AHCIP were obtained from the data repository.

Discharge Abstract Database. The Discharge Abstract Database (DAD) includes records of all inpatient services for patients and contains primary and secondary discharge diagnosis codes of the International Classification of Diseases, 10th Revision (ICD-10), with up to 25 diagnosis fields per individual admission.

Physician Claims Database. Physician claims contain information for each outpatient clinic encounter for patients covered by the provincial insurance program and to track shadow-billed claims. Practitioners submit claims for their services, which contain the diagnosis code [International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)], with up to three diagnosis fields for each visit.

RA case definition

We used the 2016 RA case definition by the PHAC for the Canadian Chronic Disease Surveillance System (CCDSS) (6). A modification to the definition was introduced in 2018, which assigns a case date of 730 days or 2 years after the second physician claims visit or discharge date of hospitalization (whichever came first) to permit the opportunity to use all available data for surveillance purposes. For our study purposes, we assigned the date of the second physician claims visit or discharge date of hospitalization with RA diagnosis code (whichever came first) as the case date for all patients with RA. The base case definition [ie, one hospitalization separation or two physician claims (greater than or equal to 8 weeks apart) within 2 years, with ICD-9-CM codes of 714.x or ICD-10-CA codes of M05.x, M06.x] has been validated and yielded a sensitivity, specificity, positive predictive value, and negative predictive value of 83%, 99%, 52%, and 100%, respectively (8). We identified RA cases of patients aged 16 years and older by applying this case definition to linked health administrative databases (ie, the DAD, Physician Claims Database, and AHCIP Population Registry) using a unique personal identifier.

Subsequent to qualifying, patients were excluded if they were diagnosed with non-RA inflammatory arthritides (ie, systemic autoimmune rheumatic diseases, polyarthritis nodosa and allied conditions, polymyalgia rheumatica, psoriasis, ankylosing spondylitis and other spondyloarthritides, and arthropathy associated with other disorders classified elsewhere) in the following 2 years. These conditions were identified using the following case definition: two physician claims with the same non-RA diagnosis codes (at least 1 day apart) within 2 years, with ICD-9-CM codes of 710.x, 446.x, 725.x, 696.x, 713.x, and 720.x. The exclusion criteria were applied to all cases that qualified, and those who were excluded were excluded for the remainder of the study period.

Statistical analysis

Statistical analyses were performed using SAS Enterprise Guide (version 7.1). Cases were defined as incident if the individual was newly diagnosed with RA and never met the case definition in any of the previously available years starting in fiscal years 2002-2003 (starting on April 1 of the measurement year and ending on March 31 of the following year). RA incidence was calculated by dividing the total number of new RA cases in each fiscal year by the total number of people covered by AHCIP during the same fiscal year excluding cases that were prevalent at the beginning of the fiscal year, multiplied by 1000. Prevalence was calculated by dividing the total number of prevalent RA cases during the capture
period by the total number of people covered by AHCIP during the fiscal year and multiplied by 100.

A run-in period from 2002-2003 to 2010-2011 was used to allow enough time to capture all prevalent cases and to avoid misclassification of prevalent cases as incident given the lack of historical information prior to the index year. The last two years of data were not reported in order to permit each RA case an equal opportunity to be excluded as specified in the case definition. Therefore, estimates are reported for 2015-2016 and a trend analysis from 2011-2012 to 2015-2016.

The age-standardized incidence and prevalence estimates were calculated using the 2011 Canadian census population (patients aged 16 years and older) using the direct standardization method to allow for the comparison of RA estimates over the study period. The 95% confidence intervals (CIs) were calculated based on the gamma distribution. A trend analysis was conducted using a Poisson regression model and significance level of $P < .05$.

**RESULTS**

**RA incidence and prevalence**

Crude and age-standardized incidence and prevalence are presented in Table 1. There were 2704 new RA cases and 39,348 prevalent cases in the 2015-2016 fiscal year, with an overall crude incidence of 0.74 (95% CI: 0.71-0.77) per 1000 and crude prevalence of 1.08% (95% CI: 1.07-1.09). Over the reporting period, age-standardized incidence decreased, whereas age-standardized prevalence remained stable. The results of the regression model showed a significant annual decrease of 4.5% (95% CI: 3.3-5.6) in incidence after adjustment for age and sex from 2011-2012 to 2015-2016.

Overall, RA incidence was higher among women compared with men (Table 2). In fiscal year 2015-2016, there was a total of 1798 incident RA cases among women and 906 incident RA cases among men with a crude incidence of 1.00 (95% CI: 0.95-1.04) per 1000 and 0.49 (95% CI: 0.46-0.52) per 1000, respectively. The age-standardized incidence for women was 1.26 (95% CI: 1.20-1.31) per 1000 in 2011-2012 and decreased to 1.05 (95% CI: 1.00-1.10) per 1000 in 2015-2016. Similarly, the age-standardized incidence for men decreased from 0.86 (95% CI: 0.78-0.95) and 0.36 (95% CI: 0.31-0.41) per 1000 over the same time period. The prevalence of RA in women was twice the prevalence in men (Table 3). By 2015-2016, there were 26,857 women with RA, whereas there were 12,491 men with RA in Alberta. The crude prevalence rate for that year was 1.49% (95% CI: 1.47-1.51) for women and 0.68% (95% CI: 0.67-0.69) for men. The age-standardized prevalence for women and men was stable from 2011-2012 to 2015-2016.

The incidence and prevalence of RA by age group and sex for 2015-2016 are shown in supplementary Figures 1 and 2, respectively. Overall, the incidence of RA increased with age but declined among those 80 years and older. The incidence of RA was 0.86 (95% CI: 0.78-0.95) and 0.36 (95% CI: 0.31-0.41) per 1000 for women and men age 35-49 years, respectively, and nearly doubled among those who were 35-49 to 50-64 years of age for both sexes. Similarly, the prevalence of RA increased with age, with the

**Table 1.** Overall crude and age-standardized RA incidence and prevalence by fiscal year in individuals 16 years and older in Alberta*

| Fiscal Year | Incidence Cases | Crude Incidence per 1000 (95% CI) | Age-Standardized Incidence per 1000 (95% CI) | Prevalent Cases | Crude Prevalence % (95% CI) | Age-Standardized Prevalence % (95% CI) | Population |
|-------------|----------------|----------------------------------|---------------------------------------------|----------------|-----------------------------|---------------------------------------|------------|
| 2011-12     | 2849           | 0.90 (0.87-0.93)                 | 0.97 (0.94-1.01)                            | 3285           | 1.05 (1.04-1.06)            | 1.17 (1.15-1.18)                       | 3,167,880 |
| 2012-13     | 2719           | 0.83 (0.80-0.87)                 | 0.90 (0.86-0.93)                            | 3416           | 1.05 (1.04-1.06)            | 1.15 (1.14-1.17)                       | 3,262,060 |
| 2013-14     | 2825           | 0.83 (0.80-0.86)                 | 0.89 (0.86-0.92)                            | 3605           | 1.06 (1.05-1.07)            | 1.17 (1.16-1.18)                       | 3,394,057 |
| 2014-15     | 2788           | 0.79 (0.76-0.82)                 | 0.85 (0.81-0.88)                            | 3778           | 1.07 (1.06-1.08)            | 1.17 (1.16-1.19)                       | 3,528,499 |
| 2015-16     | 2704           | 0.74 (0.71-0.77)                 | 0.79 (0.76-0.82)                            | 39348          | 1.08 (1.07-1.09)            | 1.18 (1.17-1.19)                       | 3,647,825 |

Abbreviation: CI = confidence interval, RA = rheumatoid arthritis.

* Age-standardized incidence and prevalence estimates were calculated using the 2011 Canadian census population.

**Table 2.** Crude and age-standardized RA incidence by sex and fiscal year in individuals 16 years and older in Alberta*

| Fiscal Year | Incident Cases | Crude Incidence per 1000 (95% CI) | Age-Standardized Incidence per 1000 (95% CI) | Prevalent Cases | Crude Prevalence % (95% CI) | Age-Standardized Prevalence % (95% CI) | Population |
|-------------|----------------|----------------------------------|---------------------------------------------|----------------|-----------------------------|---------------------------------------|------------|
| Women       | Men            | Women                            | Men                                         | Women          | Men                         | Women                                | Men        |
| 2011-12     | 1882           | 967                              | 1.19 (1.13-1.24)                            | 0.61 (0.57-0.65) | 1.26 (1.20-1.31)           | 0.68 (0.64-0.73)                       | 1,585,027  |
|             |                |                                  |                                             |                |                             |                                       | 1,582,853  |
| 2012-13     | 1797           | 922                              | 1.10 (1.05-1.16)                            | 0.56 (0.53-0.60) | 1.16 (1.11-1.21)           | 0.62 (0.58-0.66)                       | 1,628,964  |
|             |                |                                  |                                             |                |                             |                                       | 1,633,096  |
| 2013-14     | 1850           | 975                              | 1.10 (1.05-1.15)                            | 0.57 (0.54-0.61) | 1.15 (1.10-1.21)           | 0.63 (0.59-0.67)                       | 1,688,079  |
|             |                |                                  |                                             |                |                             |                                       | 1,705,978  |
| 2014-15     | 1854           | 934                              | 1.06 (1.01-1.11)                            | 0.52 (0.49-0.56) | 1.12 (1.06-1.17)           | 0.58 (0.54-0.62)                       | 1,748,963  |
|             |                |                                  |                                             |                |                             |                                       | 1,779,536  |
| 2015-16     | 1798           | 906                              | 1.00 (0.95-1.04)                            | 0.49 (0.46-0.52) | 1.05 (1.00-1.10)           | 0.53 (0.50-0.57)                       | 1,804,165  |
|             |                |                                  |                                             |                |                             |                                       | 1,843,660  |

Abbreviation: CI = confidence interval, RA = rheumatoid arthritis.

* Age-standardized incidence estimates were calculated using the 2011 Canadian census population.
incidence and prevalence of rheumatoid arthritis

Population

1.00) in Alberta (2008-2009) (9,10). (95% CI: 0.78-0.79) in Ontario (2010) and 1.00% (95% CI: 1.00-

Age- and sex-standardized prevalence estimates were 0.78%

and 0.68 per 1000 in British Columbia from 2001-2006 (9,12).

(95% CI: 0.52-0.55) per 1000 in the province of Ontario in 2010
dian estimates of age- and sex-standardized incidence were 0.54
of 0.41 (95% CI: 0.37-0.45) per 1000 from 2005-2014 (11). Cana-
miology of RA using administrative health data however, are
not directly comparable on account of different case definitions
and methodologies employed (9–12) . A study in the United
States reported an overall age- and sex-standardized incidence
was not implemented in our study because of differences in our
case date definition currently used by the PHAC for the CCDSS
in 2015-2016 (6). From 2011-2012 to 2015-2016, the
age-standardized incidence of RA decreased in Canada from
0.83 per 1000 (95% CI: 0.81-0.88) to 0.75 per 1000 (95% CI: 0.74-0.76), like what was observed in this study. In contrast, there
was an increasing age-standardized prevalence of RA observed
in Canada in the same time period [1.09% (95% CI: 1.09-1.09) to
1.13% (95% CI: 1.13-1.14)], whereas we observed a stable trend
in Alberta.

Studies have found variability in RA incidence trends, with
some reporting an increase in incidence while others have
reported a stable or decreasing trend overtime (11,13,14). A study
examining the incidence of RA by serological phenotype found a
decrease in rheumatoid factor (RF)-positive RA and an increase
in RF-negative RA from 2005-2014 compared with the previous
decades (11). The decreasing trend in RA incidence may be attrib-
uted to the dramatic decline in RA risk factors, such as smoking
(15). Another explanation may be a possible birth cohort effect,
where the risk of RA changes based on social and environmental
conditions at time of birth (13). Changes in data collection, cod-
ing, how RA is classified and diagnosed, clinical practice, and/or
billing methods are other important considerations for the variation
in RA incidence.

These disease burden estimates, in combination with clin-
cial and administrative data, can be used for quality improve-
ment initiatives in the detection and treatment of RA. The
development of system performance indicators to evaluate a

highest prevalence of RA observed among those 80 years and
older. The prevalence of RA more than doubled between the ages
of 35-49 and 50-64 years for both men and women.

**DISCUSSION**

We used administrative health data to estimate the inci-
dence and prevalence of RA in Alberta. Over the study period, the
age-standardized incidence decreased, whereas age-standardized
prevalence remained stable. Consistent with established disease
patterns, women had a higher incidence and prevalence of RA
compared with men (9). Estimates of RA were generally higher
among older adults and seniors; however, a significant proportion
of those in their prime working years were also affected, which has
important economic implications for the labor force if left undiag-
nosed and untreated.

There is currently no gold standard administrative data case
definition used in RA, and the use of case definitions will vary
depending on the feasibility of accessing data sources and study
purpose, which highlights the importance of reporting case defini-
tions in research methods for accurate comparisons (8). The RA
case date definition currently used by the PHAC for the CCDSS
was not implemented in our study because of differences in our
study purpose. For our study and future research using these esti-
mates, we were interested in individual-level health data after case
qualification to accurately measure the health care utilization of
patients for health care planning purposes and quality improvement
efforts.

Previous published studies that have examined the epide-
miology of RA using administrative health data however, are
not directly comparable on account of different case definitions
and methodologies employed (9–12) . A study in the United
States reported an overall age- and sex-standardized incidence
of 0.41 (95% CI: 0.37-0.45) per 1000 from 2005-2014 (11). Cana-
dian estimates of age- and sex-standardized incidence were 0.54
(95% CI: 0.52-0.55) per 1000 in the province of Ontario in 2010
and 0.68 per 1000 in British Columbia from 2001-2006 (9,12).
Age- and sex-standardized prevalence estimates were 0.78%
(95% CI: 0.78-0.79) in Ontario (2010) and 1.00% (95% CI: 1.00-
1.00) in Alberta (2008-2009) (9,10).

The RA estimates reported in this study are comparable to
those produced by PHAC's CCDSS (6). When comparing the lat-
est data available for Alberta from the CCDSS (ie, fiscal year 2014-
2015), our age-standardized incidence of RA (0.85 per 1000,
95% CI: 0.81-0.88) was slightly higher than the CCDSS (0.75 per
1000, 95% CI: 0.72-0.78), and our age-standardized prevalence
(1.17 %, 95% CI: 1.16-1.19) was a little lower than that produced
by the CCDSS (1.22%, 95% CI: 1.21-1.24). The small differences
observed between our estimates and the PHAC's CCDSS are
likely attributable to the difference in the case date definition used
and the shorter run-in period applied in this study because there
were fewer years of data available.

Nationally, our Alberta RA incidence and prevalence esti-
mates were higher than the overall Canadian population from the
CCDSS in 2015-2016 (6). From 2011-2012 to 2015-2016, the age-standardized incidence of RA decreased in Canada from
0.83 per 1000 (95% CI: 0.82-0.84) to 0.75 per 1000 (95% CI:
0.74-0.76), like what was observed in this study. In contrast, there
was an increasing age-standardized prevalence of RA observed
in Canada in the same time period [1.09% (95% CI: 1.09-1.09) to
1.13% (95% CI: 1.13-1.14)], whereas we observed a stable trend
in Alberta.

Table 3. Crude and age-standardized RA prevalence by sex and fiscal year in individuals 16 years and older in Alberta*

| Fiscal Year | Women | Men |
|-------------|-------|-----|
| 2011-12     | 22,758| 10,527|
| 2012-13     | 23,374| 10,787|
| 2013-14     | 24,627| 11,427|
| 2014-15     | 25,795| 11,991|
| 2015-16     | 26,857| 12,491|

Abbreviation: CI = confidence interval, RA = rheumatoid arthritis.

* Age-standardized prevalence estimates were calculated using the 2011 Canadian census population.

...
centralized intake system for patients with RA and osteoarthritis is one example of quality improvement efforts in Alberta (5). Many of these measures will be tested and operationalized using administrative data sources and will require accurate estimates of disease burden to optimize health care planning. Some of this work is currently underway using administrative data from Alberta (16).

A strength of this study is the use of long periods of administrative health data to minimize the misclassification of prevalent cases as incident and to allow enough time to capture all prevalent cases. For accurate estimates of incidence and prevalence, longitudinal data over long time periods are required; otherwise incidence may be over-reported and prevalence underreported. Other strengths of the study include the capture of medically diagnosed cases, near universal coverage, and ability to measure and monitor incidence overtime.

Limitations of the study warrant discussion. Estimates of RA burden may be underestimated in this study as some individuals may delay seeking medical care for prolonged periods of time and thus were missed in the case ascertainment. The reasons for this delay can be due to patient-dependent factors and initial disease onset and presentation. Delays in referral from primary care providers to specialist care may be another contributing factor. Patients seen by a salaried physician who does not shadow bill may also underestimate burden. Those who accessed private health care services are not reflected in the present cohort, although this number is not expected to be significant as there are no rheumatologists practicing in private medical clinics in Alberta. Furthermore, the ICD diagnosis codes submitted by physicians may not be clinically accurate, and therefore, RA care may not be reflected in the codes reported. The generalizability of these findings may be limited because of variations in coding and classification systems, clinical practices, and billing methods across provinces. We were unable to examine RA trends by patient ethnicity or serological phenotype, as these data are not available in the administrative health data sources. Lastly, only 4 years of data were available to assess trends because of the long run-in period used.

In Canada, RA represents a significant public health issue associated with reduced quality of life and economic burden for patients living with the disease (1). According to a national rheumatology workforce survey in Canada, the current number of rheumatologists may be inadequate to meet population needs for managing patients living with RA (2,17). This is concerning given the expected resource needs of this population in the future (1). The factors contributing to the shortage of rheumatology care, in addition to disease estimates of burden, are critical to adequately planning health services for this population to ensure early diagnosis and treat to target.

**AUTHOR CONTRIBUTIONS**

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

**Study conception and design.** Marshall, Faris, Barber, Katz, Homik, Mosher.

**Acquisition of data.** Marshall, Faris, Chen, Katz, Lopatina, Mosher.

**Analysis and interpretation of data.** Marshall, Pham, Faris, Chen, O’Donnell, Barber, LeClercq, Katz, Homik, Patel, Lopatina, Roberts, Mosher.

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