# Descriptive Epidemiology of Osteoarthritis in British Columbia, Canada

JACEK A. KOPEC, M. MUSHFIQUR RAHMAN, JEAN-MARIE BERTHELOT, CHRISTEL LE PETIT, JAAFAR AGHAJANIAN, ERIC C. SAYRE, JOLANDA CIBERE, ASLAM H. ANIS, and ELIZABETH M. BADLEY

***ABSTRACT.*** ***Objective***. Osteoarthritis (OA) is a highly prevalent and often disabling disease. Data on the incidence of OA in the general population are limited. Our objectives were (1) to estimate OA prevalence and incidence rates by age and sex in a geographically defined population of 4 million people [British Columbia (BC), Canada] using an administrative database; and (2) to determine the effects of different administrative definitions of OA and observation (run-in) time on such estimates.

***Methods***. We used data on all visits to health professionals and hospital admissions covered by the Medical Services Plan (MSP) of BC for the fiscal years 1991-92 through 2000-01. OA was defined based on International Classification of Diseases, 9th Revision, diagnostic codes required for administrative purposes.

***Results***. The overall prevalence of OA in 2001 was 10.8%: 8.9% in men and 12.6% in women. Prevalence was higher in women in all age groups. By age 70–74 years, about one-third of men and 40% of women had OA. Incidence rates in 2000-01 were 11.7 per 1000 person-years in the total population, 10.0 in men and 13.4 in women. Rates increased linearly with age between 50 and 80 years. Both prevalence and incidence depended strongly on the definition of OA and the run-in period.

***Conclusion***. Prevalence of physician-diagnosed OA in BC was slightly lower than self-reported prevalence of arthritis in population surveys. Routinely collected administrative data could be a valuable source of information for OA surveillance, but more research is needed on the validity of OA diagnosis in administrative databases. (First Release Dec 15 2006; J Rheumatol 2007;34:386–93)

*Key Indexing Terms:*
OSTEOARTHRITIS EPIDEMIOLOGY PREVALENCE INCIDENCE DATABASES

Osteoarthritis (OA) is the most common form of arthritis and is recognized as one of the most important health problems in modern industrial societies[1-4]. However, the frequency of OA in the general population is not well established. In a review of 29 studies in 14 countries by Sun, *et al*[5] prevalence ranged from 0.5% to 36%, presumably due to differences in OA definitions and methodology. Lawrence, *et al* reviewed data on the prevalence of radiographic, symptomatic, and clinical OA of specific joints in the US[2]. Most of the data came from studies carried out in the 1960s and 1970s, and large differences were found between their report and studies in other countries. Self-reported prevalence of arthritis, rheumatism, and chronic joint problems has been estimated in many national surveys in North America, Europe, and elsewhere, and such surveys are the main source of data for describing the population burden of arthritis. However, OA-specific self-reported data have rarely been reported.

There is relatively little information on the incidence of OA. In Sun, *et al*'s international review, incidence rates ranged from 0.1 to 22.3 per 1000 person-years[5]. Wilson, *et al*[6] studied hip and knee OA incidence among residents of Rochester, Minnesota. Oliveria, *et al*[7] estimated the incidence of OA of the knee, hip, and hand among members of the Fallon Community Health Plan, a health maintenance organization in Massachusetts. Both studies required symptoms and radiographic changes to define OA, but estimates of OA incidence by age and sex from these 2 studies differed substantially. Several prospective cohort studies in the USA and Europe provided data on the incidence of radiographic OA of specific joints[8-11]. However, such studies do not estimate total OA incidence, are not representative of the general population, and are restricted to certain age groups. Also, the definition of OA varied between studies. Wilkins[12] reported the incidence of self-reported "arthritis or rheumatism" in Canada from the National Population Health Survey.

OA surveillance could potentially be facilitated by the use

*From the Department of Health Care and Epidemiology, University of British Columbia, and the Arthritis Research Centre of Canada, Vancouver, BC, Canada.*

*Supported by a grant from the Canadian Institutes of Health Research. J.A. Kopec is a Michael Smith Foundation for Health Research Senior Scholar.*

*J.A. Kopec, PhD, Associate Professor, Department of Health Care and Epidemiology, University of British Columbia, Research Scientist, Arthritis Research Centre of Canada; M.M. Rahman, MSc, Arthritis Research Centre of Canada, Vancouver, BC; J-M. Berthelot, MSc, Canadian Institute of Health Information; C. Le Petit, BSc, Statistics Canada, Ottawa, Ontario; J. Aghajanian, MSc; E.C. Sayre, MSc, PhD candidate, Arthritis Research Centre of Canada; J. Cibere, MD, PhD, Department of Medicine; A.H. Anis, PhD, Department of Health Care and Epidemiology, University of British Columbia; E.M. Badley, PhD, Department of Public Health Sciences, University of Toronto, Toronto, Ontario, Canada.*

*Address reprint requests to Dr. J.A. Kopec, Arthritis Research Centre of Canada, 895 West 10th Avenue, Vancouver, BC V5Z 1L7.*
*E-mail: jkopec@arthritisresearch.ca*

*Accepted for publication October 23, 2006.*

of large population-based administrative databases. Harrold, *et al* estimated the prevalence of OA by age and sex in a health maintenance organization in Massachusetts and compared administrative diagnosis with that based on medical records[13]. There are no published data on the incidence of administratively diagnosed OA. The objectives of our study were (1) to estimate the prevalence and incidence of OA by age and sex in a large geographically defined population using an administrative database; and (2) to perform a sensitivity analysis to investigate the effects of OA definition and observation (run-in) time on these estimates.

## MATERIALS AND METHODS

*Database*. We used data on all visits to health professionals and hospital admissions covered by the Medical Services Plan (MSP) of British Columbia (BC) for the fiscal years 1991-92 through 2000-01. This database is maintained by the BC Ministry of Health. The database included International Classification of Diseases, 9th Revision (ICD-9) diagnostic codes (one 3-digit code per visit), date and type of service, provider's specialty code, birth and death dates, sex, postal codes, and MSP registration start and exit dates. We also obtained information about hospital admission and separation dates and up to 16 diagnoses coded on hospital discharge summaries. We defined OA diagnosis (Definition 1) as either the first visit to a health professional or the first hospital separation with a 3-digit ICD-9 code 715 (osteoarthrosis and allied disorders). An alternative definition (Definition 2) was used in a sensitivity analysis. A visit was defined as any service covered by the MSP with the exclusion of diagnostic procedures and certain other procedures, for example, dialysis/transfusion, anesthesia, obstetrics, or therapeutic radiation. Visits to all types of health professionals were included.

*Calculation of prevalence and incidence*. Prevalence rate (proportion) was defined as the number of affected persons in the population at a specified time divided by the number of persons in the population at that time[14]. The numerator of prevalence rate was the number of persons, within 5-year age-sex groups, who met the definition of OA between April 1, 1991, and March 31, 2001, and were alive and registered with the MSP on March 31, 2001. The denominator was the number of BC residents covered by the MSP. Population estimates for July 1, 2000, and July 1, 2001, by age and sex were obtained from the BC Vital Statistics Agency, and the population on March 31, 2001, was estimated by linear interpolation. The MSP coverage rate was estimated at 98.8% using information from the BC Ministry of Health. All cases in the numerator were also part of the denominator, as required. We had no data on persons diagnosed before the 10-year run-in period who had no subsequent visits for OA or persons with OA who came to BC during that period and had no OA-related visits.

Incidence rates by age and sex were obtained for the 1-year period between April 1, 2000, and March 31, 2001. The number of new cases (numerator of incidence rate) in a given age-sex category was calculated as those who met a given definition of OA for the first time during this period. Persons diagnosed with OA during the 9-year run-in period from April 1, 1991, until March 31, 2000, were not eligible to become incident cases. Person-time (PT) was estimated by the following formula: $PT = N \times (1 - P) \times C$, where N is the BC census population, P is prevalence rate (both on October 1, 2000), and C = 0.988 is the MSP coverage rate. In this formula, mid-year prevalence is used to exclude PT contributed by prevalent cases from the denominator of incidence rate. Prevalence on October 1, 2000, was calculated as the average of prevalence on March 31, 2000, and March 31, 2001. Since BC census estimates take into account death and migration, we did not adjust for those demographic events.

Data were obtained for all age-sex groups. However, age-specific prevalence and incidence rates of OA in persons under the age of 20 years are not reported due to concerns about coding accuracy. Since clinical observations suggest that OA in this age group is very rare, we assumed these rates to be 0 in the calculation of overall rates for the population. This assumption has a negligible effect on the overall rates.

*Sensitivity analysis*. We performed sensitivity analyses to assess the effect of alternative administrative definitions of OA and different run-in periods on the estimates of prevalence and incidence. Our alternative definition (Definition 2) required at least 2 visits within 2 years separated by at least 1 day or a hospital diagnosis (this definition is similar to the definition of diabetes used in the National Diabetes Surveillance System in Canada). We applied maximum run-in periods (observation period for identifying cases) from 1–10 years for estimating prevalence and 0–9 years to eliminate prevalent cases when estimating incidence.

## RESULTS

*Prevalence*. On March 31, 2001, there were 433,439 persons in our database who had been diagnosed with OA (Definition 1). The BC population covered by the MSP was approximately 4,020,000. Overall prevalence for all age groups combined was 10.8%, 8.9% in men and 12.6% in women (male-to-female prevalence ratio = 0.7). Prevalence was higher for women in all age groups studied (Table 1). In the age group 45–49, about 10% of the population had OA. After age 50, the estimates increased approximately linearly with age. By age 70–74, about one-third of men and 40% of women had OA. The largest absolute number of prevalent cases was in the age group 70–74 for men and 75–79 for women. The average age of male prevalent cases was 61 years and the average age of female prevalent cases was 64 years.

*Incidence*. A total of 42,114 new cases of OA were diagnosed between April 1, 2000 and March 31, 2001. The incidence rate for all age-sex groups combined was 11.7 per 1000 person-years, 10.0 in men and 13.4 in women (male-to-female incidence rate ratio = 0.75). Rates were higher in women in all age groups studied (Table 2) and increased linearly with age between 50 and 80 years in both sexes. By age 70–74, the rates were 39.0 and 51.9 per 1000 in men and women, respectively. The largest number of new cases occurred in the age group 50–54 for both sexes. The average age at diagnosis was 57 years for men and 59 for women.

*Sensitivity analysis*. Both prevalence and incidence depended strongly on the definition of OA and the run-in period. Using Definition 2 (2 visits in 2 years) reduced prevalence to 4.8% in men and 6.9% in women, i.e., by 46% and 45%, respectively (Figure 1). The effect of definition on the incidence of OA was similar, with rates for Definition 2 reduced to 5.5 per 1000 for men and 7.7 for women, i.e., by 45% and 43%, respectively (Figure 1). With a shorter run-in, prevalence was underestimated as cases with long periods without OA-related visits were missed (Figure 2). For example, using a 5-year run-in, prevalence for Definition 1 (both sexes combined) was 7.7%, compared with 10.8% using a 10-year run-in (29% reduction). Using Definition 2, the combined prevalence proportions were 4.2% versus 5.9% for a 5-year versus 10-year run-in (29% reduction). Extrapolating the curves beyond 10 years would result in a higher estimated prevalence. Incidence rates were overestimated when a shorter run-in was used due

*Table 1.* Prevalence of osteoarthritis (OA) in British Columbia on March 31, 2001 by age and sex.

| Age Group | Men | | | Women | | | Total[a] |
|---|---|---|---|---|---|---|---|
| | With OA | Population at risk | Prevalence per 1000 | With OA | Population at risk | Prevalence per 1000 | Prevalence per 1000 |
| 0–19[b] | — | 511,994 | — | — | 482,370 | — | — |
| 20–24 | 1,819 | 134,443 | 13.5 | 2,080 | 129,496 | 16.1 | 14.8 |
| 25–29 | 2,589 | 134,636 | 19.2 | 2,986 | 133,197 | 22.4 | 20.8 |
| 30–34 | 4,405 | 149,167 | 29.5 | 4,799 | 149,968 | 32.0 | 30.8 |
| 35–39 | 7,427 | 168,923 | 44.0 | 8,132 | 169,793 | 47.9 | 45.9 |
| 40–44 | 11,271 | 170,019 | 66.3 | 12,565 | 173,705 | 72.3 | 69.3 |
| 45–49 | 14,361 | 157,477 | 91.2 | 17,232 | 159,842 | 107.8 | 99.6 |
| 50–54 | 17,678 | 142,601 | 124.0 | 23,260 | 141,925 | 163.9 | 143.9 |
| 55–59 | 17,938 | 105,942 | 169.3 | 25,290 | 105,420 | 239.9 | 204.8 |
| 60–64 | 18,573 | 83,860 | 221.5 | 25,800 | 84,824 | 304.2 | 263.7 |
| 65–69 | 20,308 | 75,089 | 270.5 | 27,379 | 75,442 | 362.9 | 317.8 |
| 70–74 | 20,977 | 64,797 | 323.7 | 28,987 | 70,682 | 410.1 | 370.4 |
| 75–79 | 18,212 | 48,436 | 376.0 | 29,510 | 63,057 | 468.0 | 430.1 |
| 80–84 | 12,369 | 28,670 | 431.4 | 23,285 | 44,805 | 519.7 | 489.6 |
| 85–90 | 6,881 | 14,365 | 479.0 | 14,866 | 26,681 | 557.2 | 537.7 |
| 90+ | 2,692 | 5,180 | 519.7 | 7,968 | 13,222 | 602.6 | 599.6 |
| Total[c] | 177,500 | 1,995,380 | 89.0 | 254,139 | 2,024,431 | 125.5 | 107.8 |

[a] Including 1800 persons with OA whose sex is unknown. [b] Not given due to possible coding inaccuracy. [c] Assuming 0 cases in the age group 0–19.

*Table 2.* Incidence rates of osteoarthritis in British Columbia in 2000–2001 by age and sex. Person-years have been estimated as mid-year population at risk times duration of the observation period (1 year). Incidence rates have been estimated for the period from April 1, 2000 to March 31, 2001.

| Age Group | Men | | | Women | | | Total[a] |
|---|---|---|---|---|---|---|---|
| | Number of Cases | Person-years | Incidence Rate per 1000 | Number of Cases | Person-years | Incidence Rate per 1000 | Incidence Rate per 1000 |
| 0–19[b] | — | 509,623 | — | — | 480,489 | — | — |
| 20–24 | 293 | 131,449 | 2.2 | 283 | 126,412 | 2.2 | 2.2 |
| 25–29 | 400 | 133,609 | 3.0 | 433 | 131,810 | 3.3 | 3.1 |
| 30–34 | 672 | 145,170 | 4.6 | 664 | 145,074 | 4.6 | 4.6 |
| 35–39 | 1,109 | 163,881 | 6.8 | 1,210 | 163,593 | 7.4 | 7.1 |
| 40–44 | 1,506 | 158,533 | 9.5 | 1,749 | 160,862 | 10.9 | 10.2 |
| 45–49 | 1,804 | 142,638 | 12.6 | 2,427 | 141,510 | 17.2 | 14.9 |
| 50–54 | 2,247 | 123,190 | 18.2 | 2,958 | 116,847 | 25.3 | 21.7 |
| 55–59 | 1,978 | 87,037 | 22.7 | 2,741 | 79,730 | 34.4 | 28.4 |
| 60–64 | 1,858 | 65,238 | 28.5 | 2,436 | 59,212 | 41.1 | 34.6 |
| 65–69 | 1,846 | 55,657 | 33.2 | 2,297 | 49,334 | 46.6 | 39.6 |
| 70–74 | 1,719 | 44,094 | 39.0 | 2,214 | 42,677 | 51.9 | 45.6 |
| 75–79 | 1,350 | 30,818 | 43.8 | 2,010 | 34,874 | 57.6 | 51.7 |
| 80–84 | 851 | 16,384 | 51.9 | 1,333 | 21,914 | 60.8 | 57.7 |
| 85–90 | 409 | 7,662 | 53.4 | 715 | 12,226 | 58.5 | 58.4 |
| 90+ | 151 | 2,584 | 58.4 | 344 | 5,435 | 63.3 | 66.2 |
| Total[c] | 18,193 | 1,817,567 | 10.0 | 23,814 | 1,771,998 | 13.4 | 11.7 |

[a] Including 107 cases whose sex is unknown. [b] Not given due to possible coding inaccuracy. [c] Assuming 0 cases in the age group 0–19.

to misclassifcation of prevalent cases as new cases (Figure 2). For Definition 1, using a 4-year run-in would increase the overall rate to 14.3 per 1000, compared with 11.7 with a 9-year run-in (22% increase). The effect was slighltly smaller for Definition 2, with the rate increasing from 6.6 to 7.7 per 1000 person-years (17% increase). Extending the run-in period beyond 9 years would have a relatively small effect on the incidence rates.

## DISCUSSION

This study used administrative data to estimate the prevalence and incidence of OA in a large, geographically defined popu-

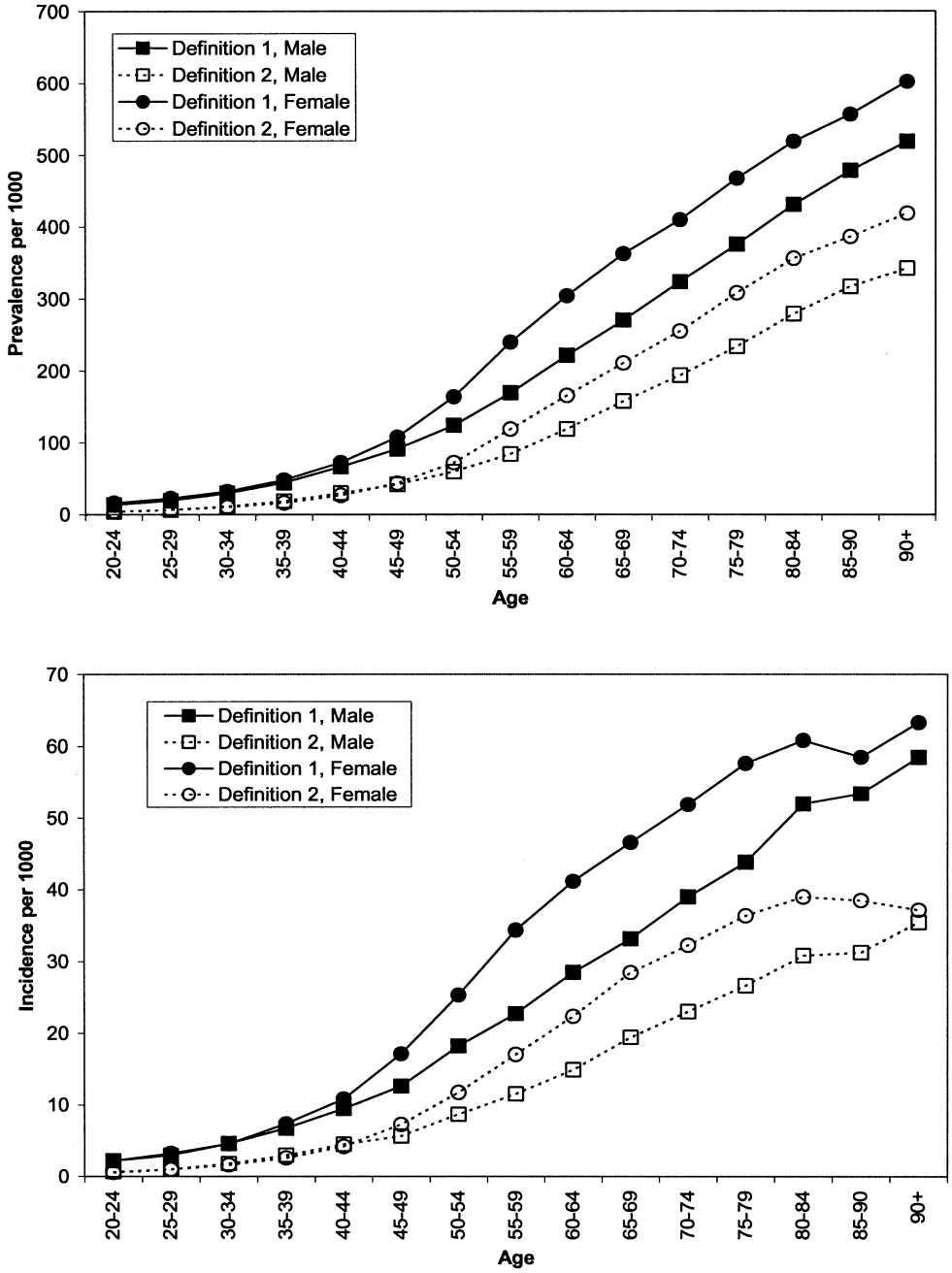


*Figure 1*. Sensitivity analysis of the effect of OA definition on age/sex-specific prevalence and incidence rates of OA in BC. Definition 1: At least one visit to a health professional or one hospital separation with a 3-digit ICD-9 code 715 (Osteoarthrosis and allied disorders). Definition 2: At least 2 visits to a health professional within 2 years, separated by at least one day, or one hospital separation with a 3-digit ICD-9 code 715.

lation. To our knowledge, this is the first study to provide incidence rates from a population-based administrative database for all types of OA combined. To facilitate comparisons with published studies we have calculated prevalence and incidence rates in our data for different values of the lower age cutoff (Table 3).

Prevalence studies have often applied an OA definition based on radiographs of specific joints. However, prevalence estimates in such studies depend on which joints are evaluated and the radiographic technique used[15]. Further, many people with radiographic changes are asymptomatic[16]. For example, Hannan, *et al*[16] found that only 11% of persons age 25–74 in the National Health and Nutrition Examination Survey I who reported physician-diagnosed arthritis had radiographic knee OA, and 61% of those with radiographic knee OA were told by a physician they had arthritis. Therefore, comparing

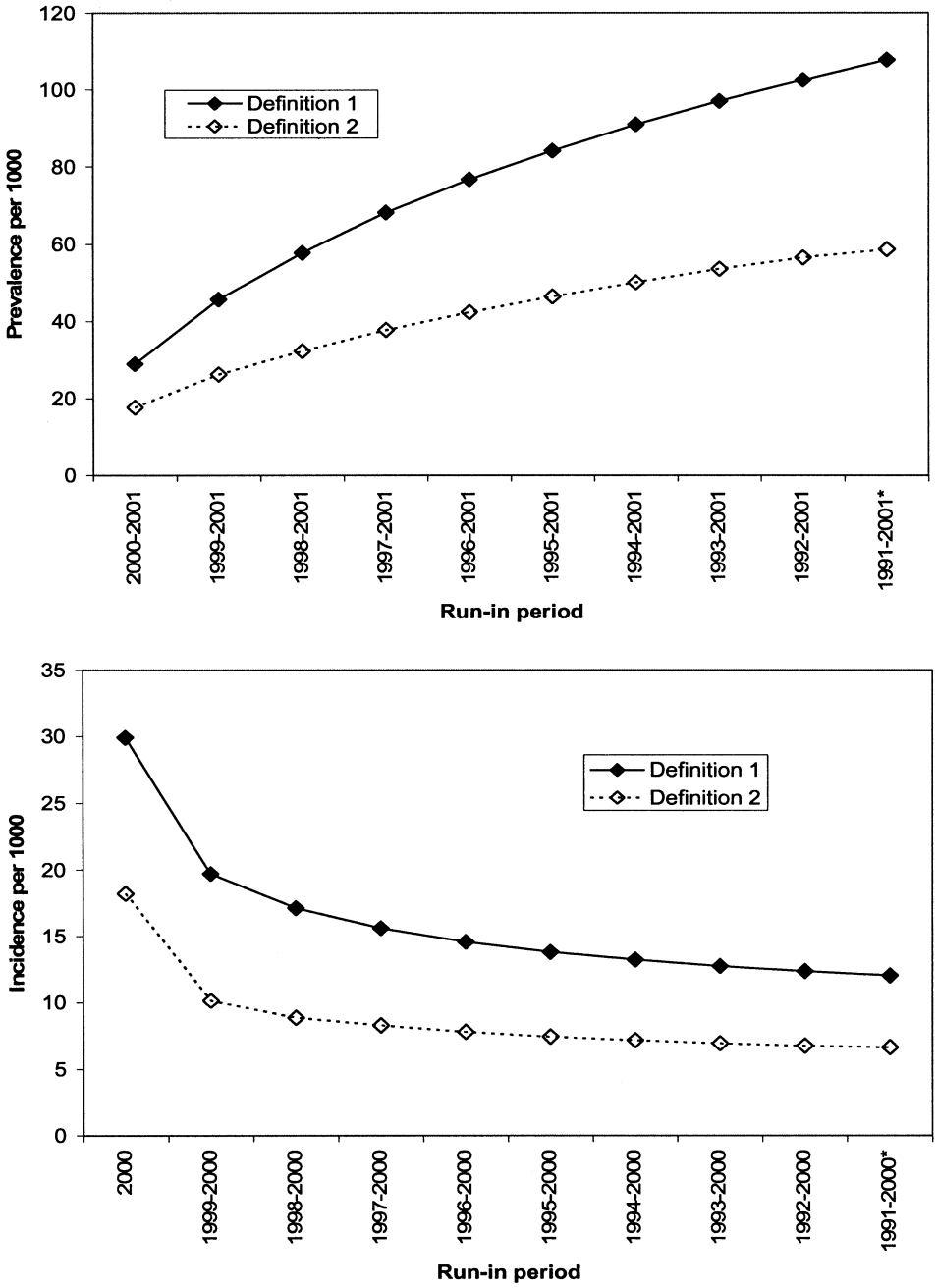


*Figure 2*. Sensitivity analysis of the effect of run-in period on prevalence and incidence of OA in BC. For incidence (lower panel), the initial run-in period (year 2000) is 0 years, indicating no exclusion of prevalent cases. The run-in period used in the primary analyses is marked by asterisks. For OA definitions please see the note to Figure 1.

our data with estimates based on radiographic diagnosis would not be appropriate. In epidemiological studies, a common definition of OA is one that combines radiographic changes and symptoms. No such studies have been carried out in Canada. In the US, Felson and Zhang[4] estimated that symptomatic knee OA with radiographic changes is present in about 6% of the population 30 years of age and older, and hip OA is present in about 3%. In our database, prevalence of OA in this age group was 17%, i.e., much higher. This is to be expected, as our definition included all joints and did not require radiographic confirmation.

Prevalence of OA in an administrative database in Massachusetts has been studied by Harrold, *et al*[13]. They observed a prevalence of 8.7% for all forms of OA combined in persons 18 years of age and older, 6.8% in men and 10.3% in women, i.e., significantly lower than our estimate of about

*Table 3.* Prevalence of osteoarthritis on March 31, 2001 and incidence in 2000–2001 in British Columbia according to lower age cutoff.

| Population | Prevalence (%) | Incidence per 1000 person-yrs |
|---|---|---|
| All ages | 10.8 | 11.7 |
| 10 years of age and older | 12.2 | 13.5 |
| 15 years of age and older | 13.1 | 14.7 |
| 20 years of age and older | 14.3 | 16.2 |
| 25 years of age and older | 15.6 | 17.8 |
| 30 years of age and older | 17.0 | 19.6 |
| 35 years of age and older | 18.9 | 22.1 |
| 40 years of age and older | 21.5 | 25.4 |
| 45 years of age and older | 24.8 | 29.7 |
| 50 years of age and older | 28.8 | 34.6 |

Prevalence and incidence in persons aged 0–19 is assumed to be 0.

14% in the same age group. It should be noted that the run-in period in their study was only 3 years. Our data indicate that this could result in underestimating prevalence by more than 40%. Harrold, *et al* performed a validation study that suggested a higher prevalence of OA based on medical records, compared with administratively coded OA.

Prevalence of OA in an administrative database could be compared to self-reported prevalence. However, most surveys report only the prevalence of arthritis or rheumatism. In the 2000-01 Canadian Community Health Survey, 14.5% of respondents 12 years of age and older in BC reported any "arthritis or rheumatism" diagnosed by a health professional, and 7.4% reported OA (CCHS public use file, unpublished data). The 1989/91 National Health Interview Survey in the USA reported a 15% prevalence of any arthritis in the general adult population[2]. Surveys in Australia, UK, and other European countries reported similar prevalence[17-19]. In a recent US study, 23% of adult respondents were told by a physician they had arthritis and an additional 10% had chronic joint symptoms[20].

In contrast to prevalence, data on the incidence of OA are limited. Comparing our data with the incidence of radiographic OA in cohort studies would not be meaningful due to differences in OA definitions. The most representative study of OA incidence in the US is the study by Oliveria, *et al* in Fallon County, Massachusetts[7]. Their definition of OA required an administrative diagnosis verified by radiograph plus symptoms recorded in the patient's chart. The incidence rates were lower than reported here, as one would expect, and were 0.9 per 1000 person-years for hip OA, 2.4 for knee OA, and 1.0 for hand OA. The authors did not report how many subjects diagnosed with OA in the database lacked radiographic confirmation.

In Canada, incidence rates of self-reported arthritis/rheumatism in the household population aged 40 or older were estimated at 31 and 48 per 1000 person-years for men and women, respectively[12]. In our data, the estimates of OA incidence for the same age cutoff were 21 per 1000 person-years for men and 29 for women.

The estimated overall prevalence of OA in our study is somewhat lower than self-reported prevalence of arthritis/rheumatism from several population surveys in Canada, US, and other countries. However, it is higher than self-reported prevalence of OA in the CCHS. Our estimate of OA incidence is lower than survey-based incidence of arthritis/rheumatism in Canada. These observations are epidemiologically plausible. We would expect lower estimates for OA compared to arthritis/rheumatism. We would also expect that a large proportion of persons reporting arthritis have OA. The accuracy of self-report for OA is unknown. It is possible that a significant number of those diagnosed with OA would report other types of arthritis.

The relationships of OA with age and sex in our study are similar to those observed in the majority of other studies. The relationship with age is characterized by an approximately exponential increase between ages 20 and 50 and a linear increase between ages 50 and 80. The rates are higher in women in general, and there is an interaction between age and sex, with a clear separation of the curves for men and women around the time of menopause. There is no evidence in our data that prevalence of OA stabilizes after age 80. Incidence rates among persons 85 years of age and older tend to flatten and display significant fluctuations. A similar finding was reported by Oliveria, *et al*[7]. This may be due to a relatively small number of cases, inaccuracy in estimating population denominators, coding issues in persons with multiple comorbidities (competing diagnoses), or fewer symptoms due to less physical activity[7]. Therefore, estimates of OA incidence in the very old should be treated with caution.

In our study, the male-to-female prevalence ratio was 0.70. Harrold, *et al* found a ratio of 0.67[13]. A recent metaanalysis reported a male-to-female ratio of 0.69 for clinically defined OA[21]. Radiographic studies, on the other hand, generally showed a smaller difference between men and women for all types of OA combined but a greater difference for knee and hand OA[21].

The most important limitation of our study is that the accuracy of the diagnosis and coding of OA in our database are unknown. False negatives may occur because a person with OA does not see a doctor, is not properly diagnosed, or is given a wrong diagnostic code by mistake. In addition, in a patient who has a comorbid condition requiring monitoring, that condition may be coded as the main reason for the visit. False positives may occur because of misdiagnosis or coding errors. In particular, a preliminary diagnosis of OA may later turn out to be incorrect. The only study to provide an estimate of positive predictive value (PPV) of administratively coded OA in the general population is that by Harrold, *et al*, which estimated PPV at 62%[13]. The authors did not report sensitivity, but their data suggested a low sensitivity of about 40%. This may be due to a short run-in time in their study. More

research on the accuracy of OA definition in administrative data is needed.

It may be noted that the estimate of prevalence is unbiased if sensitivity = PPV; prevalence is overestimated if sensitivity > PPV and underestimated if sensitivity < PPV. Unfortunately, we do not have data on the sensitivity/PPV ratio in our database. Since PPV depends on prevalence as well as sensitivity and specificity, the sensitivity/PPV ratio is likely to vary across age-sex groups. In groups with very low prevalence, such as children and young adults, PPV tends to be low and estimates of prevalence from administrative data would be inflated due to a relatively large proportion of false positives. For this reason we do not report age-specific rates for persons under the age of 20 years.

Using an alternative definition (Definition 2) that required 2 visits for OA within 2 years resulted in a dramatic, almost 2-fold decrease in both prevalence and incidence. It seems likely that this alternative definition has a higher specificity and PPV, but lower sensitivity. For some epidemiological studies, a more specific definition may be desirable to reduce the effect of measurement error[22]. However, for studies aimed at estimating overall population incidence and prevalence of OA, the best definition is one that balances false positives and false negatives. Comparisons with other studies suggest that our Definition 1 may be more appropriate for this purpose, although more validation studies are needed.

There is some additional inaccuracy in our estimates of both prevalence and incidence resulting from the duration of the run-in period, as demonstrated by the sensitivity analysis. Prevalence estimates based on a 10-year run-in are underestimated and incidence rates based on a 9-year run-in are slightly overestimated. In addition, the run-in period was shorter for people who immigrated to BC during the observation period. Between 1991 and 2001, net immigration to BC has been estimated at about 440,000[23]. Analyses of the MSP registration time showed that 61% of the population were observed for 10 years and 87% were observed for 5 years or longer. The effect of immigration was roughly equivalent to reducing the run-in time for the whole population by 1–2 years.

Accurate estimates of the number of persons with OA, especially those seeking treatment, are important for health services planning. Information about incidence is critical from a public health point of view because incidence rates change faster than prevalence in response to changes in the distribution of risk factors in the population, and are not influenced by disease duration. Our study provided detailed estimates of the prevalence and incidence of OA by age and sex in a large geographically defined population. As one would expect, prevalence estimates were significantly higher than previously reported prevalence of symptomatic plus radiographic OA, and slightly lower than self-reported prevalence of arthritis/rheumatism. The relationships with age and sex were similar to those previously found. Our study also demonstrated a strong effect of disease definition and run-in period on both incidence and prevalence of OA. These results underscore the importance of the chosen definition of OA in any study that uses data collected for administrative purposes. More validation studies of different definitions of OA are needed. Ideally, such studies would link administrative data with self-reports and with information from medical records. Nevertheless, our data are epidemiologically plausible and suggest that administrative databases represent a useful potential source of information for OA surveillance.

## REFERENCES


1. Murray CJL, Lopez AD. The global burden of disease in 1990: final results and their sensitivity to alternative epidemiological perspectives, discount rates, age weights and disability weights. In: Murray JL, Lopez AD, editors. The global burden of disease. Geneva: WHO, Harvard School of Public Health; 1996.
2. Lawrence RC, Helmick CG, Arnett FC, et al. Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. Arthritis Rheum 1998;41:778-99.
3. Badley EM, Wang PP. Arthritis and the aging population: projections of arthritis prevalence in Canada 1991 to 2031. J Rheumatol 1998;25:138-44.
4. Felson DT, Zhang Y. An update on the epidemiology of knee and hip osteoarthritis with a view to prevention. Arthritis Rheum 1998;41:1343-55.
5. Sun Y, Sturmer T, Gunther KP, Brenner H. Incidence and prevalence of cox- and gonarthrosis in the general population. Z Orthop Ihre Grenzgeb 1997;135:184-92.
6. Wilson MG, Michet CJ Jr, Ilstrup DM, Melton LJ 3rd. Idiopathic symptomatic osteoarthritis of the hip and knee: a population-based incidence study. Mayo Clin Proc 1990;65:1214-21.
7. Oliveria SA, Felson DT, Reed JI, Cirillo PA, Walker AM. Incidence of symptomatic hand, hip, and knee osteoarthritis among patients in a health maintenance organization. Arthritis Rheum 1995;38:1134-41.
8. Felson DT, Zhang Y, Hannan MT, et al. The incidence and natural history of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study. Arthritis Rheum 1995;38:1500-5.
9. Lachance L, Sowers MF, Jamadar D, Hochberg M. The natural history of emergent osteoarthritis of the knee in women. Osteoarthritis Cartilage 2002;10:849-54.
10. Cooper C, Snow S, McAlindon TE, et al. Risk factors for the incidence and progression of radiographic knee osteoarthritis. Arthritis Rheum 2000;43:995-1000.
11. Reijman M, Pols HA, Bergink AP, et al. Body mass index associated with onset and progression of osteoarthritis of the knee but not of the hip. The Rotterdam Study. Ann Rheum Dis 2006 Jul 12; (epub ahead of print).
12. Wilkins K. Incident arthritis in relation to excess weight. Health Rep 2004;15:39-49.
13. Harrold LR, Yood RA, Andrade SE, et al. Evaluating the predictive value of osteoarthritis diagnoses in an administrative database. Arthritis Rheum 2000;43:1881-5.
14. Gordis L. Epidemiology. 3rd ed. Philadelphia: WB Saunders Co.; 2004.
15. Duncan RC, Hay EM, Saklatvala J, Croft PR. Prevalence of radiographic osteoarthritis — it all depends on your point of view. Rheumatology Oxford 2006;45:757-60.
16. Hannan MT, Felson DT, Pincus T. Analysis of the discordance between radiographic changes and knee pain in osteoarthritis of the knee. J Rheumatol 2000;27:1513-7.
17. March LM, Bagga H. Epidemiology of osteoarthritis in Australia. Med J Aust 2004;180 Suppl:S6-10.

18. Arden N, Nevitt MC. Osteoarthritis: epidemiology. Best Pract Res Clin Rheumatol 2006;20:3-25.
19. Picavet HS, Hazes JM. Prevalence of self reported musculoskeletal diseases is high. Ann Rheum Dis 2003;62:644-50.
20. Centers for Disease Control and Prevention (CDC). Prevalence of self-reported arthritis or chronic joint symptoms among adults — United States, 2001. MMWR Morb Mortal Wkly Rep 2002;51:948-50.
21. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage 2005;13:769-81.
22. Armstrong BK, White E, Saracci R. Principles of exposure measurement in epidemiology. Oxford: Oxford University Press; 1995.
23. Vital Statistics Agency of British Columbia. British Columbia regional district migration components. Available at: http://www.bcstats.gov.bc.ca/data/pop/mig/comp_RD1.pdf (accessed October 2, 2006).