# Osteoarthritis in Family Physician Practices in Canada: A Report of the Canadian Primary Care Sentinel Surveillance Network (CPCSSN)

Richard Birtwhistle MD[1, 2], Rachael Morkem MSc[1], George Peat PhD[3], Tyler Williamson PhD[4], Michael E. Green MD[1, 2], Shahriar Khan MSc[1], Kelvin P Jordan PhD[3]

[1] Centre for Studies in Primary Care, Department of Family Medicine, Queen's University, Kingston, Ontario

[2] Department of Public Health Sciences, Queen's University, Kingston, Ontario

[3]Arthiritis Research UK Primary Care Centre, Institute for Primary Care Sciences, Keele University, Staffordshire, United Kingdom

[4] Department of Community Health Sciences, University of Calgary, Calgary, Alberta



Corresponding Author:

Rachael Morkem
220 Bagot St,
Kingston, ON, K7L 5E9
Phone: 613-533-9300 ext 79567
Fax: 613-533-9302
Email: rachael.morkem@dfm.queensu.ca

## ABSTRACT

**Background:** Osteoarthritis (OA) is a common chronic condition that affects a large proportion of the older Canadians and is a major source of disability. The objective of this study is to describe the primary care epidemiology of OA using electronic medical records (EMR) in the Canadian population.

**Methods:** We analyzed the electronic medical records (EMR) from 207,610 patients over 30 years of age extracted on December 31, 2012 who had at least one clinic visit in the last 2 years. We calculated the age-gender standardized EMR prevalence of OA and its association with co-morbidities and covariates available in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) database.

**Results:** The estimated prevalence of OA found was 14.2% (15.6% women, 12.4% men). OA was associated with other comorbidities such as hypertension (PR 1.17, 95% CI [1.15-1.18]), depression (PR 1.26, 95% CI [1.22-1.3]), chronic obstructive pulmonary disease (COPD) (PR 1.16, 95% CI [1.11-1.21]) and epilepsy (PR 1.27, 95% CI [1.13-1.43]). We also found that 56.6% of patients received a prescription for a range of nonsteroidal anti-inflammatory drugs (NSAID), 45% of which were topical NSAIDs. Opioid medications were prescribed to 33% of patients for pain.

**Conclusions:** This study is the first to report on the diagnosis of OA using primary care EMR data in Canada. Many patients are being treated with narcotic analgesics which may increase risk of fall and injury in these patients. Primary care EMR data can be a valuable tool for the ongoing assessment of chronic disease, risk factors and management.

## INTRODUCTION

Osteoarthritis (OA) is a common chronic condition affecting a large proportion of older Canadians and is a major source of disability[1] . It is the most common form of arthritis and is frequently diagnosed and managed in primary care.[2] As the Canadian population ages, the burden of OA on the healthcare system will increase and we must look at trends in risk factors, diagnosis and management.

International reports on the prevalence of OA show an increasing number of patients being diagnosed with OA.[3] This is predominantly due to an increase in people over 60 years and an increase in obesity, a leading risk factor for OA.[4-7] A number of previous studies have provided information about the state of OA in Canada.[7-11] In British Columbia, Canada an overall prevalence of 10.8% was found using administrative data and by age 70-74 years, 30% of men and 40% of women had OA. A study of OA in Ontario, Canada linked survey data with administrative data and found that quality of life was 10-25% lower in the OA population and healthcare costs were 2-3 times higher than in the non-OA group.[10] These studies demonstrate the high prevalence, reduction in quality of life and economic burden associated with OA in Canada.

These studies of arthritis in Canada come from surveys, administrative data and reporting systems.[8-12] However, findings are often inconsistent and difficult to compare due to variations in design and methods.[12, 13] Determining the prevalence of osteoarthritis can be difficult as the estimates are sensitive to (a) the case definition of OA, (b) the period used to estimate the period prevalence, and (c) the denominator population, specifically the exclusion of very young ages. In 2012 a Canadian group (CANRAD network), collaborating with international experts, developed

a consensus statement for using administrative data to study rheumatic disease in order to improve the consistency and value of this data for arthritis research.[14] While this provides some continuity and comparability of findings from administrative data, primary care electronic medical record (EMR) data can provide a complementary source of information for occurrence estimates, workload, case profile (including comorbidities), and patterns of OA in primary care. Direct clinical information on comorbidities, medications, weight, blood pressure and other risk factors as well as the longitudinal nature of these data are all important information that primary care EMR data can contribute.

The current study uses a new source of health data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN). CPCSSN is Canada's first multi-disease EMR-based surveillance system that collects longitudinal data on over half a million patients from 600 primary care practices across Canada. We have developed validated case definitions for eight chronic conditions, including OA, which takes into account prescribed medications, billing codes, lab tests and multiple ICD- 9 diagnostic codes to find cases.[15, 16] CPCSSN is a primary care network made up of 11 practice based research networks in 7 provinces and 1 territory in Canada that extracts patient data from 12 different EMR vendor products. The details of the data extraction procedures have been previously described.[17, 18] Previous work has shown that the population of patients within CPCSSN is broadly representative of the primary care population in Canada.[19]

The objective of this paper is to: (1) estimate the prevalence of OA recorded in the EMR in men and women, (2) assess the association of OA with co-morbidities and potential risk factors, and (3) describing the pattern of medication prescription for people with OA in primary care.

## METHODS

This study evaluated EMR data on over 600,000 patients contributed by 340 primary care providers participating in the CPCSSN at the time this study was done.

### *Case Definition*

A CPCSSN diagnosis of osteoarthritis includes osteoarthritis and allied disorders as well as spondylosis and allied disorders such as kissing spine and ankylosing vertebral hyperostosis. It excludes intervertebral disc disorders, ankylosing spondylitis and other inflammatory spondylopathies and spinal stenosis. The algorithm identifies an OA case as any occurrence of ICD-9 codes 715 or 721 in the billing table or the problem list/encounter table. In a CPCSSN validation study this case definition for OA had a sensitivity of 77.8% (95% CI 74.5-81.1), positive predictive value of 87.7% (95% CI 84.9-90.5) and a negative predictive value of 90.2 (95% CI 88.7-91.8) when compared to the reference standard of independent chart abstraction.[15,16]

### *Study Population*

The study population consisted of any patient 30 years of age and older by December 31, 2012, who had at least one encounter with their provider's practice in the previous 24 months and who did not opt out of participation in CPCSSN. We eliminated those younger than 30 years because OA is an age related condition with very low rates under 30 years of age. A 24 month contact period was used because most patients with a chronic condition will visit their primary care provider at least once in two years.[20] Patients identified as having osteoarthritis, based on the CPCSSN case criteria at any point in their available EMR record were included for analysis and compared to those without a diagnosis of OA.[14, 15]

*Statistical Methods*

We used descriptive statistics and multivariate modeling using the statistics software SAS® version 9.3.

We calculated the prevalence estimate of osteoarthritis in the two-year contact group by age and gender. We also did direct age-sex standardized prevalence estimates according to Canadian national age-sex distribution (Census 2011). We then calculated prevalence ratios of three risk factors: patient's rurality (determined by the middle digit of the first three digits of postal code, if the digit was a "0", then we defined it to be a rural location, otherwise, it was an urban location), BMI (underweight: BMI<18, normal: 18≤BMI<25, overweight: 25≤BMI<30 and obese≥30), and smoking (never, past, current). Three separate log-binomial regression analyses were carried out to calculate prevalence ratios, each controlling for age and sex of the study population.[21] Along with prevalence ratios, the corresponding 95% confidence intervals (CI) and p-values were reported.

The presence of other CPCSSN comorbid conditions were analyzed, adjusting for age and sex, using the same log-binomial approach and then expressing the results in terms of prevalence ratios, 95% CI and p-values. In addition, we looked at the cumulative proportion of patients diagnosed with one or more of the other CPCSSN chronic diseases, in patients with the diagnosis of OA.

Medication data was assessed by analyzing the pattern of medication use by patients diagnosed with OA. In this report, medication use means that there is at least one prescription for that medication prescribed for the patient at any time in their EMR.

CPCSSN received ethics approval from the Research Ethics Boards (REB) of each host university for all networks and from the Health Canada REB.

## RESULTS

We found 207,610 patients over 30 years of age who had at least one clinic visit in the 2 year period preceding December 31, 2012. Our case definition identified 29,562 patients with a diagnosis of OA at any time in their records. The prevalence of OA by age and sex is presented in Table 1 and Figure 1. There is a marked increase in OA prevalence with age, with female estimates being higher than males in each age group. The overall prevalence of OA was 14.2% (95% CI [14.1-14.4]), rising from 1.6% (95% CI [1.5-1.8]) in those aged 30-39 to 35.1% (95% CI [34.4-35.8]) in those aged 80 and over.

The effect of location, BMI and smoking on OA risk are presented in Table 2. In the regression model the risk of osteoarthritis was comparable for those in urban versus rural locations. However, there was a significant increase in the risk of osteoarthritis for those underweight or obese compared to those within the normal weight class. While only 41.3% of the study population had any smoking data in their medical records, there was a small but significant decrease in the risk of osteoarthritis for current smokers compared to those who had never smoked.

Table 3 presents the association of each of seven comorbid CPCSSN-defined conditions with OA diagnosis. We found that patients with osteoarthritis had no significant increased risk of diabetes, dementia or Parkinsonism but did have an increased risk of hypertension, depression, chronic obstructive pulmonary disease (COPD) and epilepsy. Evaluation of multimorbidity, shown in Table 4, reveals that 67.7% of those with OA, versus 43% of those without OA, have at least one of the other CPCSSN-defined chronic conditions.

More than half of those with OA had been prescribed a non-steroidal anti-inflammatory drug (NSAID), about one third had been prescribed a narcotic (Table 5). Only 25% of OA patients had been prescribed the over-the-counter (OTC) medication Acetaminophen. This probably is underreported because OTC medications are not often captured in the EMR medication field.

## DISCUSSION

This study presents a cross-sectional evaluation of OA prevalence, its associations with potential risk factors and its management in primary care using EMR data from CPCSSN. This study is the first in Canada to describe OA using primary care EMR data.

There is wide variation in the prevalence of osteoarthritis reported in previous research as the estimates are dependent on the sample population, the case definition of OA and the joint involved.[13, 22, 23] Previous Canadian studies focused on quantifying the burden of OA and its association to other conditions such as obesity and cardiovascular disease. Two studies that used data from the Canadian Community Health Survey (CCHS) evaluated arthritis and its association to other conditions. De Angelis et al described arthritis, but did not specify osteoarthritis, and its association to obesity in a sample of patients 18 years and older and found that obesity and female sex increase the risk of arthritis prevalence.[7] Rahman et al assessed osteoarthritis in a sample of patients 20 years and older and found that OA was significantly associated with heart disease, angina and CHF in both men and women.[9] One of the only general descriptive epidemiological studies on a Canadian population was conducted in British Columba using administrative billing data and detected OA cases. Although their study population included patients of all ages they assumed the rate OA cases in those under 20 years to be 0 when calculating population rates. The sensitivity analysis showed that their estimates were greatly

dependent on the definition of OA and the observation period.

A study conducted in Manitoba, Canada used administrative data to determine the crude cross-sectional prevalence of OA by defining multiple arthritis algorithms to determine their estimates. Some of their algorithms (physician billing, hospital billing and prescription data) produced estimates that were similar to the ones found in our study.[24]

While this study's methods and estimates vary from previous Canadian OA estimates, they are similar to those found in international studies that evaluated osteoarthritis prevalence using primary care data. In primary care studies that restricted the population to adults, prevalence estimates ranged from 16.4 to 42.6 per 1000 in the UK and 23.2 and 35.3 per 1000 in Dutch and US studies respectively.[25-27] These international estimates support our findings and use of CPCSSN data for osteoarthritis surveillance in Canada.

In primary care, osteoarthritis is both under diagnosed and over diagnosed.[28, 29] As an example there are many patients who have joint pain thought to be osteoarthritis that have no radiological confirmation. As well there are patients who have OA who do not raise it as a concern with their physicians. In our study the case definition included all patients with an EMR diagnosis of OA and without specifying a particular joint involved. We found estimates that were higher in both men and women than estimates from administrative data. Administrative data may have lower estimates because cases are identified using only billing data and this may be restricted to one diagnostic code per visit. If OA was not the main reason for visit it may not appear. Our OA case definition included billing data and the problem list or health condition. Another reason our estimates may be higher than other studies is the use of a case definition restricted to radiologically confirmed OA.[13] Our study uses primary care data and general practitioners often make the diagnosis without radiological confirmation. Further, differences in

OA prevalence in self-report and surveys compared to our prevalence estimates from EMR data may be that patients over report joint pain as arthritis.

While there was no association between rurality and OA, smoking appears to have a small protective effect, with current smokers having a 10% reduction in OA risk. Previous studies are conflicting on the association between smoking and OA. However, two recent meta-analyses of observational studies found no compelling evidence that smoking has a protective effect on the progression of OA and the association only remained true in some case-control studies.[30, 31] As more than half of our population are missing smoking documentation this finding may be a result of measurement and selection bias.

The known association of OA with BMI in our study although prevalence ratios were lower than DeAngelis found using CCHS data.[7] We also found an association of OA with BMI measurements considered underweight, which further exploration.[10]

Previous research has found associations between OA and myocardial infarction and congestive heart failure.[29] While we did not assess these associations we found significant association with other chronic conditions such as depression, COPD and epilepsy. However there was no association with diabetes, dementia or Parkinson's disease. We found that patients with OA had an increased level of multi-morbidity. A study using primary care data in the UK also found extensive comorbidity with OA, even after controlling for age, sex and socioeconomic status, but did state that propensity to consult may be part of the explanation.[32] It is likely that this selection bias plays a role in our findings.

While NSAIDs were frequently prescribed to our study population, the number of patients with acetaminophen, ibuprofen and naproxen prescriptions was much lower. This is not surprising since these drugs are available over the counter in Canada. Lawson et al recently

showed that medications and complementary and alternative medicines are frequently used by the elderly for OA.[32] We also found that many patients with OA were receiving opioids for pain which is consistent with findings from UK primary care.[34]

*Limitations*

This study may not represent the full range of patients and providers as CPCSSN is made up of a selected sample of family physicians who use EMRs. When compared to respondents of the 2010 National Physician Survey (NPS) CPCSSN practitioners were slightly younger and a higher proportion of females but the geographic distribution of the practices were similar to that of the NPS.[36, 37] While the case definition has been validated for OA in the CPCSSN population, there is the potential for misclassification. It is unclear how family doctors diagnose and chart OA . It is likely that some patients with OA will not bring their joint pain to the attention of their family doctor and will be misclassified. OA may also be diagnosed incidentally on imaging for other symptoms in people without symptoms. In this study we evaluated medications recorded at any time within the EMR. This would introduce some misclassification as the medications may been prescribed before or after the onset of OA. Data discipline is variable among primary care providers which could lead to some misclassification due to recording bias.

Despite these limitations this study is the first to evaluate osteoarthritis in Canadian primary care using EMR data. OA has a gradual onset and is often first diagnosed by primary care providers. It follows that primary care data, specifically CPCSSN data, is a good source of information to evaluate the prevalence, progression and treatment of osteoarthritis in Canada.

## REFERENCES


1. Vos T, Flaxman AD, Naghavi M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* 2012;380(9859):2163-2196.
2. Hootman JM, Helmick CG. Projections of US prevalence of arthritis and associated activity limitations. *Arthritis Rheum.* 2006;54(1):226-229.
3. Haq I, Murphy E, Dacre J. Osteoarthritis. *Postgrad Med J.* 2003;79:377-383.
4. Lawrence RC, Felson DT, Helmick CG, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. *Arthritis Rheum.* 2008;58(1):26-35.
5. Hsiao CJ, Cherry DK, Beatty PC, Rechtsteiner EA. National Ambulatory Medical Care Survey: 2007 summary. *Natl Health Stat Report.* 2010(27):1-32.
6. Badley EM, Wang PP. Arthritis and the aging population: projections of arthritis prevalence in Canada 1991 to 2031. *J Rheumatol.* 1998;25(1):138-144.
7. De Angelis G, Chen Y. Obesity among women may increase the risk of arthritis: observations from the Canadian Community Health Survey, 2007-2008. *Rheumatol Int.* 2013;33(9):2249-2253.
8. Kopec JA, Rahman MM, Berthelot JM, et al. Descriptive epidemiology of osteoarthritis in British Columbia, Canada. *J Rheumatol.* 2007;34(2):386-393.
9. Rahman MM, Kopek JA, Cibere J, Goldsmith CH, Anis AH. The relationship between osteoarthritis and cardiovascular disease in a population health survey: a cross-sectional study. *BMJ Open*. 2013;3:e002624.
10. Tarride JE, Haq M, O'Reilly DJ, et al. The excess burden of osteoarthritis in the province of Ontario, Canada. *Arthritis Rheum.* 2012;64(4):1153-1161.
11. Gariepy G, Rossignol M, Lippman A. Characteristics of subjects self-reporting arthritis in a population health survey: distinguishing between types of arthritis. *Can J Public Health.* 2009;100(6):467-471.
12. Hirdes JP, Poss JW, Caldarelli H, et al. An evaluation of data quality in Canada's Continuing Care Reporting System (CCRS): secondary analyses of Ontario data submitted between 1996 and 2011. *BMC Med Inform Decis Mak.* 2013;13:27.
13. Pereira D, Peleteiro B, Araújo J, Branco J, Santos RA, Ramos E. The effect of osteoarthritis definition on prevalence and incidence estimates: a systematic review. *Osteoarthritis Cartilage.* 2011;19(11):1270-1285.

14. Bernatsky S, Lix L, O'Donnell S, Lacaille D, Network C. Consensus statements for the use of administrative health data in rheumatic disease research and surveillance. *J Rheumatol.* 2013;40(1):66-73.
15. Kadhim-Saleh A, Green M, Williamson T, Hunter D, Birtwhistle R. Validation of the diagnostic algorithms for 5 chronic conditions in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN): a Kingston Practice-based Research Network (PBRN) report. *J Am Board Fam Med.* 2013;26(2):159-167.
16. Williamson T, Green ME, Birtwhistle R, et al. Validating the 8 CPCSSN case definitions for chronic disease surveillance in a primary care database of electronic health records. *Ann Fam Med.* 2014;12(4):367-372.
17. Birtwhistle RV. Canadian Primary Care Sentinel Surveillance Network: a developing resource for family medicine and public health. *Can Fam Physician.* 2011;57(10):1219-1220.
18. Birtwhistle R, Keshavjee K, Lambert-Lanning A, et al. Building a pan-Canadian primary care sentinel surveillance network: initial development and moving forward. *J Am Board Fam Med.* 2009;22:412-22.
19. Williamson T, Lambert-Lanning A, Martin K, Leggett J, Morkem R, Khan S, Birtwhistle R. Primary Health Care Intelligence: The Canadian Primary Care Sentinel Surveillance Network (CPCSSN) 2013 Annual Report. October 15, 2013.
20. Sibley LM, Moineddin R, Agha MM, Glazier RH. Risk adjustment using administrative data-based and survey-derived methods for explaining physician utilization. *Med Care*. 2009;48:175-82.
21. Williamson T, Eliasziw M, Hilton Fick, G. Log-binomial models: exploring failed convergence. *Emerging Themes in Epidemiology*. 2013;10:14.
22. Douglas G Manuel, Laura C Rosella, Thérèse A Stukel. Importance of accurately identifying chronic disease in studies using electronic health records. *Br Med J.* 2010;**341**(7770):440.
23. Green ME**,** Hogg W, Johnston S, Savage C, Glazier R et al. Assessing methods for measurement of clinical outcomes and performance in primary care practices. *BMC Health Services Research,* 2012; **12**:214
24. Lix L, Yogendran M, Burchill C, Metge C, McKeen N, Moore D, Bond R. Defining and Validating Chronic Diseases: An Administrative Data Approach. Winnipeg, Manitoba Centre for Health Policy, July 2006.
25. Jordan K, Clarke AM, Symmons DP, Fleming D, Porcheret M, Kadam UT, Croft P. Measuring disease prevalence: a comparison of musculoskeletal disease using four general practice consultation databases. *Br J Gen Pract.*2007;57(534):7-14.

26. Westert GP, Schellevis FG, de Bakker DH, Groenewegen PP, Bensing JM, van der Zee J. Monitoring health inequalities through general practice: the Second Dutch National Survey of General Practice. *EUPHA*. 2005;15(1):59-65.
27. Jordan KP, Jöud A, Bergknut C, Croft P, Edwards JJ, Peat G, Petersson IF, Turkiewicz A, Wilkie R, Englund M. International comparisons of the consultation prevalence of musculoskeletal conditions using population-based healthcare data from England and Sweden. *Ann Rheum Dis*.2014;73(1):212-8.
28. Jackson JL, O'Malley PG, Kroenke K. Evaluation of Acute Knee Pain in Primary Care. *Ann Intern Med*. 2003;139;575-588.
29. Turkiewicz A, Gerdardsson de Verdier M, Engström G, Nilsson PM, Mellström C, Lohmander LS, Englund M. Prevalence of knee pain and knee OA in southern Sweden and the proportion that seeks medical care. *Rheumatology*. 2014. doi:10.1093/rheutmatology/keu409.
30. Hui M, Doherty M, Zhang W. Does smoking protect against osteoarthritis? Meta-analysis of observational studies. *Ann Rheum* Dis. 2011;70:1231-1237.
31. Pearce F, Hui M, Ding C, Doherty M, Zhang W. Does smoking reduce the progression of osteoarthritis? Meta-Analysis of Observational Studies. *Arthritis Care and Research*. 2013;65(7):1026-1033.
32. Kadam UT, Jordan K, Croft PR. Clinical comorbidity in patients with osteoarthritis: a case-control study of general practice consulters in England and Wales. *Ann Rheum Dis.* 2004;63(4):408-414.
33. Lawson B, Putnam W, Nicol K, et al. Managing osteoarthritis. Medication use among seniors in the community. *Can Fam Physician.* 2004;50:1664-1670.
34. Edwards JJ, Jordan KP, Peat G, Bedson J, Croft PR, Hay EM, Dziedzic KS. Quality of care for OA: the effect of a point-of-care consultation recording template.Rheumatology (Oxford). 2014 Oct 20. pii: keu411. [Epub ahead of print]
35. Rolita L, Spegman A, Tang X, Cronstein BN. Greater number of narcotic analgesic prescriptions for osteoarthritis is associated with falls and fractures in elderly adults. *J Am Geriatr Soc.* 2013;61(3):335-340.
36. Primary health care intelligence: 2013 progress report of the Canadian Primary Care Sentinel Surveillance Network (CPCSSN). Kingston, Ontario: Queen's University; 2013.
37. National Physician Survey. Ottawa: College of Physicians of Canada and Canadian Medical Association; 2010.

**Table 1 EMR prevalence of osteoarthritis by patient age and sex, CPCSSN 2012-Q4**

| Age group | Male | | Female | | All | |
|---|---|---|---|---|---|---|
| | % | n | % | n | % | n |
| 30-39 | 1.9 | 14516 | 1.5 | 23839 | 1.6 | 38355 |
| 40-49 | 4.9 | 17508 | 5.1 | 24836 | 5.0 | 42344 |
| 50-59 | 10.8 | 20562 | 14.0 | 26812 | 12.6 | 47374 |
| 60-69 | 16.7 | 17208 | 23.4 | 20798 | 20.4 | 38006 |
| 70-79 | 24.2 | 10446 | 32.7 | 13316 | 29.0 | 23762 |
| 80+ | 30.0 | 6832 | 38.2 | 10937 | 35.1 | 17769 |
| All ages | 12.4 | 87072 | 15.6 | 120538 | 14.2 | 207610 |



**Figure 1 EMR Prevalence of osteoarthritis by patient age and sex, CPCSSN 2012-Q4**

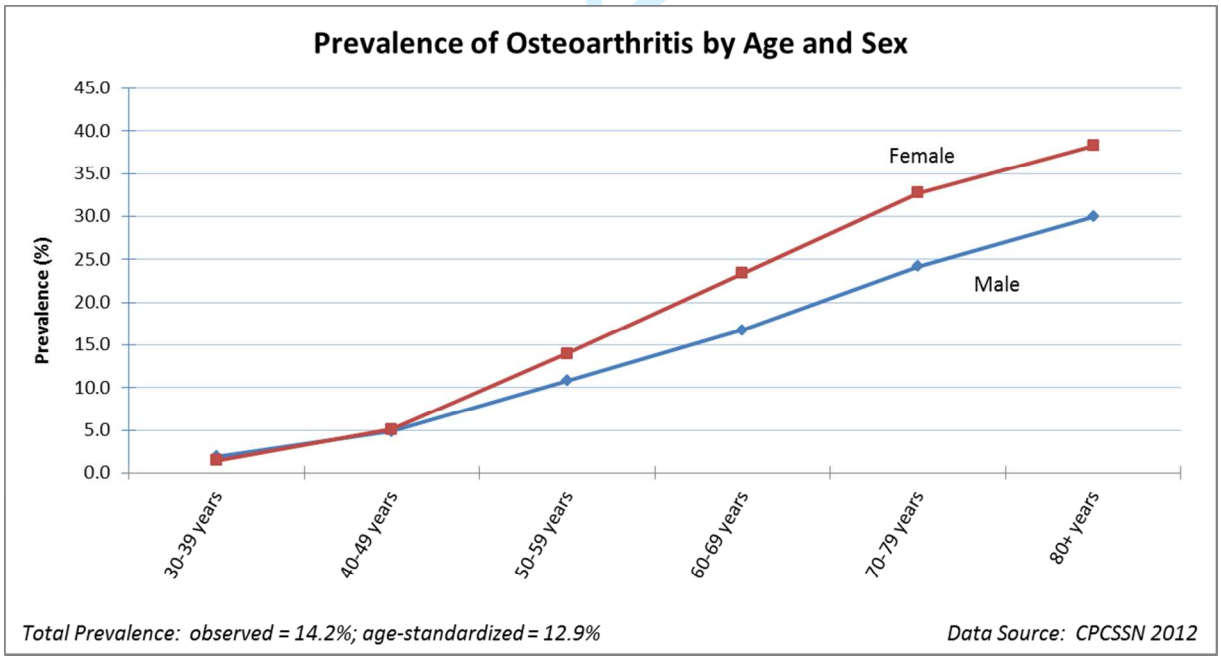

**Table 2 Age and sex adjusted prevalence ratio: A log-binomial approach (3 separate models)**

| Characteristics | Parameter Estimates | | | p |
|---|---|---|---|---|
| | Prev. Ratio | Lower 95% CI | Upper 95% CI | |
| **Location** (N=201718) | | | | |
| *Urban = ref* | *1* | -- | -- | -- |
| Rural | 0.99 | 0.964 | 1.010 | 0.273 |
| **BMI group** (N=136765) | | | | |
| Underweight (<18)** | 1.11 | 1.043 | 1.171 | <0.001 |
| *Normal (18-24) = ref* | *1* | -- | -- | -- |
| Overweight (25-29)* | 1.04 | 1.013 | 1.073 | 0.004 |
| Obese (>= 30)** | 1.14 | 1.107 | 1.172 | <0.001 |
| **Smoking** (N=85705) | | | | |
| *Never = ref* | *1* | -- | -- | -- |
| Past | 0.98 | 0.947 | 1.012 | 0.214 |
| Current** | 0.90 | 0.860 | 0.943 | <0.001 |

Note: Location missing 5892 (2.8%); BMI missing 70845 (34.1%); smoking missing 121905 (58.7%).

* p <0.01, ** p<0.001.

**Table 3 Comorbidity – age and sex adjusted prevalence ratio: A log-binomial approach**

| Comorbidity | Parameter Estimates | | | p |
|---|---|---|---|---|
| | Prev. Ratio | Lower 95% CI | Upper 95% CI | |
| Hypertension | 1.17 | 1.152 | 1.188 | <0.001 |
| Diabetes | 1.02 | 0.985 | 1.051 | NS |
| Depression | 1.26 | 1.220 | 1.299 | <0.001 |
| COPD | 1.16 | 1.107 | 1.213 | <0.001 |
| Dementia | 1.00 | 0.946 | 1.056 | NS |
| Epilepsy | 1.27 | 1.129 | 1.433 | <0.001 |
| Parkinsonism | 1.08 | 0.934 | 1.242 | NS |

Modeled the probability of each of the comorbid conditions, for which the predictor is OSTEOARTHRITIS (yes/no), along with age, sex and number of encounters in the last 2 years. Interpretation: Patients with osteoarthritis are 1.17 times as likely to have hypertension as those without osteoarthritis, and so on.

**Table 4 Multimorbidity: osteoarthritis by number of other conditions**

| # of other conditions | Osteoarthritis Present | Osteoarthritis Absent |
|---|---|---|
| 0 other condition | 32.3 | 57.0 |
| 1 other condition | 39.4 | 30.6 |
| 2 other conditions | 20.6 | 10.0 |
| 3 other conditions | 6.2 | 2.1 |
| 4+ other conditions | 1.5 | 0.3 |
| Total | 100.0 | 100.0 |
| N | (29562) | (178048) |



**Table 5 Use of medications by patients with osteoarthritis (N=29562)**

| Drug class | % | Drugs | % |
|---|---|---|---|
| Acetaminophen (alone and/or combo) | 25.1 | ACETAMINOPHEN alone | 16.0 |
| | | ACETAMINOPHEN combo | 9.1 |
| NSAIDs | 56.6 | CELECOXIB | 17.0 |
| | | DICLOFENAC | 29.6 |
| | | IBUPROFEN | 4.1 |
| | | MELOXICAM | 6.6 |
| | | NAPROXEN | 19.9 |
| | | Other NSAIDs* | 10.2 |
| Narcotics | 33.0 | CODEINE | 23.3 |
| | | HYDROCODONE | 1.6 |
| | | HYDROMORPHONE | 3.9 |
| | | MORPHINE | 2.7 |
| | | OXYCODONE | 5.0 |
| | | TRAMADOL | 7.8 |

* Other NSAIDs include DIFLUNISAL, ETODOLAC, FLOCTAFENINE, FLURBIPROFEN, INDOMETACIN, KETOPROFEN, KETOROLAC, LUMIRACOXIB, NABUMETONE, PIROXICAM, ROFECOXIB, SULINDAC, TIAPROFENIC ACID, VALDECOXIB

**Note**: There were 4808 patients with ATC code M01AB05 (Diclofenac) and about 45% were in the form of topical gel/cream.