Incident arthritis in relation to excess weight

Kathryn Wilkins

Abstract

Objectives

This article reports incidence rates of arthritis, based on data for people aged 40 or older who were followed over six years. The association between excess weight and arthritis, controlled for possible confounders, is also studied.

Data sources

Data are from the household components of cycle 1.1 of Statistics Canada's Canadian Community Health Survey (2000/01) and from the first four cycles of the National Population Health Survey (1994/95 to 2000/01).

Analytical techniques

The prevalence of arthritis in 2000/01 was estimated using cross-sectional data; 1994/95-to-2000/01 incidence density is based on longitudinal data. Logistic regression was used to study the association between excess weight and arthritis (respondent-reported, doctor-diagnosed), while controlling for age, household income, smoking, number of physician consultations, strenuous daily activity, and other factors.

Main results

In 2000/01, 19% of men and 31% of women aged 40 or older reported having been diagnosed with arthritis. Incidence rates of arthritis were 31 and 48 cases per 1,000 person-years for men and women, respectively. For both sexes, the odds ratio for obesity (based on self-reported height and weight) in association with subsequent arthritis was significantly elevated, at 1.6.

Key words

incidence, prevalence, predisposing factors, body mass index, longitudinal studies

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Arthritis is a major public health problem in Canada. It is a leading cause of chronic pain and mobility limitation, especially in older people.[1,2] And, as Canadians age, the rapid increase in the number with arthritis is imposing a growing burden on the health care system. Joint replacement, performed chiefly on people with arthritis, already accounts for sharply rising numbers of surgical procedures and hospital days of care.[3]

Various factors appear to give rise to arthritis, although the specific causal mechanisms are not yet fully understood. Research suggests that genetic, hormonal, and biomechanical or "wear and tear" influences are important.[4-15] Certain inherent factors that cannot be altered predispose some people to arthritis; for example, being female and having certain genetic traits. But other characteristics can be controlled. A better understanding of the role of currently recognized modifiable risk factors—the most important of which is obesity—offers the best potential for arthritis prevention.

This article presents estimates of the prevalence and incidence of respondent-reported, physician-diagnosed

Definitions

Data from cycle 1.1 of the Canadian Community Health Survey (CCHS) were used to calculate prevalence estimates of respondent-reported, diagnosed *arthritis* (see *What is arthritis?*). CCHS respondents were asked about "long-term health problems that have lasted or are expected to last six months or more and that have been diagnosed by a health professional." Specifically, the CCHS asked, "Do you have arthritis or rheumatism, excluding fibromyalgia?"

Incidence density estimates of arthritis, as well as relationships between selected characteristics and incident arthritis, were based on data from the National Population Health Survey (NPHS). The NPHS question, "Do you have arthritis or rheumatism?", did not explicitly exclude fibromyalgia; therefore, more people may have reported arthritis in the NPHS than in the CCHS.

For prevalence and incidence estimates of arthritis, *age* was grouped into five categories: 40 to 49, 50 to 59, 60 to 69, 70 to 79, and 80 or older. Age was used as a continuous variable in multivariate analysis.

Body mass index (BMI) is a measure of weight adjusted for height. In this analysis, BMI was derived from self-reports of weight and height. BMI is calculated by dividing weight in kilograms by the square of height in metres. Three categories were defined, based on the World Health Organization's standards:[16] acceptable (BMI less than 25.0), overweight (25.0 to 29.9) and obese (30.0 or more). BMI was not calculated for pregnant women.

Four *household income* groups, based on household size and total household income from all sources in the 12 months before the interview, were derived; these groups were not adjusted for regional differences in the cost of living.

Household income group	People in household	Total household income
Lowest	1 or 2	Less than $15,000
	3 or 4	Less than $20,000
	5 or more	Less than $30,000
Lower-middle	1 or 2	$15,000 to $29,999
	3 or 4	$20,000 to $39,999
	5 or more	$30,000 to $59,999
Upper-middle	1 or 2	$30,000 to $59,999
	3 or 4	$40,000 to $79,999
	5 or more	$60,000 to $79,999
Highest	1 or 2	$60,000 or more
	3 or more	$80,000 or more

Respondents were asked about their past and current cigarette consumption to establish *smoking status* as current (daily or occasional), former, or never smokers.

Level of physical activity during *leisure time* was based on total accumulated energy expenditure (EE). EE was calculated using the reported frequency and duration of a respondent's leisure-time physical activities in the three months before the cycle 1 interview and the metabolic energy demand of each activity.[17,18] Leisure time was classified as active (3.0 or more kilocalories per kilogram per day), moderately active (a value between 1.5 and 2.9 kcal/kg/day) or inactive (below 1.5 kcal/kg/day).

Daily lifting was assessed by asking, "Thinking back over the past three months, what best describes your usual daily activities or work habits?" A "yes" response to either "Usually lift or carry light loads" or "Do heavy work or carry very heavy loads" was defined as daily lifting.

Number of *physician visits* in the past year was assessed by asking respondents how many times they had consulted a physician; that is, a general practitioner, a family doctor, or other specialist. Two categories were established: 0 to 6, and 7 or more (upper 20% of the weighted distribution in 1994/95).

Psychological distress was based on a five-point scale response (all of the time = 4, most of the time = 3, some of the time = 2, a little of the time = 1, none of the time = 0) to the following: "During the past month, about how often did you feel:

- so sad that nothing could cheer you up?"
- nervous?"
- restless or fidgety?"
- hopeless?"
- worthless?"
- that everything was an effort?"

The range of possible scores was 0 to 24, with higher scores indicating more distress. For bivariate tabulations, scores for psychological distress were dichotomized: values of 0 through 5 indicated a low level of distress; scores of 6 or higher (the upper decile of the weighted distribution in 1994/95) indicated a high level. Psychological distress was used as a continuous variable in multivariate analysis.

Hormone replacement use was determined by the following questions, asked of all women aged 30 or older: "In the past month, did you take hormones for menopause or aging symptoms?" and "When did you start this hormone therapy?" Three categories were used for bivariate analysis: none, less than five years, and five years or more. For multivariate analysis, responses were grouped as none or less than five years; and five years or more.

Respondents were designated as proxies by convenience if, in cycle 1, 2 or 3, the NPHS General questionnaire (which contained the questions on chronic conditions) was answered by someone other than the selected respondent, but the Health questionnaire was answered by the selected respondent. This response pattern indicated that proxy reporting for the General section probably arose from the interviewer's convenience rather than from the selected respondent's unavailability.

arthritis among the Canadian household population aged 40 or older (see *Definitions*). Prevalence was estimated using cross-sectional, population-based data from the 2000/01 Canadian Community Health Survey (CCHS). The availability of longitudinal data on a panel of individuals followed over time in the biennial National Population Health Survey permitted estimates of incidence density over the 1994/95-to-2000/01 period. The analysis also quantifies the contribution of overweight and obesity to the risk of developing arthritis (see *Analytical techniques, Data sources* and *Limitations*). Because some research suggests that the relationship of excess weight to arthritis differs somewhat by

Analytical techniques

Incidence density—a measure of accumulated cases per person-years at risk—was calculated to estimate the incidence of arthritis.[19,20] This accounts for the reported disease status of respondents in each survey cycle. The numerator for the incidence density of arthritis was the number of new cases that accumulated; the denominator was the number of person-years contributed by the population at risk over the follow-up period. Rates were expressed as cases per 1,000 person-years at risk.

For calculation of incidence density, up to three records were produced for each respondent—one for each two-year interval (1994/95-to-1996/97, 1996/97-to-1998/99 and 1998/99-to-2000/01). For each period, a record was generated if the respondent was at least 40 years old and without arthritis at the beginning of the period, and if information on arthritis at the end of the two years was also available.

For the numerator, an incident case of arthritis was defined as a report of a diagnosis of the disease at the cycle 2, 3, or 4 National Population Health Survey (NPHS) interview from a respondent who had not reported having the disease in the previous cycle (see Table). Based on the assumption that arthritis is a lifelong condition, each respondent could contribute a maximum of one incident case. Over cycles 2, 3, and 4, the number of respondents who reported a newly diagnosed case of arthritis totaled 1,162.

Respondents without arthritis at beginning of interval who reported diagnosed arthritis at the end of interval, by two-year interval, National Population Health Survey, 1994/95 to 2000/01

	Cycles 1 to 2 (1994/95 to 1995/97	Cycles 2 to 3 (1996/97 to 1998/99	Cycles 3 to 4 (1998/99 to 2000/01)
No arthritis at beginning of interval	4,787	4,696	4,521
Arthritis at end of interval	356	317	489

For the denominator, in cycles 2, 3 and 4, respondents contributed two person-years "at risk" each time they reported that they did not have arthritis. Thus, over the three two-year intervals, the maximum total time at-risk that a respondent could accumulate was six person-years. Based on the assumption that new cases were evenly distributed throughout the two years between interviews, each respondent reporting a new case contributed one person-year to the denominator for that cycle. For example, a respondent who reported in cycles 1 and 2 that she did not have arthritis, and then in cycle 3 that she did, would contribute one case to the numerator, and three person-years of follow-up time to the denominator—two years from cycle 1 to 2, and one year between cycles 2 and 3.

To calculate incidence density, the weighted number of cases reported over the six-year period was divided by the weighted total person-years of follow-up time (that is, years "at risk") and multiplied by 1,000.

For the bivariate and multivariate analyses of incident arthritis in relation to respondent characteristics, the values of respondent characteristics (such as body mass index) were those reported at the beginning of each two-year period; the characteristics were assumed to have remained constant over the two years. For example, the body mass index used for the 1994/95-to-1996/97 interval was that reported in 1994/95, regardless of any change by 1996/97. The analysis thus examined risk factors in association with incident arthritis in each two-year period; the units of analysis were records, rather than individual respondents.

Logistic regression was used to examine the influence of overweight and obesity on incident arthritis, while taking into account the effects of other risk factors. Odds ratios and 95% confidence intervals were estimated using multiple logistic regression analysis. The primary independent variables reflected levels of BMI. Additional independent variables entered into multivariate models were selected based on findings from the literature, as well as their availability in the NPHS; these variables controlled for age, household income, smoking status, daily lifting, number of physician visits in the past year, psychological distress, and hormone replacement use (women). Although physical activity has been identified as a risk factor for osteoarthritis, to avoid multicollinearity, it was not included in models containing daily lifting. For both men and women, the incidence rate was slightly, but significantly, higher among those for whom information on diagnosed arthritis was provided by self-report, rather than by proxy (data not shown). Therefore, a variable to reflect proxy- or self-report was included in multivariate models.[21] However, including this variable did not affect the values of the odds ratios for the independent variables reflecting body mass index.

Variance on prevalence and incidence rate estimates, on differences between rates, and on odds ratios, was calculated using the bootstrap technique, which accounts for survey design effects.[22-24]

sex, perhaps because of differences in hormonal influences or in tolerance of biomechanical stressors,[25] men and women are considered separately.

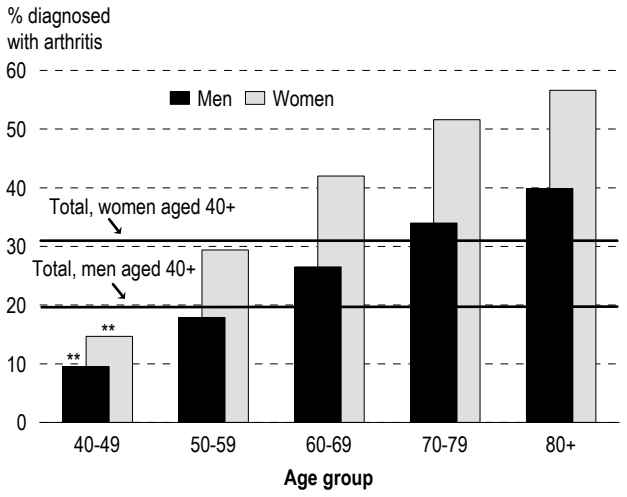
More common among women

In 2000/01, 19% of men and 31% of women aged 40 or older reported that they had been diagnosed with arthritis. The prevalence of the condition increased steadily with age; by age 80 or older, 40% of men and 57% of women were affected (Chart 1). These prevalence rates are consistent with, but slightly lower than, overall age-specific estimates of self-reported arthritis estimates for the United States.[26]

Similar to the pattern for prevalence, incident arthritis affected more women than men, and was strongly related to age (Chart 2). Incidence density rates were estimated at 31 and 48 new cases of arthritis per 1,000 person-years for men and women, respectively (Table 1).

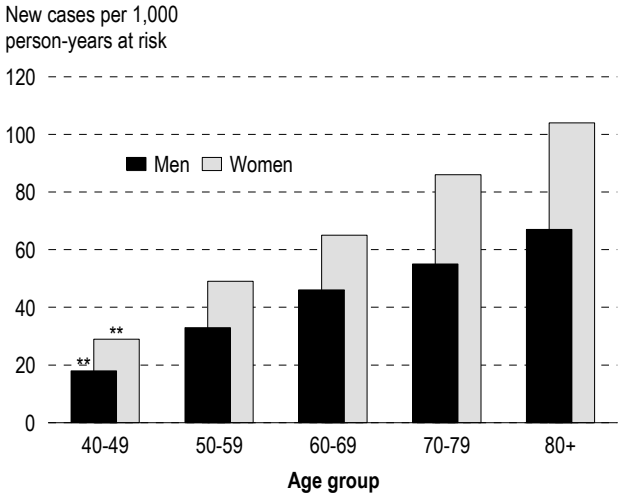
Authors of a study in the United States have speculated that higher rates of arthritis in women are linked to their higher prevalence of obesity.[27] But this explanation does not apply in Canada, where overweight or obesity is more prevalent among men (Chart 3).

Chart 1
Prevalence of respondent-reported diagnosed arthritis, by sex and age group, household population aged 40 or older, Canada, 2000/01



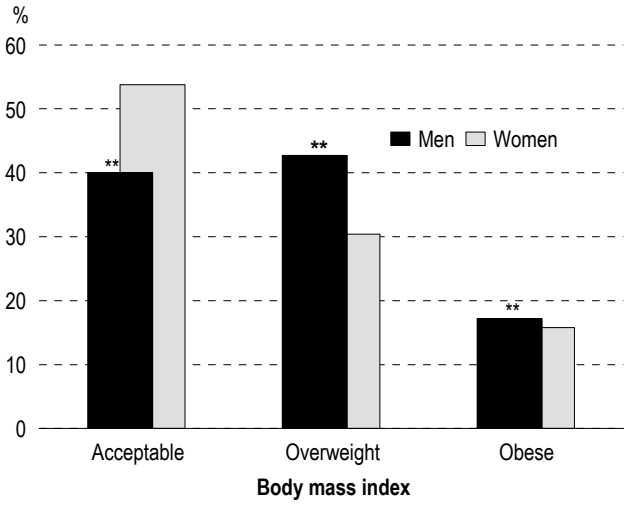
Data source: *2000/01 Canadian Community Health Survey, cycle 1.1*
Note: *Within each age group, estimates for men and women differ significantly ($p < 0.01$).*
*** Significantly different from other age group estimates within same sex ($p < 0.01$).*

Chart 2
Incidence density of respondent-reported diagnosed arthritis, by sex and age group, household population aged 40 or older, Canada excluding territories, 1994/95 to 2000/01



Data source: *1994/95 to 2000/01 National Population Health Survey, longitudinal sample, Health file*
Note: *Within each age group except 80+, estimates for men and women differ significantly ($p < 0.01$).*
*** Significantly different from other age group estimates within same sex ($p < 0.01$).*

Chart 3
Percentage distribution of body mass index, by sex, household population aged 40 or older, Canada, 2000/01



Data source: *2000/01 Canadian Community Health Survey, cycle 1.1*
*** Significantly different from value for women ($p < 0.01$)*

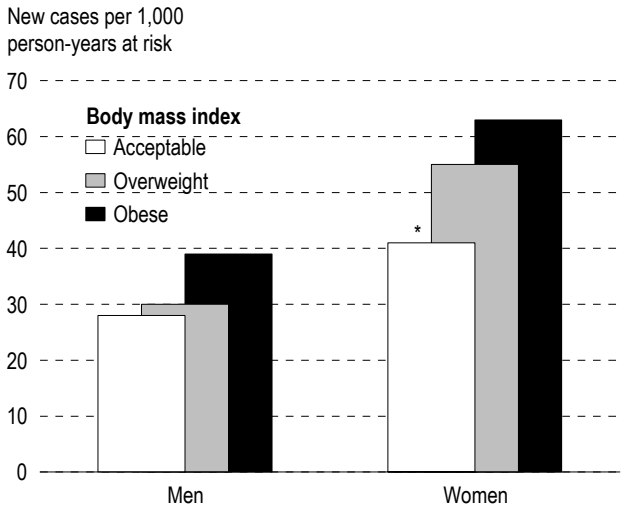
Linked with obesity

Women who were overweight or obese had higher rates of subsequently diagnosed arthritis than did women of acceptable weight (Chart 4). For men, differences in arthritis incidence rates according to BMI showed the same pattern, but were not statistically significant.

However, when the effects of other influences were controlled, associations between excess body weight and incident arthritis emerged for both sexes. For both men and women who were obese, the odds of being diagnosed with arthritis were nearly 60% higher than the corresponding odds for those in the acceptable weight range (Table 2). For women who were overweight, the odds of developing arthritis were 30% higher, compared with women of acceptable weight. The elevation in the odds ratio for men who were overweight was not statistically significant.

The finding that obesity confers a similar risk of subsequent arthritis in men and women is consistent with some previous research.[27,28] Other studies, however, have reported that obese women are at greater risk of arthritis than are obese men.[25,29]

Chart 4
Incidence density of respondent-reported diagnosed arthritis, by sex and body mass index, household population aged 40 or older, Canada excluding territories, 1994/95 to 2000/01



Data source: *1994/95 to 2000/01 National Population Health Survey, longitudinal sample, Health file*
** Significantly different from estimates for other BMI categories (p < 0.05)*

Table 1
Incidence density of respondent-reported diagnosed arthritis, by sex and selected characteristics, household population aged 40 or older, Canada excluding territories, 1994/95 to 2000/01

	Incidence density rates	
	Men	**Women**
	New cases per 1,000 person-years at risk	
Total	**31**†	**48**
Body mass index (BMI)		
Acceptable (< 25.0)‡	28	41
Overweight (25.0 to 29.9)	30	55*
Obese (≥ 30.0)	39	63*
Age group		
40-49‡	18	29
50-59	33*	49*
60-69	46*	65*
70-79	55*	86*
80+	67*E2	104*E1
Household income		
Lowest	34	78*
Lower-middle	44*	49*
Upper-middle	29	45*
Highest‡	23E1	31
Smoking status		
Current/Former	33*	51
Never smoked‡	23	46
Leisure time		
Active	26	46
Moderately active	29	43
Inactive‡	31	51
Daily lifting		
No‡	30	48
Yes	29	48
Physician visits in past year		
0 to 6‡	27	43
7 or more	63*	80*
Psychological distress		
Low‡	27	46
High	53*	62*
Years of hormone replacement use		
None‡	...	47
Less than 5	...	52E1
5 or more	...	65E1

Data source: *1994/95 to 2000/01 National Population Health Survey, longitudinal sample, Health file*
† Significantly different from estimate for women (p < 0.05)
‡ Reference category
E1 Coefficient of variation between 16.6% and 25.0%
E2 Coefficient of variation between 25.1% and 33.3%
** Significantly different from sex-specific estimate for reference category (p < 0.05)*
... Not applicable

Other factors influential

Independent of the association with obesity, incident arthritis was associated with other characteristics. Increasing age conferred higher odds of arthritis;

Data sources

Canadian Community Health Survey: Estimates of arthritis prevalence are based on self-reports of diagnosed disease from cycle 1.1 of Statistics Canada's Canadian Community Health Survey (CCHS). Data collection for cycle 1.1 began in September 2000 and was conducted over 14 months. The CCHS covers the household population aged 12 or older in all provinces and territories, except persons on Indian reserves, on Canadian Forces bases, and in some remote areas.

The CCHS uses the area frame designed for the Labour Force Survey as its primary sampling frame. A multistage stratified cluster design was used to sample dwellings within the area frame. A list of the dwellings was prepared, and a sample was selected from the list. The majority (83%) of the sampled households came from the area frame, and face-to-face interviews were held with respondents randomly selected from these households. In some health regions, a random digit dialing (RDD) and/or list frame of telephone numbers was also used. Respondents in the telephone frames, who accounted for the remaining 17% of the targeted sample, were interviewed by telephone.

In approximately 82% of the households selected from the area frame, one person was randomly selected; two people were randomly chosen in the remaining households. For households selected from the RDD frame, one person was randomly chosen. The response rate was 84.7%. The responding sample size for cycle 1.1 was 131,535. The sample used for this article consists of 74,602 respondents aged 40 or older in the 10 provinces. More detail about the sample design of the CCHS is available in a previously published report.[30]

National Population Health Survey: The analysis related to the incidence of arthritis is based on longitudinal data from the National Population Health Survey (NPHS), which is conducted every two years. The NPHS covers household and institutional residents in all provinces and territories, except persons on Indian reserves, on Canadian Forces bases, and in some remote areas. The NPHS has both longitudinal and cross-sectional components.

For household residents in the NPHS, individual data are organized into two files: General and Health. The General file contains socio-demographic and some health information for each member of participating households. The Health file contains additional, in-depth health information for one randomly selected household member, as well as the information from the General file pertaining to that individual.

Among individuals in the longitudinal component, the person providing in-depth health information about himself/herself for the Health file was the randomly selected person for the household in cycle 1 and was usually the person who provided information on all household members for the General file in subsequent cycles.

In 1994/95, the NPHS collected information from a sample of 20,725 households. In 18,342 of these households, the selected person was aged 12 or older. Their response rate to the in-depth health questions was 96.1%, or 17,626 respondents. Beginning with cycle 4 in 2000/01, the NPHS became strictly longitudinal. More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[31,32]

The 2000/01 NPHS cycle 4 longitudinal square master file was used for this analysis. This file contains records for all longitudinal respondents in the household component (n = 17,276), whether or not they provided information for all four cycles (that is, those individuals selected for the longitudinal sample for whom information is available on the General file of cycle 1). This analysis is based on data for respondents who: were aged 40 or older in cycle 1, 2 or 3; reported in cycle 1 that they had not received a diagnosis of arthritis; and responded in consecutive cycles in a logically consistent pattern to the question on arthritis.

In cycle 1, a total of 5,746 respondents were aged 40 or older and reported that they had not been diagnosed with arthritis. From this file, 435 records with inconsistent responses over the four cycles regarding diagnosed arthritis (no, yes, yes, no, for example) were deleted. An additional 524 records were not usable because of missing data on arthritis; in most cases, because of refusal to participate in the survey or because of the respondent's death before cycle 2.

in both men and women, each additional year of age was associated with a 4% increase in odds (data not shown).

For women, income was also associated with a subsequent diagnosis of arthritis. Women living in households in the lowest income category had odds of developing arthritis over the six-year period that were 60% higher than the odds for women in the highest income category. No association with income emerged for men. The finding for women is consistent with results of an Australian study of both sexes together that reported an inverse relationship between income and arthritis prevalence.[33]

Table 2
Adjusted odds ratios relating selected characteristics to two-year incidence of respondent-reported diagnosed arthritis, by sex, household population aged 40 or older, Canada excluding territories, 1994/95 to 2000/01

	Men		Women	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Body mass index (BMI)				
Acceptable (< 25.0)†	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.3	1.0, 1.7	1.3*	1.0, 1.7
Obese (≥ 30.0)	1.6*	1.1, 2.3	1.6*	1.2, 2.1
Age in years‡	1.0*	1.0, 1.0	1.0*	1.0, 1.0
Household income				
Lowest	1.0	0.6, 1.6	1.6*	1.1, 2.4
Lower-middle	1.3	0.9, 2.0	1.2	0.8, 1.6
Upper-middle	1.1	0.7, 1.7	1.3	0.9, 1.8
Highest†	1.0	...	1.0	...
Smoking status				
Current	1.2	0.8, 1.8	1.2	0.9, 1.6
Former	1.3	0.9, 1.8	1.2	0.9, 1.5
Never†	1.0	...	1.0	...
Daily lifting				
No†	1.0	...	1.0	...
Yes	1.2	0.9, 1.7	1.1	0.9, 1.5
Physician visits in past year				
0 to 6†	1.0	...	1.0	...
7 or more	1.8*	1.2, 2.5	1.7*	1.3, 2.2
Psychological distress				
Score (low to high) ‡	1.1*	1.0, 1.1	1.0*	1.0, 1.1
Years of hormone replacement use				
None/Less than 5 †	...	...	1.0	...
5 or more	...	...	1.3	0.9, 1.9

***Data source**: 1994/95 to 2000/01 National Population Health Survey, household component, longitudinal Health file*
***Notes**: Models are based on records for 6,479 men and 6,792 women. Because of rounding, some odds ratios having confidence intervals with 1.0 as the upper/lower limit are statistically significant. Variables for missing body mass index, household income, daily lifting and psychological distress were entered into the models; the odds ratios are not shown. The models also contain a variable to control for proxy response for arthritis information; the odds ratios are not shown.*
† Reference category
‡ Treated as a continuous variable
** p < 0.05*
... Not applicable

The relationship between stress and physical disease in general is a growing area of study. It has been postulated that the negative effects of stress may alter the immune response and increase susceptibility to disease.[34] However, longitudinal research focusing on the relationship between stress and arthritis is scarce. One previous study reported a cross-sectional association between arthritis and psychiatric disorders including depression, which is perhaps an indicator of psychological distress.[36] Results of the analysis of longitudinal data from the NPHS show that respondent-reported incident arthritis was significantly related to psychological distress for both sexes. For men, each 1-point increase in the 24-point scale used to measure psychological distress raised the odds of being diagnosed with arthritis by 8%; for women, by 3% (data not shown). This relationship emerged even though the number of physician consultations within the past year was taken into account. Therefore, the results suggesting that stress may be a precusor to arthritis were not simply attributable to more frequent medical contact and thus more opportunity for diagnosis.

What is arthritis?

Arthritis is one of the most common chronic conditions of middle and old age. The term "arthritis" refers to several different diseases affecting the musculoskeletal system (see *Definitions* and *Limitations*).

Osteoarthritis, or degenerative joint disease, is the most common type, affecting an estimated 12% of Americans aged 25 or older.[26] By age 70, arthritic joint changes as shown by x-ray are nearly universal, although osteoarthritis can appear as early as the second or third decade of life. At these younger ages, symptoms are not usually present, but from age 40, changes in the weight-bearing joints occur and symptoms—chiefly pain and stiffness—may begin to appear. Osteoarthritis most commonly affects the knee, hip, spine and hand. It is thought to have a combination of causes, including mechanical stress and biochemical, genetic and hormonal factors.

Rheumatoid arthritis is an autoimmune disorder that involves inflammation and tenderness of the joints; progressive disease can result in joint destruction. It has been estimated that rheumatoid arthritis affects about 1% of people in the United States.[26]

Other arthritic diseases include juvenile rheumatoid arthritis, spondylarthropathies, systemic lupus erythematosus, scleroderma, polymyalgia and gout.[26,35]

Limitations

A total of 435 records with inconsistent response patterns to the National Population Health Survey (NPHS) question on self-reports of diagnosed arthritis were excluded from the analysis. Reasons for inconsistent responses are unknown, but some may be explained by fluctuations in respondents' symptoms. An additional 524 records could not be used because of missing data. Excluding records from the analysis might result in inaccurate or biased results. For example, records removed because of inconsistent patterns for the question on diagnosed arthritis all contained at least one "yes" response; the degree to which deletion of these records might deflate incidence estimates depends on the proportion reflecting true new diagnoses of arthritis. To examine the possibility of bias as a result of removing records with inconsistent responses or missing data, selected characteristics of respondents were compared (see table). Although the mean age of the group of deleted respondents was older than the corresponding mean for the group that was included, distribution by sex and mean BMI did not differ significantly.

Respondents' characteristics in cycle 1 (1994/95):

	Included (n = 4,787)	Deleted (n = 959)
Age (mean)	54.0	58.1**
Female (%)	48.4	49.8
Body mass index (mean)	25.6	25.7

***Significantly different from value for included respondents ($p < 0.01$)*

To maximize sample size and increase precision, the sample that was used comprised all respondents eligible for the study in cycle 1, and the survey weights used were those for this population. However, because the weights were not adjusted for attrition or other deletions, their use may lead to bias in estimates.[31]

The definition of arthritis used for this analysis is based on a respondent's report of a diagnosis (see *Definitions*); reports were not validated against clinical records, and no radiological information was available. Not all people with the disease have symptoms, however, so not all are diagnosed.[37] Under-ascertainment of arthritis would result in prevalence estimates that are lower than their true proportion in the population.

Inflated estimates of incidence would result from a false negative response (erroneous response of no diagnosed disease) in one cycle, followed by a positive response in the subsequent cycle. This would likely have the largest effect on data from NPHS cycles 1 and 2 because of the relatively high proportion of responses that were accepted from proxy respondents in cycle 1; compared with self-response, proxy response has been shown to underestimate disease prevalence.[21] A variable for proxy report of diagnosed arthritis was used in multivariate analysis to control for any such effects.

"Arthritis" was considered a single entity, although the term applies to a variety of clinically distinct conditions (see *What is arthritis?*). Osteoarthritis is the most prevalent, and its onset is age-related.[26] Thus, most respondents who reported arthritis probably had osteoarthritis, especially since age was restricted to 40 or older. Although excess weight is a known risk factor for osteoarthritis,[6,38] there is little evidence of its relationship to other arthritic disorders. Therefore, the observed values of the odds ratios for overweight and obesity in relation to "arthritis" are likely lower than they would be in association with osteoarthritis alone.

Information about the specific part of the body affected by arthritis was not available for this analysis. The literature indicates that the association between obesity and osteoarthritis is not consistent for all joints: a stronger relationship with the knees, and an unclear relationship with the hips.[39] If the analysis could have been restricted to people with diagnosed knee osteoarthritis, the relationships observed with overweight/obesity would likely have been more pronounced.

Because data are not available for some arthritis risk factors, such as family history, congenital and developmental diseases, and previous damage to the joints,[10,40,41] they could not be included in the analysis.

Although the longitudinal data establish a temporal relationship between the dependent and independent variables, causality cannot be inferred. The findings do not rule out the possibility of an unknown factor that might cause both arthritis *and* obesity.

The sample used for this analysis was drawn from the household population, and does not include residents of institutions. An earlier report indicated a lower prevalence of arthritis among institutionalized seniors (35%) than among those living in households (40%).[42]

The follow-up period for this analysis was relatively short. Previous research suggests that cumulative exposure to excess weight over several decades confers a greater risk of subsequent arthritis than exposure over a shorter period.[43]

Information about the actual date of diagnosis is also not available from the National Population Health Survey, so time-dependent analytical techniques could not be used.

The survey data are self- or proxy-reported and the degree to which they are biased because of reporting error is unknown. For example, body mass index was based on self-reported weight and height. Other research has shown that error in self-reported weight and height is more pronounced among certain groups—the overweight, women, and older people—resulting in greater underestimates of the prevalence of overweight and obesity in these groups.[44,45] The resulting bias would weaken the observed association between overweight/obesity and arthritis.

Although the findings of the analysis of NPHS data suggest a positive association between hormone replacement therapy and incident arthritis in women, the estimate failed to attain statistical significance. This may have been because of small numbers, as has been the case in other research.[46] As well, the variety of formulations used for hormone replacement therapy may have diluted any relationship with arthritis. The relationship between hormone replacement use and arthritis remains unclear, and the results of previous studies have been inconsistent.[47-49]

Concluding remarks

The results of this prospective study, based on a sample representative of the adult household population, show a strong relationship between excess weight and subsequent arthritis. For both men and women, the odds of developing arthritis were 60% higher among people who were considered obese, compared with those of acceptable weight—independent of other influences including age, household income, daily lifting, physician visits, and psychological distress. Being overweight was also associated with developing arthritis, but for women only.

The longitudinal data used to measure incidence in relation to excess weight support the hypothesis that obesity and overweight lead to arthritis (rather than the reverse), possibly by increasing stress on the joints. Clearly, though, additional factors influence the likelihood of developing the disease: prevalence and incidence rates of arthritis are consistently higher for women than for men, even though greater proportions of men are overweight or obese.

Despite widespread attitudes that tend to stigmatize excess weight, as well as public initiatives promoting healthy weight, the majority of middle-aged and older Canadians are overweight. In addition to the more well-known dangers to health (for instance, diabetes and heart disease), excess weight is an important modifiable risk factor for arthritis, a major cause of disability. In 2000/01, 1 in 4 Canadians aged 40 or older reported that they had been diagnosed with arthritis; an estimated 3% of men and nearly 5% of women these ages develop arthritis each year. By age 70, one-third of men and half of women have arthritis. Measures taken to lower the prevalence of excess weight may, in turn, lower the risk of arthritis, not to mention numerous other chronic conditions linked with excess weight. ●

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