

Age at diagnosis of smoking-related disease

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Abstract

Objectives

This study assesses the relationship between the age of daily smoking initiation and the age at diagnosis of chronic obstructive pulmonary disease (COPD), heart disease and rheumatoid arthritis.

Data source

The data are from the 2000/01 Canadian Community Health Survey (CCHS). The sample for the analysis consisted of 34,144 respondents aged 35 to 64 living in private households in the provinces and territories.

Analytical techniques

The life table approach was used to estimate the cumulative incidence of smoking-related disease. Cox proportional hazards regression models were used to estimate the relative risks of disease by the age when daily smoking began.

Main results

For both sexes, the younger the individuals were when they became daily smokers, the sooner they were diagnosed with COPD, heart disease or rheumatoid arthritis. Even when education, household income and number of cigarettes smoked per day were taken into account, adolescent starters were at increased risk of these diseases, compared with never-smokers.

Key words

chronic obstructive pulmonary disease, heart disease, rheumatoid arthritis, adolescent behaviour

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Cigarette smoking is recognized as the single most preventable cause of debilitating illness and premature death.¹ While smoking usually begins in adolescence or early adulthood, associated diseases and death typically occur much later in life.² It has been suggested, however, that there may be a relationship between the age when smoking begins and the age at which such diseases are diagnosed.³ Specifically, the earlier the initiation of smoking, the earlier the development of certain health problems.

This article uses data from the 2000/01 Canadian Community Health Survey (CCHS) to assess the relationship between the age when daily smoking began and the age at which three diseases were diagnosed: chronic obstructive pulmonary disease (COPD), heart disease and rheumatoid arthritis (see *Methods, Definitions and Limitations*). Daily smokers aged 35 to 64 are compared with their contemporaries who had never smoked. The smokers are divided into two groups according to the age at which they became daily smokers: 13 to 17 (adolescence) and 18 to 22 (young adulthood).

Studies of sex differences in the effects of smoking are inconclusive, but some recent research suggests that women may be more susceptible than men.^{4,11} Accordingly, results are presented separately for men and women.

Early smoking/High disease prevalence

Of the 15,517 male respondents aged 35 to 64 (an estimated 3.3 million) in the analysis, 34% were daily smokers who had started smoking daily at ages 13 to 17, and 20% were daily smokers who had begun

Methods

Data source

The data are based on cycle 1.1 of Statistics Canada's 2000/01 Canadian Community Health Survey (CCHS). Data collection for this cycle 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 living on Indian reserves, on Canadian Forces bases, and in some remote areas.

The CCHS uses the area frame designed for Statistics Canada's Labour Force Survey as its primary sampling frame. A multistage stratified cluster design was used to sample dwellings in the area frame. A list of the dwellings was prepared, and a sample of dwellings 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 households in this frame. In some health regions, a random digit dialling (RDD) technique 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 telephone frames, one person was chosen at random. The response rate was 84.7%. The responding sample size for cycle 1.1 was 131,535; 6.6% of interviews were obtained by proxy.¹²

Analytical techniques

This analysis focuses on three diseases: chronic obstructive pulmonary disease (COPD), heart disease and rheumatoid arthritis. The incidence of each was examined among respondents aged 35 to 64 (when they were interviewed) who had not been diagnosed with that disease by age 25. Three groups were compared: current daily smokers who began daily smoking at ages 13 to 17, current

daily smokers who started at ages 18 to 22, and lifetime never-smokers.

The 35-to-64 age range was chosen because of the low prevalence of the three diseases at younger ages, and to reduce potential biases stemming from attrition due to mortality or institutionalization among seniors. The two age-at-initiation groups, 13 to 17 and 18 to 22, were selected because they are the ages at which daily smoking typically begins.¹³

The analysis excluded respondents who had stopped daily smoking for more than five years before the survey (14,492) because their duration of smoking was uncertain, and lifetime occasional smokers (9,915) because of the lack of information about when they started or stopped occasional smoking. A small number (149) of respondents who reported that they had started to smoke daily before the age that they reported smoking their first whole cigarette were also excluded. A sample of 34,144 respondents aged 35 to 64 remained for analysis: 15,517 men and 18,627 women (Appendix Table A).

Standard life-table methods were used to retrospectively estimate the cumulative incidence of being diagnosed with each of the three diseases (see *Definitions*). The cumulative incidence was estimated with the SAS LIFETEST procedure.¹⁴ Respondents who had not been diagnosed with one of these diseases were considered censored at the age when they were interviewed.

Cox proportional hazards regression models¹⁵ were used to estimate hazard ratios for being diagnosed with the diseases according to age at smoking initiation. The models included household income, education, and number of cigarettes smoked per day. The estimates were obtained using the PHREG in SAS.¹⁴ Because of possible sex differences in smoking effects, separate models were fitted for men and women.

All analyses were based on weighted data. The standard errors of regression coefficients were estimated using the bootstrap technique to fully account for the sample weights and the complex survey design.¹⁶

at ages 18 to 22; the remaining 46% had never smoked. The corresponding proportions among the 18,627 female respondents (an estimated 3.7 million) were 23%, 18%, and 59% (Appendix Table A).

The potential health consequences of becoming a daily smoker at an early age are evident in the prevalence of three smoking-related diseases. In 2000/01, the prevalence of chronic obstructive pulmonary disease (COPD), heart disease and rheumatoid arthritis among these 35- to 64-year-olds was significantly higher for smokers than for people who had never smoked, and tended to be highest among those who had started smoking daily in adolescence (Chart 1).

Possible health effects of adolescent smoking are also evident in the incidence of these diseases. Among people who had been free of COPD, heart disease and rheumatoid arthritis at age 25, those who

started smoking daily in adolescence tended to have been diagnosed earlier in life than those who had started smoking daily in young adulthood or those who were non-smokers.

Chronic obstructive pulmonary disease

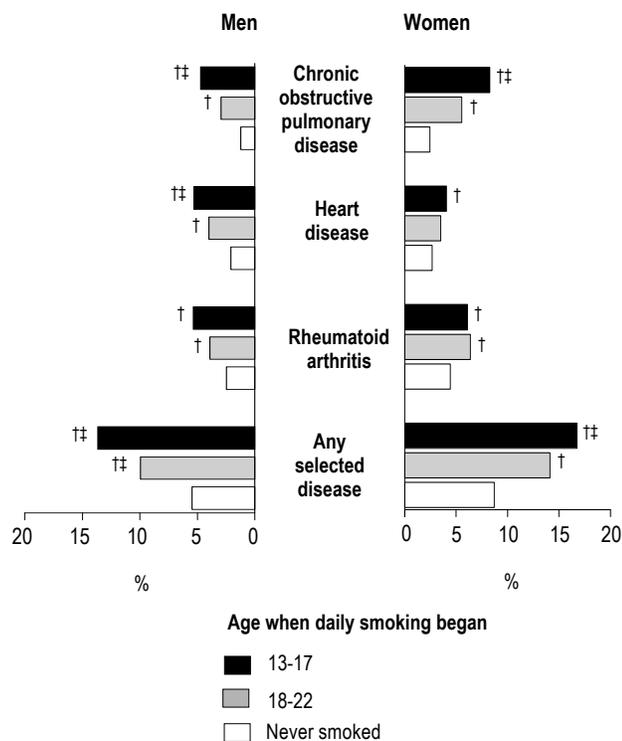
By the time they were in their thirties, the proportions of people with COPD began to diverge, depending on their smoking history. The cumulative incidence of the disease was higher among smokers than among never-smokers (Chart 2). And among smokers, a higher percentage of adolescent starters than young adult starters had been diagnosed.

By age 60, 7% of male and 12% of female adolescent starters had been diagnosed with COPD. The figures for young adult starters were lower: 4% of men and 7% of women. Just 2% of men and 3% of women who had never smoked had COPD at age 60.

Of course, adolescent starters had, on average, been smoking daily five years longer than young adult starters, which might explain the discrepancy by age 60. Even so, the cumulative incidence of COPD among adolescent starters surpassed that among young adult starters by more than the five-year age difference. For example, *by age 55*, over 5% of male adolescent starters had COPD, but *by age 60*, young adult starters had not completely narrowed the gap, as less than 4% had the disease. There was a similar difference among women: *by age 55*, 9% of adolescent starters had COPD, whereas *by age 60*, the figure for young adult starters was 7%. This indicates that with the same duration of smoking, adolescent starters were at increased risk of developing COPD, compared with young adult starters.

At each age, the cumulative incidence of COPD was higher among women. Since women are less likely than men to smoke heavily, regardless of how old they were when they started, the difference may indicate a greater vulnerability.¹⁷ In fact, consistent with a previous study, even among never-smokers there was a sex gap in the cumulative incidence of COPD, although it was much narrower.

Chart 1
Prevalence of selected smoking-related diseases, by sex and age when daily smoking began, household population aged 35 to 64, Canada, 2000/01



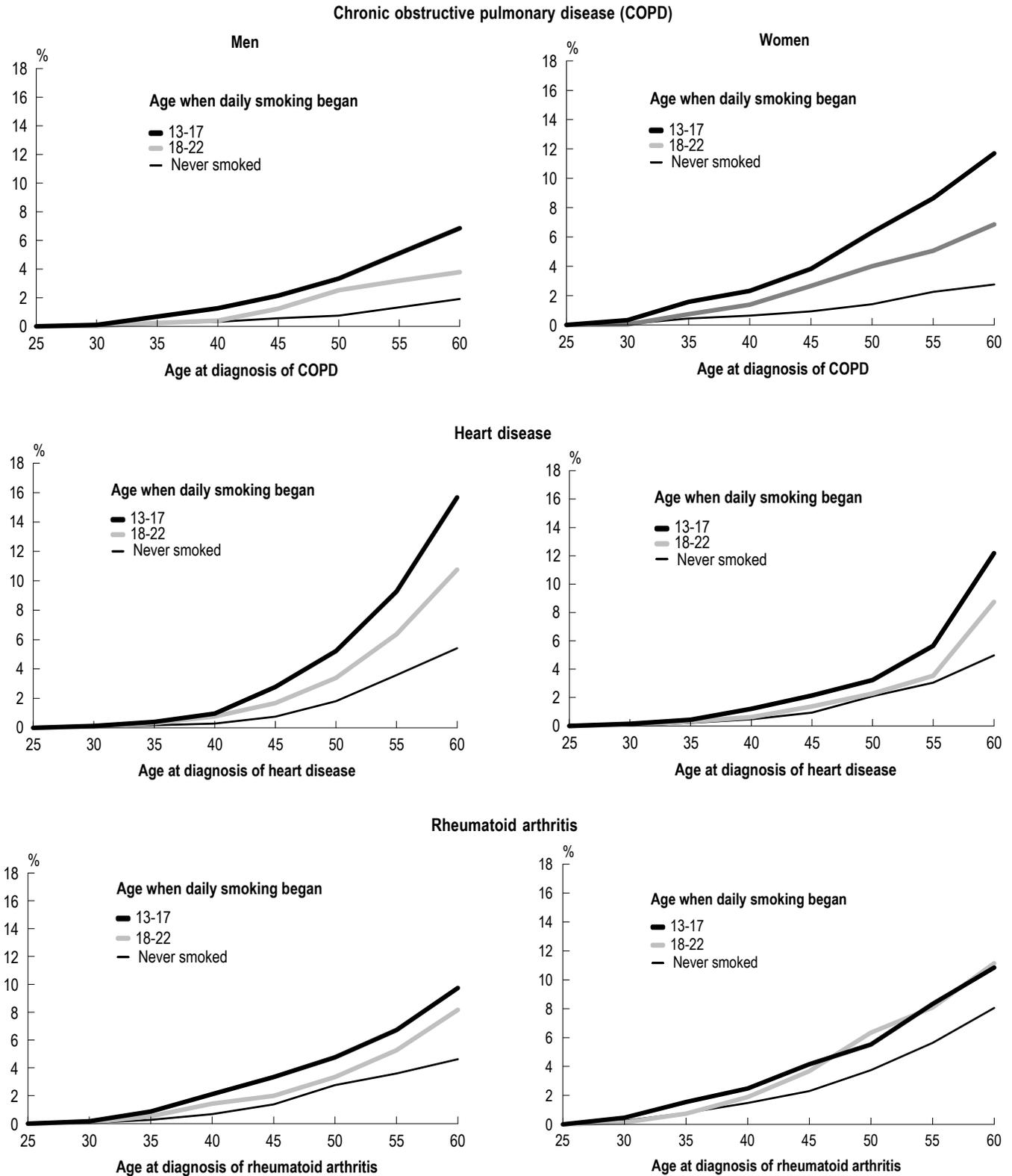
Data source: 2000/01 Canadian Community Health Survey, Cycle 1.1

† Significantly different from "Never smoked" ($p < 0.05$)

‡ Significantly different from those who began daily smoking at ages 18 to 22 ($p < 0.05$)

Chart 2

Cumulative incidence of selected smoking-related diseases, by sex and age when daily smoking began, household population aged 35 to 64, Canada, 2000/01



Data source: 2000/01 Canadian Community Health Survey, Cycle 1.1

Heart disease

The cumulative incidence of heart disease began to diverge, depending on smoking history, at around age 40. By age 60, 16% of male and 12% of female adolescent starters had been diagnosed with heart disease. The corresponding figures for young adult starters were 11% and 9%, and for never-smokers, 5% for both sexes.

Although women's cumulative incidence of heart disease was lower than men's, the increase from age 55 to 60 among adolescent starters was much sharper among women. Between these ages, the proportion of female adolescent starters with heart disease doubled from 6% to 12%; over the same period of their lives, the increase for male adolescent starters was from 9% to about 16%.

Rheumatoid arthritis

The link between cigarette smoking and rheumatoid arthritis is less well-established than that with COPD or heart disease.¹⁸⁻²⁵ It has been suggested that "cigarette smoking may have direct biological effects on rheumatoid arthritis by increasing serum rheumatoid factor and altering immune function in the lung."^{18,26-28}

Results of the 2000/01 CCHS show that by age 35 for men and by age 40 for women, the cumulative incidence of rheumatoid arthritis among smokers exceeded that of never-smokers. By age 60, among men, 10% of adolescent starters and 8% of young adult starters had rheumatoid arthritis, compared with 5% of never-smokers. For women, the cumulative incidence of the disease for the two groups of smokers converged around age 45, and by age 60, it had reached 11%, compared with 8% for never-smokers.

At least one

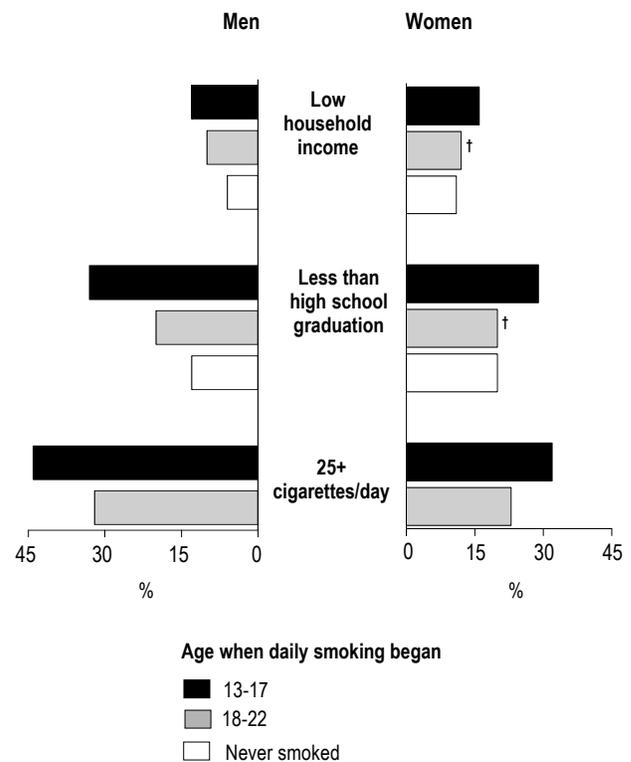
Not surprisingly, the cumulative incidence of having at least one of the three diseases was highest among smokers who had started smoking daily in adolescence. By age 60, 32% of male adolescent starters had been diagnosed with COPD and/or heart disease and/or rheumatoid arthritis; corresponding figures were 24% for young adult starters, and 14% for never-smokers. Among

women, the percentages were even higher: 41%, 29% and 17%, respectively.

Relationships hold when other factors considered

Smoking-related diseases are often deeply rooted in the socio-economic environment.²⁹ Therefore, the age at which an individual becomes a daily smoker is unlikely to be the only factor contributing to the eventual development of a chronic disease. According to the results of the CCHS, smokers, especially those who began smoking daily in adolescence, tended to have less formal education than did never-smokers and were more likely to live in low-income households (Chart 3). As well, cigarette consumption tended to be higher among

Chart 3
Prevalence of low household income, low education and heavy smoking, by sex and age when daily smoking began, household population aged 35 to 64, Canada, 2000/01



Data source: 2000/01 Canadian Community Health Survey, Cycle 1.1
† All differences between groups are statistically significant ($p < 0.05$) except for this group compared with "Never smoked." Significance tests were adjusted for multiple comparisons.

Definitions

Respondents to the Canadian Community Health Survey (CCHS) were asked about chronic conditions that had lasted or were expected to last six months or more and that had been diagnosed by a health professional.

The clinical definition of *chronic obstructive pulmonary disease (COPD)* includes chronic bronchitis characterized by a persistent cough productive of sputum with airflow obstruction, and emphysema accompanied by airflow obstruction. Emphysema is an abnormal permanent enlargement of the tiny air sacs of the lungs (alveoli) and the destruction of their walls.³⁰ Responses to two CCHS questions were used to determine if respondents had COPD. One question asked if they had “emphysema or chronic obstructive pulmonary disease” and the other, if they had “chronic bronchitis.” For this analysis, respondents who replied positively to at least one of these questions were defined as having COPD.

Respondents were considered to have *heart disease* if they answered “yes” to the question: “Do you have heart disease?”

Respondents were asked: “Do you have arthritis or rheumatism, excluding fibromyalgia?” Those who replied affirmatively were asked: “What kind of arthritis do you have?” The choices were rheumatoid arthritis, osteoarthritis, and other. This analysis concerns only those who reported *rheumatoid arthritis*.

To determine *age at diagnosis*, respondents who replied “yes” to a condition were asked: “How old (age in years) were you when this was first diagnosed?”

Respondents were asked if they had smoked 100 or more cigarettes (about 4 packs) in their lifetime. They were also asked: “At the present time, do you smoke cigarettes daily, occasionally, or not at all?” Those who reported smoking daily were asked at what age they began to do so. Respondents who reported that they currently smoked occasionally or not at all were asked: “Have you ever smoked daily?” If they had, they were asked at what age they had begun to smoke daily and when they had stopped (less than

one year ago, 1 to 2 years ago, 3 to 5 years ago, or more than 5 years ago). Smokers selected for this analysis were those who had started smoking daily at ages 13 to 22 and had smoked at least 100 cigarettes in their lifetime for at least 7 years. Never-smokers were those who reported that they had not smoked at all.

Age when daily smoking began was classified as adolescence (13 to 17) or young adulthood (18 to 22).

Current daily smokers were asked: “How many cigarettes do you smoke each day now?” *Number of cigarettes smoked per day* was classified as 25 or more or less than 25. Because no information was available about lifetime cigarette consumption, the number of cigarettes smoked per day as reported to the CCHS was used as a proxy for the amount smoked before the onset of disease.

Three levels of *education* were established: less than high school graduation; high school graduation or some postsecondary; and postsecondary graduation. Since most postsecondary graduates obtain their first qualification (diploma, certificate, or bachelor’s degree) in their early twenties, it is assumed that the highest education level used for this analysis had been attained by age 25.

Current *household income* was based on total annual income and number of household members:

| Household income group | People in household | Total household income |
|------------------------|-------------------------------|--|
| Low | 1 to 4 5 or more | Less than \$10,000 Less than \$15,000 |
| Lower-middle | 1 or 2 3 or 4 5 or more | \$10,000 to \$14,999 \$10,000 to \$19,999 \$15,000 to \$29,999 |
| Upper-middle/High | 1 to 4 3 or 4 5 or more | \$15,000 or more \$20,000 or more \$30,000 or more |

adolescent starters than young adult starters. Consequently, in assessing the temporal relationship between smoking and the incidence of disease, it is necessary to take income, education and daily cigarette consumption into account. In this analysis, household income and educational attainment as reported in 2000/01 were used as a proxy for those factors during the years when daily smoking began (see *Limitations*). The number of cigarettes smoked

per day in 2000/01 was used as a proxy for cigarette consumption before the diagnosis of a smoking-related disease.

Even when household income, education and number of cigarettes smoked per day were taken into account, the risk of developing COPD among adolescent starters was three times that of never-smokers; for young adult starters, the risk was about twice as high (Table 1). Moreover, among women,

Table 1
Hazards ratios for diagnosis of selected smoking-related diseases, by sex and age when daily smoking began, household population aged 35 to 64, Canada, 2000/01

| Age when daily smoking began | Chronic obstructive pulmonary disease | | Heart disease | | Rheumatoid arthritis | | Any of three selected diseases | |
|---|---------------------------------------|-------------------------|--------------------|-------------------------|----------------------|-------------------------|--------------------------------|-------------------------|
| | Hazards ratio | 95% confidence interval | Hazards ratio | 95% confidence interval | Hazards ratio | 95% confidence interval | Hazards ratio | 95% confidence interval |
| Model 1 (unadjusted) | | | | | | | | |
| Men | | | | | | | | |
| 13-17 | 4.22 ^{‡§} | 2.45, 7.27 | 2.84 ^{‡§} | 2.12, 3.81 | 2.22 ^{‡§} | 1.70, 2.88 | 2.65 ^{‡§} | 2.23, 3.15 |
| 18-22 | 2.51 [‡] | 1.34, 4.71 | 1.90 [‡] | 1.33, 2.72 | 1.58 [‡] | 1.11, 2.26 | 1.82 [‡] | 1.47, 2.26 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |
| Women | | | | | | | | |
| 13-17 | 4.30 ^{‡§} | 3.19, 5.79 | 2.12 ^{‡§} | 1.55, 2.89 | 1.54 [‡] | 1.26, 1.89 | 2.59 ^{‡§} | 2.27, 2.95 |
| 18-22 | 2.60 [‡] | 1.87, 3.62 | 1.40 | 0.99, 1.99 | 1.46 [‡] | 1.16, 1.84 | 1.75 [‡] | 1.50, 2.04 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |
| Model 2 (adjusted for household income and education) | | | | | | | | |
| Men | | | | | | | | |
| 13-17 | 3.66 [‡] | 2.09, 6.40 | 2.71 ^{‡§} | 2.02, 3.64 | 2.04 [‡] | 1.54, 2.70 | 2.50 ^{‡§} | 2.09, 3.00 |
| 18-22 | 2.43 [‡] | 1.26, 4.69 | 1.82 [‡] | 1.26, 2.63 | 1.53 [‡] | 1.06, 2.22 | 1.76 [‡] | 1.41, 2.20 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |
| Women | | | | | | | | |
| 13-17 | 3.60 ^{‡§} | 2.66, 4.86 | 1.84 ^{‡§} | 1.35, 2.51 | 1.47 [‡] | 1.19, 1.81 | 2.38 ^{‡§} | 2.08, 2.72 |
| 18-22 | 2.56 [‡] | 1.84, 3.57 | 1.31 | 0.92, 1.86 | 1.41 [‡] | 1.11, 1.78 | 1.71 [‡] | 1.47, 2.00 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |
| Model 3 (adjusted for household income, education and number of cigarettes smoked per day) | | | | | | | | |
| Men | | | | | | | | |
| 13-17 | 3.00 [‡] | 1.58, 5.67 | 2.50 ^{‡§} | 1.82, 3.43 | 2.03 [‡] | 1.49, 2.76 | 2.35 ^{‡§} | 1.92, 2.87 |
| 18-22 | 2.09 [‡] | 1.01, 4.34 | 1.71 [‡] | 1.15, 2.55 | 1.52 [‡] | 1.03, 2.26 | 1.68 [‡] | 1.32, 2.13 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |
| Women | | | | | | | | |
| 13-17 | 3.00 ^{‡§} | 2.15, 4.17 | 1.73 [‡] | 1.22, 2.47 | 1.64 [‡] | 1.28, 2.11 | 2.33 ^{‡§} | 2.00, 2.70 |
| 18-22 | 2.23 [‡] | 1.55, 3.19 | 1.26 | 0.87, 1.82 | 1.53 [‡] | 1.19, 1.95 | 1.69 [‡] | 1.43, 1.99 |
| Never smoked [†] | 1.00 | ... | 1.00 | ... | 1.00 | ... | 1.00 | ... |

Data source: 2000/01 Canadian Community Health Survey, Cycle 1.1

[†] Reference group

[‡] Significantly different from "Never smoked" ($p < 0.05$)

[§] Significantly different from those who began daily smoking at ages 18 to 22 ($p < 0.05$)

... Not applicable

the risk of being diagnosed with COPD was significantly higher for adolescent starters than for young adult starters.

The relationship between early smoking initiation and heart disease was similar. Adolescent starters had about twice the risk of having been diagnosed with heart disease, compared with never-smokers. And among men, but not women, the risk compared with never-smokers was also significantly high for young adult starters. In addition, for men the risk

of heart disease was significantly higher among adolescent starters than for young adult starters.

Smokers had a significantly higher risk of rheumatoid arthritis, compared with those who had never smoked. However, the risk was not significantly higher for adolescent starters than for young adult starters.

Not unexpectedly, given the results for the diseases individually, the risk of having been diagnosed with at least one of them was significantly

greater for smokers than for people who had never smoked, and it was also greater for adolescent starters than for young adult starters.

Limitations

Data from the Canadian Community Health Survey (CCHS) on the presence of chronic conditions are self-reported. No independent source verified if people who reported having been diagnosed with chronic bronchitis, emphysema/chronic obstructive pulmonary disease, heart disease or rheumatoid arthritis actually did have those diseases. As well, these broad terms do not specify the nature of a condition or its severity. For instance, cigarette smoking is a major risk factor for coronary heart disease,³¹ but the CCHS question refers to “heart disease,” which includes non-coronary heart diseases, whose relationship with smoking is unknown. Therefore, the detrimental effects of smoking on heart health may have been underestimated in this analysis. On the other hand, the prevalence of rheumatoid arthritis may be overestimated. The proportion of people affected, based on CCHS data, is high compared with other sources.^{32,33} To some degree, this may be attributable to respondents’ lack of awareness of the distinction between rheumatoid and osteoarthritis.

The central question—“How old were you when the condition was first diagnosed?”—is subject to recall error. Age at diagnosis could also vary by individuals’ awareness of illness, the point at which they were willing to seek doctors’ care, and the accuracy of diagnoses. The age at which daily smoking began is also subject to recall error, and furthermore, may be affected by a reluctance to acknowledge socially undesirable behaviour, although self-reported data on smoking are considered to be relatively valid.³⁴

As well, age at diagnosis of a disease may be affected by access to medical services. An earlier study has shown that a relatively high proportion of people in low-income households report unmet health care needs stemming from accessibility problems (cost or transportation).³⁵ Since a comparatively large percentage of smokers, especially those who became daily smokers in adolescence, lived in low-income households, they may tend to be diagnosed late or not at all. Consequently, the effects of smoking on the incidence of COPD, heart disease and rheumatoid arthritis may have been underestimated.

Restricting the analysis to people who were free of the three diseases at age 25 may have excluded the most susceptible, especially among early smokers. For example, 220 respondents who became daily smokers in adolescence and 106 who began as young adults reported that they had been diagnosed with COPD

Concluding remarks

The results of this analysis of data from the 2000/01 Canadian Community Health Survey show that people who began daily smoking in adolescence and

when they were younger than 25; this compared with 61 never-smokers. The weighted percentages of those who had COPD at age 25 or earlier were 2.0%, 1.3% and 0.3%, respectively. The proportions for heart disease were 0.5% (n=61), 0.5% (n=23) and 0.2% (n=37), and for rheumatoid arthritis, 1.2% (n=125), 0.8% (n=64) and 0.4% (n=84). As a result, the association between early smoking initiation and the incidence of those diseases may be underestimated.

Even though the analysis excludes seniors, the possibility of attrition-related bias remains, because the people most susceptible to the three diseases may have died or moved to a health-related institution.

Some measurement error may exist because people in poor health are simply more inclined to report themselves as having several different illnesses. However, co-morbidity for the three diseases was relatively low. For example, the prevalence of at least one of the three was 13.6% for adolescent starters, 11.4% for young adult starters, and 7.3% for never-smokers, but the corresponding prevalence of co-morbidity (having two or more of the three diseases) was just 1.5%, 1.1%, and 0.7%.

The etiology of smoking-related illness is multifactorial, involving both genetic and environmental elements.^{4,28,36} However, this analysis includes relatively few control variables because of the potential for measurement errors related to their time-dependent nature. Notably, education, household income and number of cigarettes smoked per day pertain to the time of the CCHS interview, but are used as proxies for education, income and smoking before the onset of smoking-related disease. A respondent’s situation might have changed, so the effects of these control variables are not highlighted.

The ages of respondents included in the analysis spanned 30 years (ages 35 to 64). During the last three decades, the prevalence of smoking has declined. In addition, the risk of COPD, heart disease and rheumatoid arthritis increases with age. Consequently, it is possible that non-smokers may be younger and at lower risk of being diagnosed with these diseases. Nonetheless, even with a breakdown of the sample into two sex-specific age groups (35 to 49 and 50 to 64), the patterns of estimated incidence of the three diseases by age of onset of daily smoking persisted (data not shown).

young adulthood were at increased risk of developing COPD, heart disease and rheumatoid arthritis, even when current educational attainment, household income and cigarette consumption were taken into account. From a population health standpoint, the implications are substantial. Prevention of smoking, especially in adolescence, may substantially delay the onset of these disabling or fatal diseases.

The link between early smoking and COPD independent of a duration of smoking effect is particularly striking. Smoking in adolescence may impede the normal development of lung function.³⁷⁻³⁹

As well, although women are less likely to smoke heavily, their risk of being diagnosed with COPD was higher than that of men. Thus, the CCHS data support some recent studies suggesting that women may be more vulnerable to the detrimental effects of smoking.^{4,6,8,9} Biological differences in terms of

lung size may increase women's sensitivity and put them at greater risk.^{6,8,9,29,40,41}

The link between early smoking initiation and an early onset of coronary heart disease has been attributed to cumulative exposure.³ It has also been suggested that the effects of smoking on lipid levels in adolescence may contribute to the development of atherosclerosis in young adulthood.³⁶

While the relationship between the age of smoking initiation and rheumatoid arthritis in this analysis is modest, it is not negligible. The disease imposes a tremendous societal and individual burden.⁴² If the link between smoking and rheumatoid arthritis is causal and the condition can be added to the list of smoking-related diseases, reducing the prevalence of smoking among adolescents and young adults³⁰ could be expected to yield even greater public health benefits than are estimated in current smoking prevention initiatives. ●

References

- 1 US Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. DHHS Publication No. (CDC) 89-8411. Rockville, Maryland: US Department of Health and Human Services, 1989.
- 2 Burns DM. Cigarette smoking among the elderly: disease consequences and the benefits of cessation. *The Science of Health Promotion* 2000; 14(6): 357-61.
- 3 Kawachi I, Colditz GA, Stampfer MJ, et al. Smoking cessation and time course of decreased risks of coronary heart disease in middle-aged women. *Archives of Internal Medicine* 1994; 154: 169-75.
- 4 Prescott E. Commentary: Tobacco-related diseases: a gender difference? *International Journal of Epidemiology* 2001; 30: 793-4.
- 5 Prescott E, Hippe M, Schmoor P, et al. Smoking and risk of myocardial infarction in women and men: longitudinal population study. *British Medical Journal* 1998; 316: 1043-7.
- 6 Prescott E, Bjerg AM, Andersen PK, et al. Gender differences in smoking effects on lung and risk of hospitalization for COPD: results from a Danish longitudinal population study. *European Respiratory Journal* 1997; 10: 822-7.
- 7 Marang-van de Mheen PJ, Davey Smith G, Hart CL, et al. Are women more sensitive to smoking than men? Findings from the Renfrew and Paisley study. *International Journal of Epidemiology* 2001; 30: 787-92.
- 8 Xu X, Li B, Wang L. Gender difference in smoking effects on adult pulmonary function. *European Respiratory Journal* 1994; 7: 477-83.
- 9 Xu X, Weiss ST, Rijcken B, et al. Smoking, changes in smoking habits, and rate of decline in FEV: new insight into gender differences. *European Respiratory Journal* 1994; 7: 1056-61.
- 10 Freund KM, Belanger AJ, D'agostino RB, et al. The health risks of smoking: the Framingham Study: 34 years of follow-up. *Annals of Epidemiology* 1993; 3: 417-24.
- 11 Seltzer CC. Framingham Study data and 'established wisdom' about cigarette smoking and coronary heart disease. *Journal of Clinical Epidemiology* 1988; 42: 743-50.
- 12 Béland Y. Canadian Community Health Survey—Methodological overview. *Health Reports* (Statistics Canada, Catalogue 82-003) 2002; 13(3): 9-14.
- 13 Chen J, Millar WJ. Age of smoking initiation: Implications for quitting. *Health Reports* (Statistics Canada, Catalogue 82-003) 1998; 9(4): 39-46.
- 14 SAS Institute Inc. *SAS/STAT User's Guide. Version 6, Fourth Edition, Volume 2*. Cary, North Carolina: SAS Institute Inc., 1989.
- 15 Cox DR. Regression models and life-tables (with discussion). *Journal of the Royal Statistical Society Series B* 1972; 34: 187-220.

- 16 Yeo D, Mantel H, Liu TP. Bootstrap variance estimation for the National Population Health Survey. *American Statistical Association: Proceedings of the Survey Methods Section*. Baltimore: August 1999.
- 17 Whittemore AS, Perlin SA, DiCiccio Y. Chronic obstructive pulmonary disease in lifelong nonsmokers: Results from HANES. *American Journal of Public Health* 1995; 85(5): 702-5.
- 18 Albano SA, Santana-Sahagun E, Weisman MH. Cigarette smoking and rheumatoid arthritis. *Arthritis and Rheumatism* 2001; 31(3): 146-59.
- 19 Wilson K, Goldsmith CH. Does smoking cause rheumatoid arthritis? *Journal of Rheumatology* 1999; 26(1): 1-2.
- 20 Hutchinson D, Shepstone L, Moots R, et al. Heavy cigarette smoking is strongly associated with rheumatoid arthritis (RA), particularly in patients without a family history of RA. *Annals of the Rheumatic Diseases* 2001; 60: 223-7.
- 21 Wolfe F. The effect of smoking on clinical, laboratory, and radiographic status in rheumatoid arthritis. *Journal of Rheumatology* 2000; 27(3): 630-7.
- 22 Karlson EW, Lee I-M, Cook NR, et al. A retrospective cohort study of cigarette smoking and risk of rheumatoid arthritis in female health professionals. *Arthritis and Rheumatism* 1999; 42(5): 910-7.
- 23 Uhlig T, Hagen KB, Kvien TK. Current tobacco smoking, formal education, and the risk of rheumatoid arthritis. *Journal of Rheumatology* 1999; 26(1): 47-54.
- 24 Silman A, Newman J, MacGregor AJ. Cigarette smoking increases the risk of rheumatoid arthritis. *Arthritis and Rheumatism* 1996; 39(5): 732-5.
- 25 Vessey MP, Villard-Mackintosh L, Yeates D. Oral contraceptives, cigarette smoking and other factors in relation to arthritis. *Contraception* 1987; 35(5): 457-65.
- 26 Saag KG, Cerhan JR, Kolluri S, et al. Cigarette smoking and rheumatoid arthritis severity. *Annals of the Rheumatic Diseases* 1997; 56: 463-9.
- 27 Houssien DA, Scott DL, Jonsson T. Smoking, rheumatoid factors, and rheumatoid arthritis. *Annals of the Rheumatic Diseases* 1998; 57: 175-6.
- 28 Heliovaara M, Aho K, Aromaa A, et al. Smoking and risk of rheumatoid arthritis. *The Journal of Rheumatology* 1993; 20(11): 1830-5.
- 29 Wise RA. Changing smoking patterns and mortality from chronic obstructive pulmonary disease. *Preventive Medicine* 1997; 26: 418-21.
- 30 US Department of Health and Human Services. *Women and Smoking. A Report of the Surgeon General*. Rockville, Maryland: US Department of Health and Human Services, 2001.
- 31 Jonas MA, Oates JA, Ockene JK, Hennekens CH. American Heart Association Medical/Scientific Statement: Statement on Smoking and Cardiovascular Disease for Health Care Professionals. *Circulation* 1992; 86(5): 1664-9.
- 32 Cunningham LS, Kelsey JL. Epidemiology of musculoskeletal impairments and associated disability. *American Journal of Public Health* 1984; 74: 574-9.
- 33 Wyngaarden JB, Smith LH, Jr (eds). *Cecil Textbook of Medicine*, 17th edition. Philadelphia: WB Saunders Co., 1985.
- 34 Patrick DL, Cheadle A, Thompson DC, et al. The validity of self-reported smoking: a review and meta-analysis. *American Journal of Public Health* 1994; 84(7): 1086-93.
- 35 Chen J, Hou F. Unmet needs for health care. *Health Reports (Statistics Canada, Catalogue 82-003)* 2002; 13(2): 23-34.
- 36 Silverman EK, Speizer F. Risk factors for the development of chronic obstructive pulmonary disease. *The Medical Clinics of North America* 1996; 80(3): 501-22.
- 37 US Department of Health and Human Services. *Preventing Tobacco Use among Young People: A Report of the Surgeon General*. 1994. Atlanta, Georgia: US Department of Health and Human Services, 1994. Reprinted, with corrections, July 1994.
- 38 Tager IB, Munoz A, Rosner B, et al. Effect of cigarette smoking on the pulmonary function of children and adolescents. *American Review of Respiratory Disease* 1985; 131(5): 752-9.
- 39 Tager IB, Segal MR, Speizer FE, et al. The natural history of forced expiratory volumes: effect of cigarette smoking and respiratory symptoms. *American Review of Respiratory Disease* 1988; 138(4): 837-48.
- 40 Silverman EK, Weiss ST, Drazen JM, et al. Gender-related differences in severe, early-onset chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine* 2000; 162: 2152-8.
- 41 Gold DR, Wang X, Wypij D, et al. Effects of cigarette smoking on lung function in adolescent boys and girls. *New England Journal of Medicine* 1996; 335: 931-7.
- 42 Merkesdal S, Ruof J, Schöffski O, et al. Indirect medical costs in early rheumatoid arthritis: comparison of and changes in indirect costs within the first three years of disease. *Arthritis and Rheumatism* 2001; 44(3): 528-34.

Appendix

Table A
Distribution of selected characteristics, household population aged 35 to 64, Canada, 2000/01

| | Both sexes | | | Men | | | Women | | |
|---|---------------|----------------------|-------------------|---------------|----------------------|-------------------|---------------|----------------------|-------------------|
| | Sample size | Estimated population | | Sample size | Estimated population | | Sample size | Estimated population | |
| | | '000 | % | | '000 | % | | '000 | % |
| Total | 34,144 | 7,025 | 100.0 | 15,517 | 3,297 | 100.0 | 18,627 | 3,728 | 100.0 |
| Age when daily smoking began | | | | | | | | | |
| 13-17 | 10,999 | 1,977 | 28.1 | 5,983 | 1,108 | 33.6 | 5,016 | 868 | 23.3 |
| 18-22 | 7,086 | 1,318 | 18.8 | 3,341 | 660 | 20.0 | 3,745 | 658 | 17.7 |
| Never smoked | 16,059 | 3,731 | 53.1 | 6,193 | 1,529 | 46.4 | 9,866 | 2,202 | 59.1 |
| Education | | | | | | | | | |
| Less than high school graduation | 8,106 | 1,487 | 21.2 | 3,825 | 682 | 20.7 | 4,281 | 805 | 21.6 |
| High school graduation/Some postsecondary | 9,152 | 1,937 | 27.6 | 3,814 | 819 | 24.9 | 5,338 | 1,117 | 30.0 |
| Postsecondary graduation | 16,525 | 3,529 | 50.2 | 7,706 | 1,760 | 53.4 | 8,819 | 1,769 | 47.5 |
| Missing | 361 | 72 | 1.0 | 172 | 36 | 1.1 | 189 | 35 | 1.0 |
| Household income | | | | | | | | | |
| Lowest | 4,302 | 699 | 10.0 | 1,649 | 282 | 8.5 | 2,653 | 418 | 11.2 |
| Lower-middle | 6,623 | 1,278 | 18.2 | 2,664 | 537 | 16.3 | 3,959 | 741 | 19.9 |
| Upper-middle/High | 20,053 | 4,413 | 62.8 | 9,929 | 2,210 | 67.0 | 10,124 | 2,204 | 59.1 |
| Missing | 3,166 | 634 | 9.0 | 1,275 | 269 | 8.2 | 1,891 | 365 | 9.8 |
| Cigarettes per day | | | | | | | | | |
| 25+ | 6,418 | 1,117 | 15.9 | 3,912 | 692 | 21.0 | 2,506 | 425 | 11.4 |
| Less than 25 | 27,663 | 5,899 | 84.0 | 11,569 | 2,600 | 78.9 | 16,094 | 3,299 | 88.5 |
| Missing | 63 | 9 ^{E1} | 0.1 ^{E1} | 36 | 5 ^{E1} | 0.2 ^{E1} | 27 | 4 ^{E2} | 0.1 ^{E2} |

Data source: 2000/01 Canadian Community Health Survey, Cycle 1.1

Note: Because of rounding, detail may not add to totals.

E1 Coefficient of variation between 16.6% and 25.0%

E2 Coefficient of variation between 25.1% and 33.3%

