ORIGINAL INVESTIGATION

A Prospective Study of Age and Lifestyle Factors in Relation to Community-Acquired Pneumonia in US Men and Women

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Background: Information is limited on risk factors for community-acquired pneumonia (CAP) in free-living populations. We examined the associations of age, smoking status, body mass index (BMI), weight change during adulthood, physical activity, and alcohol intake with risk of CAP among men and women.

Methods: The study population included 26 429 men aged 44 to 79 years from the Health Professionals Follow-up Study and 78 062 women aged 27 to 44 years from the Nurses' Health Study II. Information was collected by biennial mailed questionnaires and the main outcome was physician-diagnosed incident pneumonia.

Results: There were 290 cases among men (6 years of follow-up) and 305 cases among women (2 years of follow-up). Age, smoking status, BMI, physical activity, and alcohol intake were taken into account in the multivariate logistic regression model. There was a dose-response relation between aging and risk of CAP among men. Compared with never smokers, current smoking was associated with risk of CAP among men (relative risk, 1.46; 95% confidence interval, 1.00-2.14) and women (relative risk, 1.55; 95% confidence interval, 1.15-2.10). In addition, BMI was directly associated with an increased risk of CAP among women. Compared with the participants who maintained their weight during adulthood, the risks were nearly 2-fold higher among men and women who gained 40 lb or more (≥18 kg). The risk of CAP decreased with increasing physical activity among women. We also found no significant relation between alcohol intake and risk of CAP among men and women.

Conclusions: Smoking and excessive weight gain are risk factors for CAP among men and women, and physical activity was inversely associated with risk of CAP only among women. The incidence of CAP could possibly be decreased by lifestyle factors.

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PNEUMONIA IS one of the most frequent infectious diseases and ranks as the sixth leading cause of death in the United States.[1] More than 4 million Americans are estimated to develop pneumonia annually.[2] Risk factors for mortality of community-acquired pneumonia (CAP) among hospitalized patients[3-6] and for developing CAP in case-controlled studies were identified.[7-9] However, a few investigations[10-12] have focused on risk factors for CAP in a general population. Relations between lifestyle factors such as cigarette smoking, alcohol consumption, exercise, and body weight and risk for developing pneumonia leading to death or hospitalization were examined.[3,8,10,11,13]

Heavy smoking and alcoholism are established strong risk factors for CAP.[9,12,14-17] Current smoking increased risks of hospitalization due to pneumonia in women[10] and men[11] as well as CAP incidence.[12] However, possible confounding of chronic pulmonary disease, asthma, or heart disease existed in the relation between smoking and risk of CAP, and it remained unclear whether past smoking or light-to-moderate smoking is related to CAP incidence. Similarly, heavy alcohol drinking was known to increase risks of pneumococcal infection,[9] but data including moderate alcohol use have been limited. Low body weight, especially in the setting of chronic or severe nutritional deprivation, has been considered a risk factor for CAP.[4,7,10-13] Despite the high prevalence of obesity in the United States,[18,19] little information is available on the association between body fatness and risk of CAP; recent studies reported that obesity was associated with impaired immune function[20,21] and that weight reduction resulted in recovering from immune impairment.[20] One strategy to reduce body weight is regular exercise, which may increase immunocompetence and resistance to infections. However, the effects of the intensity or duration of exercise on immune function or the incidence of respiratory tract infection are

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METHODS

STUDY POPULATION

In this study, we prospectively examined the relations between age, cigarette smoking, body mass index (BMI), physical activity, as well as alcohol intake and risk of CAP in men and women who were free of asthma, cancer, cardiovascular disease, and diabetes at the beginning of the study and who were participants in 2 large cohort studies, the Health Professionals Follow-up Study (HPFS) and the Nurses' Health Study II (NHS II).

Details of design and data collection used in the HPFS and the NHS II have been previously published.[27-29] In brief, the HPFS was started in 1986 when 51 529 US male health professionals aged 40 to 75 years responded to a mailed questionnaire. The NHS II began in 1989 when 116 686 US female registered nurses aged 25 to 42 years returned a mailed questionnaire. At the time of enrollment, members of both cohorts provided a detailed medical history, including diagnosed diseases, medication, and information on lifestyle factors including smoking. Information on dietary intake and physical activity was also obtained from a semiquantitative food frequency questionnaire[30] and a standardized physical activity questionnaire, respectively.[31] Biennial questionnaires were mailed to participants to update newly diagnosed disease. Questions about the diagnosis of pneumonia were included in the HPFS questionnaires beginning in 1990 and in the NHS II since 1991; therefore, the baseline was considered to be the date of return of the questionnaire in 1990 or 1991, respectively. Among 39 044 men and 95 237 women who responded to the baseline questionnaire, we excluded participants in whom pneumonia occurred during a hospitalization (14 men, 19 women), those in whom the diagnosis of pneumonia was not identified by medical records (246 men) or by the supplementary questionnaire (50 women), those in whom the reported pneumonia was diagnosed before the beginning of the study (338 men, 59 women), or those who did not respond to questions on body weight and physical activity (5320 men, 10 379 women). Among women, we excluded participants who reported on a supplementary questionnaire that their diagnosis of pneumonia was probable or possible (137 women) and included only women who reported a definite diagnosis. At baseline, we also excluded 6697 men (asthma, 17%; cardiovascular disease, 42%; cancer, 20%; diabetes, 21%) and 6531 women (asthma, 74%; cardiovascular disease, 6%; cancer, 8%; diabetes, 12%) to avoid confounding by diseases that could affect associations between smoking, body weight, and exercise, as well as alcohol intake and pneumonia incidence. The remaining 26 429 men and 78 062 women were eligible for analysis.

IDENTIFICATION OF CASES OF PNEUMONIA

We considered a case as physician-diagnosed pneumonia (except nosocomially acquired pneumonia) and included the first documented event of CAP occurring between February 1, 1990, and January 31, 1996, among the HPFS members and between June 1, 1991, and May 31, 1993, among the NHS II members.

For both cohorts, a supplementary questionnaire was sent to all members who reported physician-diagnosed pneumonia on a biennial questionnaire. The supplementary questionnaire included questions about symptoms, if a chest x-ray film was taken, if the diagnosis was confirmed by a chest x-ray film, if antibiotic treatment was prescribed, and if the subject required hospital admission due to pneumonia. From men, we requested permission to review medical records

Continued on next page

controversial,[22-26] and an effect of exercise on risk of CAP is limited and unclear.[13]

Previous studies that examined the associations between age, smoking, body weight, and physical activity and CAP risk were limited either because they were based on hospitalized patients or small cohorts, used case-control designs, or did not control for potential confounding due to chronic disease, which may bias relations between exposures and CAP incidence.

RESULTS

We identified 290 CAP cases during 6 years of follow-up (149 818 person-years) among men and 305 cases during 2 years of follow-up (138 262 person-years) among women. We did not have any death due to pneumonia among men and women.

The characteristics of the 2 cohorts are shown in **Table 1**. Men who developed CAP were more likely to be old and current smokers. Women who developed CAP were more likely to be heavy and current smokers and exercised less than those who did not develop CAP.

Among men, age and smoking were strong risk factors for CAP in the age-adjusted and multivariate analyses (**Table 2**). Compared with men younger than 50 years, the multivariate RRs (95% CIs) of CAP increased from 1.52 (0.97-2.39) for men aged 50 to 54 years to 4.17 (2.81-6.19) for those 70 years or older (test for trend $P<.001$). Compared with never smokers, current cigarette smoking was related to CAP; the multivariate RRs (95% CIs) were 1.46 (1.00-2.14) for current smoking and 2.54 (1.40-4.59) for current heavy smoking of 25 or more cigarettes per day compared with never smoking. Past smokers were also at an increased risk for pneumonia; the multivariate RR (95% CI) was 1.52 (1.01-2.28) among men who quit less than 10 years ago compared with never smokers. The corresponding RR (95% CI) for those who quit smoking 10 years or more ago was 1.23 (0.93-1.62).

In the analyses for body weight, men who gained 40 lb or more (≥18 kg) since the age of 21 years had about a 2-fold increased risk of CAP compared with those who maintained their weight, whereas there was no linear relation between BMI and CAP (Table 2). To reduce bias from misclassification of body fatness at older age and from leanness due to preclinical or chronic illness, we limited the analysis to 13 604 men younger than 60 years;

relating to the diagnosis of pneumonia, and a diagnosis was considered confirmed if a pulmonary infiltrate was noted on the chest x-ray report. From women who reported that they had definite pneumonia, we obtained medical records from a random sample of 76 subjects. A radiographic diagnosis of pneumonia based on medical record review was confirmed in 82% of cases. Given this high rate of concordance between self-report and the medical records in this subsample, pneumonia among women was based on self-report. The reviewer of medical records was blinded to the self-reported diagnosis.

Deaths were ascertained by information provided by family members, the postal service, and a search of the National Death Index.[32] Participants who did not respond were assumed to be alive if they were not listed in the National Death Index.

RISK FACTORS

On the baseline questionnaire, we collected information on age, weight (in pounds), height (in inches), present and past smoking history, physical activity, and alcohol intake. The validity of self-reported body weight, height, physical activity, and alcohol consumption has been reported in detail elsewhere.[27-29] We calculated BMI (a measure of weight in kilograms divided by the square of height in meters) using the reported weight and height. Height and recalled weight at the age of 21 years (for men) or at the age of 18 years (for women) were obtained in 1986 and 1991, respectively. We asked about smoking status according to never, past, and current smoking and average number of cigarettes per day (1-4, 5-14, 15-24, 25-34, 35-44, ≥45 cigarettes). We calculated a metabolic equivalents (MET)–hour score for recreational or leisure-time physical activity. The MET-hour score was calculated for each participant by multiplying the reported average time spent at each activity per week by the typical energy expenditure requirements for the activity (expressed in MET-hours).[33]

Intake of alcohol during the previous year was estimated from a semiquantitative food frequency questionnaire, which included questions about average daily consumption of beer (1 bottle or can), wine (4-oz glass), and spirits (1 drink or shot). For each item on the questionnaire, participants could select 1 of 9 frequency response categories, ranging from never or less than once per month to 6 times or more per day. Total daily alcohol consumption in grams was calculated by multiplying the frequency of consumption and alcohol content of those beverages.

DATA ANALYSIS

We grouped participants into 5-year intervals of age, 5 categories of smoking status (never smoker, past smoker, current smoker of <25 cigarettes per day, current smokers of ≥25 cigarettes per day, and current smoker who did not report the number of cigarettes), 6 categories of BMI (<21, 21-22.9, 23-24.9, 25-26.9, 27-29.9, and ≥30), weight change since the age of 21 years (men) or the age of 18 years (women) (≥5-lb loss, −4.9 to +4.9, +5 to 9.9, +10 to 19.9, +20 to 39.9, ≥40-lb gain), alcohol intake (0, 0.1-5, 5.1-10, 10.1-15, 15.1-30, >30 g/d), and quintiles of physical activity. The number of cases and the cumulative number of person-years of follow-up were assigned to each category of exposure as determined at baseline. Relative risks (RRs) were calculated by dividing the incidence rate of each specific category of exposure by that of the corresponding reference category. We calculated RRs adjusted for age (5-year categories) using the Mantel-Haenszel method,[34] and the Mantel extension test was used to test for a linear trend.[35] We also estimated RRs adjusted for age, smoking, and other risk factors using multiple logistic regression models. We calculated 95% confidence intervals (CIs) for RRs, and all *P* values are 2-tailed.

the multivariate RRs (95% CIs) using BMIs of 21 to 22.9 as the comparison group were 0.92 (0.31-2.75) for less than 21, 0.73 (0.39-1.35) for 23 to 24.9, 0.98 (0.54-1.76) for 25 to 26.9, 1.36 (0.74-2.52) for 27 to 29.9, and 1.12 (0.58-2.18) for 30 or more (test for trend *P*=.19). In a further analysis, however, when we excluded men younger than 60 years who experienced weight loss of 10 lb or more (≥4.5 kg) in the first 4 years of follow-up, the risk of pneumonia in the leanest men was greatly reduced (data not shown). For men, we also examined the associations between other indices of body fatness and risk of CAP. However, we found no significant relation between waist circumference or waist-to-hip ratio and risk of CAP (data not shown).

We found no significant associations of physical activity and alcohol intake with risk of CAP among men (Table 2).

We did not observe significant relations of women's age with risk of CAP; however, all women were younger than 45 years at baseline (**Table 3**).

Among women, current smoking increased risk of CAP; the multivariate RRs (95% CIs) were 1.55 (1.15-2.10) for current smoking, 1.67 (1.20-2.33) for current smoking less than 25 cigarettes per day (85% of current smokers), and 1.46 (0.72-2.99) for current smoking of 25 or more cigarettes per day compared with never smoking (Table 3).

We observed a direct relation between BMI and risk of CAP among women (Table 3). Compared with women with BMIs of 21 to 22.9, the multivariate RRs (95% CIs) of CAP according to BMI increased from 1.53 (1.03-2.28) for women with BMIs of 25.0 to 26.9 to 2.22 (1.56-3.18) for those with BMIs of 30.0 or greater (test for trend *P*<.001); similar associations were seen after excluding current or past smokers. Weight gain since the age of 18 years was also positively related to risk of CAP after adjusting for age, smoking status, physical activity, alcohol intake, and BMI at the age of 18 years (test for trend *P*<.001) (Table 3).

Physical activity was inversely associated with CAP among women (test for trend *P*=.02) (Table 3). Among women in the highest quintile of physical activity (MET-hours per week, ≥32.3), the risk of CAP was 0.66 (95% CI, 0.46-0.95) compared with those in the lowest quintile (MET-hours per week, ≤3.8) after adjusting for age, smoking status, and alcohol intake. After further adjusting for BMI at baseline, the risk was attenuated (RR, 0.76; 95% CI, 0.53-1.10).

Table 1. Characteristics of Men in the Health Professionals Follow-up Study in 1990 and Women in the Nurses' Health Study II in 1991*

Risk Factors	Men (n = 26 429) CAP	Men (n = 26 429) Non-CAP	Women (n = 78 062) CAP	Women (n = 78 062) Non-CAP
No. of subjects	290	26 139	305	77 757
Age, mean ± SD, y	61.1 ± 9.6	56.3 ± 9.5	36.6 ± 4.7	36.4 ± 4.7
Smoking status, %				
Never smokers	36.2	46.9	59.0	66.1
Former smokers	47.1	41.6	22.0	21.4
Current smokers	10.6	7.4	17.7	11.8
Weight, mean ± SD, lb	179.9 ± 25.0	179.4 ± 25.9	157.1 ± 37.8	145.9 ± 31.5
BMI, mean ± SD	25.7 ± 3.3	25.5 ± 3.2	26.3 ± 6.2	24.4 ± 5.0
MET-hours, mean ± SD	29.0 ± 32.2	29.5 ± 32.7	17.0 ± 22.9	20.9 ± 26.6
Alcohol intake, mean ± SD, g/d	11.1 ± 14.2	10.4 ± 14.4	3.4 ± 7.2	3.1 ± 6.0

CAP indicates subjects who developed community-acquired pneumonia; non-CAP, subjects who did not develop community-acquired pneumonia; BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); and MET, mean metabolic equivalent per week of physical activity.

There was no association between alcohol intake and risk of CAP among women (Table 3).

COMMENT

In these 2 prospective studies of men and women, cigarette smoking and excessive weight gain during adulthood were associated with increased risk of CAP. In addition, an increased risk of pneumonia was related to age among men and to BMI and sedentary lifestyle among women.

Our results are based on a prospective study of 2 large cohorts. We tried to reduce the possibility of confounding due to comorbid illnesses by excluding individuals with asthma, cardiovascular disease, cancer, and diabetes at baseline. We used the first event of CAP and also required the diagnosis of pneumonia to be confirmed by a chest x-ray examination for men. For women, self-report of the occurrence was validated in a subsample of women who stated that they had definite pneumonia. The differences in risk factors for pneumonia observed in men and women in part might be due to different age ranges between men and women rather than due to sex differences. For this issue, however, more investigations are needed.

Age, smoking, and low body weight have been previously related to pneumonia.[3-7,9-14] However, since these relations were examined among hospitalized patients[3-5,7,9] or an elderly population who might have a higher underlying risk of pneumonia due to physical or cognitive impairment[13] or other illnesses,[11] the generalizability of the findings is questionable. In general, with advancing age, immune function becomes impaired, and there is a higher risk of infectious disease, including pneumonia.[7,8,13,36] Lange et al[10] observed that among men and women aged 30 to 70 years the risk of death and hospital admission due to pneumonia increased with age during 12 years of follow-up. We found that age was related to the risk of pneumonia among men aged 40 to 75 years. However, age was not associated with pneumonia in the age range of our younger female cohort.

Smoking is a well-known risk factor for respiratory infectious disease.[37] Smoking changes the respiratory tract's mucosal surface and its function, increasing the number of abnormal cilia[38] and permeability of the airway epithelium.[39] These effects impair mucociliary clearance, increase bacterial adherence and airway colonization,[40] and help infectious organisms enter from the airways into the interstitium and parenchyma of the lung.[39] Smoking also causes impairment of systemic immune function; smokers are more likely to have reduced helper and suppresser T-cell ratios, natural killer cell activity, and immunoglobulin levels compared with nonsmokers.[41,42] Past smokers had a lower risk of pneumonia than current smokers in our data, which suggests that the changes to the respiratory tract are not permanent and that smoking cessation may reduce the risk of pneumonia toward that of never smokers.[43]

Generally, low body weight has been associated with increased risk of CAP, possibly due to malnutrition and underlying illness.[4,7,8,10-13,44,45] However, our findings showed that excessive body fatness and weight gain during adulthood clearly increased risk of pneumonia among women. These effects of obesity seem to have been independent of physical activity, whereas a relation between physical activity and risk of CAP seems to have been dependent on body weight. Among men, excessive weight gain during adulthood was also associated with an increased risk of pneumonia. In further analyses of body fatness, we tried to minimize the effects of reverse causation and misclassification of body fatness in older men that might account for the increased risk of pneumonia in the leanest men.[46] Accordingly, the risk of pneumonia in the leanest men was greatly reduced when we limited the analysis to men younger than 60 years who are less likely to have serious underlying chronic illness and excluded those who experienced excessive weight loss in the first 4 years of follow-up. However, more data from younger men are needed to evaluate the relation between obesity and risk of pneumonia. Obesity is associated with impaired T- and/or B-cell function.[18,19] The relation between obesity and impaired immunity may be mediated in part by metabolic consequences of obesity, such as hyperglycemia and insulin resistance.[47]

The relation between exercise and respiratory tract infections is controversial.[22-26] Although high-intensity and long-duration exercise may increase risk of upper respira-

Table 2. Relative Risks of Community-Acquired Pneumonia for Risk Factors in Men

Risk Factors	No. of Cases	Person-Years	Relative Risk (95% Confidence Interval) Age-Adjusted*	Relative Risk (95% Confidence Interval) Multivariate†	P for Trend
Age, y					
≤49	44	47 440	1.00 (Referent)	1.00 (Referent)	<.001
50-54	33	23 109	1.54 (0.98-2.42)	1.52 (0.97-2.39)	
55-59	44	24 383	1.94 (1.28-2.94)	1.87 (1.23-2.84)	
60-64	54	20 471	2.83 (1.90-4.21)	2.75 (1.84-4.10)	
65-69	55	19 599	2.98 (2.00-4.43)	2.94 (1.97-4.40)	
≥70	60	14 816	4.19 (2.84-6.19)	4.17 (2.81-6.19)	
Smoking status					
Never smokers	106	70 513	1.00 (Referent)	1.00 (Referent)	Not applicable
Former smokers‡					
≥10 years ago	107	48 756	1.25 (0.95-1.63)	1.23 (0.93-1.62)	
<10 years ago	31	13 464	1.56 (1.04-2.33)	1.52 (1.01-2.28)	
Current smokers§					
<25 cigarettes/d	18	7699	1.47 (0.89-2.43)	1.42 (0.85-2.35)	
≥25 cigarettes/d	13	3310	2.65 (1.49-4.74)	2.54 (1.40-4.59)	
Body mass index					
<21.0	17	5666	1.57 (0.89-2.78)	1.55 (0.87-2.75)	.39
21.0-22.9	39	22 050	1.00 (Referent)	1.00 (Referent)	
23.0-24.9	67	41 128	0.92 (0.62-1.37)	0.91 (0.62-1.36)	
25.0-26.9	68	40 077	0.96 (0.65-1.42)	0.94 (0.63-1.39)	
27.0-29.9	78	28 566	1.57 (1.07-2.32)	1.53 (1.04-2.26)	
≥30.0	21	12 331	1.02 (0.60-1.73)	0.97 (0.57-1.67)	
Weight change since age 21 y, lb‖					
≥5 loss	45	19 826	1.61 (0.96-2.70)	1.58 (0.93-2.67)	.27
−4.9 to +4.9	21	16 180	1.00 (Referent)	1.00 (Referent)	
+5.0 to 9.9	28	15 523	1.37 (0.78-2.42)	1.38 (0.78-2.43)	
+10 to 19.9	55	34 880	1.19 (0.72-1.97)	1.17 (0.71-1.94)	
+20 to 39.9	89	43 880	1.45 (0.90-2.34)	1.41 (0.87-2.30)	
≥40 gain	52	19 529	1.79 (1.08-2.98)	1.71 (1.01-2.90)	
Quintile of MET-hours¶					
Q1 (0-5.9)	57	26 000	1.00 (Referent)	1.00 (Referent)	.74
Q2 (6.0-14.3)	77	33 571	1.04 (0.74-1.47)	1.07 (0.76-1.51)	
Q3 (14.4-26.5)	44	30 217	0.67 (0.45-1.00)	0.69 (0.47-1.03)	
Q4 (26.6-45.9)	50	29 961	0.77 (0.53-1.13)	0.80 (0.54-1.17)	
Q5 (≥46.0)	62	30 069	0.93 (0.65-1.33)	0.96 (0.67-1.38)	
Alcohol intake, g/d					
Never drinkers	60	34 028	1.00 (Referent)	1.00 (Referent)	.85
≤5	78	37 769	1.30 (0.94-1.79)	1.33 (0.97-1.84)	
5.1-10	33	20 017	1.02 (0.68-1.55)	1.04 (0.69-1.57)	
10.1-15	34	18 015	1.13 (0.75-1.71)	1.13 (0.75-1.70)	
15.1-30	38	16 546	1.39 (0.94-2.07)	1.39 (0.93-2.07)	
>30	35	14 816	1.32 (0.88-1.98)	1.17 (0.77-1.77)	

*Crude relative risks for age.
†To obtain mutlivariate relative risks, a logistic regression model includes all explanatory variables: age (5-year intervals), smoking status (never, former, current smoker of fewer than 25 cigarettes per day, current smoker of 25 or more cigarettes per day, and current smoker with unknown amount), body mass index (calculated as weight in kilograms divided by the square of height in meters; 6 categories), quintile of metabolic equivalent (MET) per week of physical activity, and alcohol intake (0, 0.1-5, 5.1-10, 10.1-15, 15.1-30, or ≥30.1 g/d).
‡Years since quit smoking.
§Average number of cigarettes smoked per day.
‖For weight change since the age of 21 years, the multivariate relative risks were further adjusted for body mass index at the age of 21 years.
¶For mean MET per week of physical activity, the multivariate relative risks were adjusted for age, smoking status, and alcohol intake except body mass index.

tory tract infections,[48,49] data on moderate exercise in an active general population are limited. In a randomized controlled study involving 36 women, the risk of upper respiratory tract infections was reduced during moderate exercise.[22] In addition, moderate physical activity was reported to enhance natural killer cell activity.[22,50] In one investigation[13] among the elderly, exercise and risk of pneumonia were unrelated. We found a significantly beneficial effect of physical activity on risk of pneumonia among younger women. However, after adjusting for body weight, the relation was attenuated, possibly because of obesity being in the causal pathway between physical activity and developing pneumonia. Among men, the relation between physical activity and pneumonia was U-shaped; however, we did not observe a significant association between heavy exercise and pneumonia.

Heavy alcohol intake is closely related to the risk of pneumonia.[9,15,16] In our cohort, since only 0.1% of all subjects were heavy drinkers, defined as daily consumption of alcohol of more than 100 g for men and 80 g for women,[15] we had limited power to observe the effect of heavy drinking. However, our data were adequate to deter-

Table 3. Relative Risks of Community-Acquired Pneumonia for Risk Factors in Women

Risk Factors	No. of Cases	Person-Years	Relative Risk (95% Confidence Interval): Age-Adjusted*	Relative Risk (95% Confidence Interval): Multivariate†	*P* for Trend
Age, y					
≤34	101	44 964	1.00 (Referent)	1.00 (Referent)	
35-39	99	49 143	0.89 (0.68-1.18)	0.85 (0.64-1.12)	.59
40-45	105	44 155	1.05 (0.80-1.38)	0.93 (0.71-1.23)	
Smoking status					
Never smokers	180	91 493	1.00 (Referent)	1.00 (Referent)	
Former smokers‡					
≥10 years ago	52	23 957	1.10 (0.80-1.50)	1.12 (0.82-1.54)	
<10 years ago	15	5550	0.90 (0.40-2.01)	0.87 (0.39-1.98)	Not applicable
Current smokers§					
<25 cigarettes/d	46	13 761	1.68 (1.21-2.32)	1.67 (1.20-2.33)	
≥25 cigarettes/d	8	2510	1.60 (0.79-3.26)	1.46 (0.72-2.99)	
Body mass index					
<21.0	63	35 790	0.99 (0.69-1.42)	1.00 (0.70-1.43)	
21.0-22.9	58	32 680	1.00 (Referent)	1.00 (Referent)	
23.0-24.9	27	24 705	0.61 (0.39-0.97)	0.61 (0.39-0.96)	<.001
25.0-26.9	42	15 120	1.56 (1.05-2.32)	1.53 (1.03-2.28)	
27.0-29.9	45	13 087	1.93 (1.30-2.85)	1.87 (1.26-2.77)	
≥30.0	70	16 881	2.32 (1.64-3.30)	2.22 (1.56-3.18)	
Weight change since age 18 y, lb‖					
≥5 loss	27	15 522	1.05 (0.62-1.78)	0.90 (0.53-1.54)	
−4.9 to +4.9	29	17 542	1.00 (Referent)	1.00 (Referent)	
+5 to 9.9	29	16 409	1.07 (0.64-1.79)	1.09 (0.65-1.83)	<.001
+10 to 19.9	43	31 767	0.82 (0.51-1.31)	0.83 (0.52-1.33)	
+20 to 39.9	90	34 723	1.57 (1.03-2.38)	1.52 (1.00-2.32)	
≥40 gain	87	22 300	2.35 (1.54-3.59)	2.13 (1.38-3.29)	
Quintile of MET-hours¶					
Q1 (0-3.8)	75	27 414	1.00 (Referent)	1.00 (Referent)	
Q2 (3.9-9.1)	70	27 714	0.93 (0.67-1.29)	0.94 (0.68-1.30)	
Q3 (9.2-17.3)	58	27 684	0.78 (0.55-1.09)	0.79 (0.56-1.12)	.02
Q4 (17.4-32.2)	54	27 803	0.72 (0.51-1.02)	0.74 (0.52-1.05)	
Q5 (≥32.3)	48	27 649	0.64 (0.44-0.92)	0.66 (0.46-0.95)	
Alcohol intake, g/d					
Never drinkers	135	56 053	1.00 (Referent)	1.00 (Referent)	
≤5	107	51 864	0.86 (0.66-1.10)	0.91 (0.71-1.18)	
5.1-10	25	13 020	0.80 (0.52-1.22)	0.89 (0.58-1.38)	.58
10.1-15	18	6823	1.09 (0.67-1.79)	1.20 (0.72-1.98)	
15.1-30	8	3466	0.96 (0.47-1.97)	1.02 (0.50-2.10)	
>30	4	1380	1.22 (0.45-3.28)	1.17 (0.43-3.19)	

**Crude relative risks for age.*

†To obtain mutlivariate relative risks, a logistic regression model includes all explanatory variables: age (5-year intervals), smoking status (never, former, current smoker of fewer than 25 cigarettes per day, current smoker of 25 or more cigarettes per day, and current smoker with unknown amount), body mass index (calculated as weight in kilograms divided by the square of height in meters; 6 categories), quintile of metabolic equivalent (MET) per week of physical activity, and alcohol intake (0, 0.1-5, 5.1-10, 10.1-15, 15.1-30, or ≥30.1 g/d).

‡Years since quit smoking.

§Average number of cigarettes smoked per day.

‖For weight change since the age of 18 years, the multivariate relative risks were further adjusted for body mass index at the age of 18 years.

¶For mean MET per week of physical activity, the multivariate relative risks were adjusted for age, smoking status, and alcohol intake except body mass index.

mine that there was no association between low or moderate alcohol intake and risk of pneumonia.

Our study has several limitations. First, we used different approaches for case ascertainment among men and women. We confirmed the diagnosis of pneumonia by reviewing medical records for all male cases but not for all female cases. However, there was a relatively high concordance rate (82%) between radiographic diagnosis of pneumonia and self-report of pneumonia in a subsample of women. Second, we could not discriminate between bacterial and viral pneumonia, because we did not have etiologic information. Third, we could not take into account potential confounding by use of pneumococcal or influenza vaccination, other unmeasured illness that might affect immunity, and infections from children, especially in women. In future studies, these possible confounders should be considered, and younger men and older women should be investigated.

In summary, we found several risk factors for CAP using prospective data obtained from 2 cohort studies. Risk factors included age and cigarette smoking for men and current smoking for women. Obesity was a risk factor for CAP among women but not among men, but both men and women who gained 40 lb or more during adulthood had nearly twice the risk compared with those who maintained their weight. Active women had a lower risk for CAP than inactive women. Apparent variations in associations by sex may be related to the age difference of the cohorts. These data suggest that to a considerable degree CAP may be a preventable disease if physical activity is increased and smoking and weight gain are avoided.

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