DOES LIVING IN A COLD CLIMATE OR RECREATIONAL SKIING INCREASE THE RISK FOR OBSTRUCTIVE RESPIRATORY DISEASES OR SYMPTOMS?

Jyrki-Tapani Kotaniemi[1],
Jari Latvala[2],
Bo Lundbäck[3,4],
Anssi Sovijärvi[5],
Juhani Hassi[2],
Kjell Larsson[3]

[1] Department of Pulmonary Medicine, Päijät-Häme Central Hospital, Lahti, Finland
[2] Finnish Institute of Occupational Health, Finland
[3] Unit for Lung and Allergy Research, National Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden
[4] The OLIN studies, Dept of Medicine, Sunderby Central Hospital of Norrbotten, Luleå, Sweden
[5] Department of Clinical Physiology and Nuclear medicine, Laboratory Department, University Hospital, Helsinki, Finland

ABSTRACT

Objectives. Respiratory symptoms and obstructive pulmonary diseases experienced during exercise and in cold weather were analysed in a large postal questionnaire study of a general adult population living in a cold climate. The aim of this study was to assess the prevalence of shortness of breath (SOB) during exercise, or in cold weather, and to find out if the risks (odds ratio=OR) for asthma, chronic bronchitis, or SOB during exercise, or in cold weather, were affected by recreational cross-country skiing, or by outdoor work in a cold climate.

Results. Of the 7937 invited persons, 84% responded; 876 of them were outdoor workers and 1497 were recreational cross-country skiers. Of the non-smoking responders, asthmatic subjects had the highest prevalence of SOB during exercise in cold weather (78%-82%), but allergic and bronchitic persons also had significantly higher prevalence rates (22%-38% and 27%-59%, respectively) than healthy persons (10%-19%). In all categories, the prevalence of SOB was significantly higher among current smokers than among ex- or non-smokers.

Risk factor analysis revealed increased risks for respiratory conditions among those who had a family history of obstructive airway disease, or allergy. Skiers did not have a significantly increased risk for asthma, or respiratory symptoms. Among outdoor workers the risk for SOB during exercise in cold weather, OR 1.23 (CI 1.03-1.47), and for chronic bronchitis, OR 1.77 (CI 1.21-2.60), was higher than among indoor workers.

Conclusions. In conclusion, the risk for chronic bronchitis and bronchitic symptoms was elevated among outdoor workers, but not among regular recreational cross-country skiers, and the risk

for asthma was not significantly elevated by regular exercising, or by working in a cold climate.

Key words: cold weather, asthma, chronic bronchitis, respiratory symptoms, skiing, outdoor work

INTRODUCTION

Subjects with asthma frequently experience respiratory symptoms during exercise, or in cold weather (1-3), often accompanied by a decrease in lung function (4-6). Exercise testing of persons with mild to moderate asthma has shown that 65%-76% of adults (7-9) and 57%-100% of children (10-12) respond with a broncho-constriction following exercise.

Living in a very cold climate has been suggested to cause permanent lung function impairment, with features of chronic obstructive lung disease, known as "Eskimo lung" (13,14). In less extreme conditions exercise or cold air do not appear to cause significant disturbance in lung function in healthy persons (15,16), but strenuous exercise in cold weather conditions has been shown to slightly affect lung function also in healthy persons (17,18).

Frequent exposure to low temperatures, or to strenuous exercise has also been associated with an increased risk of asthma. In Switzerland, asthma was more common in ice hockey players (19.2%) than in floor ball players (4.2%), or in the general adult population (6.8%) (19). It has been reported that over 50% of top level cross-country skiers (20) and about one-third of competitive figure skaters (21,22) have asthma, or an asthma-like condition with bronchial hyper-responsiveness to exercise.

However, it is not known if exercising in cold weather, whether in recreational skiing, or in regular outdoor work, increase the risk for obstructive respiratory diseases and symptoms.

The aim of the present study was to assess the prevalence of shortness of breath during exercise, or in cold weather, reported by subjects with physician-diagnosed asthma, or chronic bronchitis, subjects with allergic rhinitis, or conjunctivitis, and by healthy subjects. Another aim was to compare the prevalence of asthma, chronic bronchitis, wheezing and shortness of breath in cross-country skiers and outdoor workers with that in non-skiers and indoor workers.

A third aim was to determine whether the risk (OR) for asthma, chronic bronchitis and shortness of breath during exercise, or in cold weather, is influenced by age, sex, smoking habits, family history of allergy, or obstructive airways disease (OAD), area of domicile, outdoor work, or by recreational cross-country skiing.

MATERIAL AND METHODS

Study area and population

The study area was the central and southern part of Finnish Lapland, the northernmost province in Finland located between northern Sweden, Norway and Russia (Figure 1). The climate in this area is cold. The yearly mean temperature is +1 °C in the southern part (coastal area) and –1 °C in the central part (inland). The temperature is below the freezing point for approximately 140 days/year in the coastal area and 160 days/year in the inland. The mean temperature in the study area is +15 °C in July and -13 °C in January. At the end of the year 1995, the adult population (20-69 years old) in the study area was 90 339 persons. The main occupations in the study area are in the pulp and paper industry, social services, forestry, trade and farming. A postal questionnaire was sent to a random sample of 8005 persons (20-69 years old) of the study population, during the winter 1995/1996 (23).

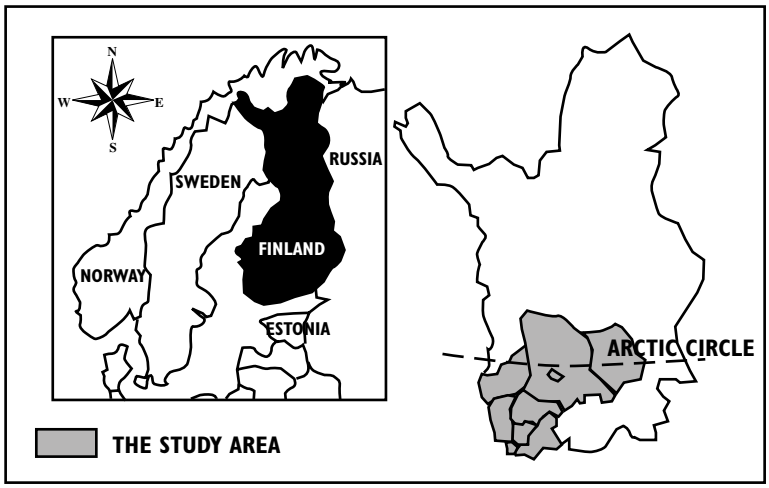

Fig 1. The Study Area.

Ethical considerations

The study was approved by the Ethics Committee of Länsi-Pohja Hospital District in Lapland.

Questionnaire

In this study, we used the Finnish version (23,24) of the FinEsS questionnaire. The questionnaire includes questions about allergy, heredity, respiratory symptoms, asthma, chronic bronchitis, symptoms under special circumstances, use of asthma medication, profession, smoking habits, smoking habits of parents, outdoor work and skiing habits.

Questions about respiratory symptoms and diseases required either "yes", or "no/don't know" answers. Classification of smoking habits was either as non-smokers, ex-smokers (those who had stopped more than 12 months earlier were classified as ex-smokers), or current smokers, according to usual questions.

Symptoms experienced during exercise, or in cold weather, were assessed by the question: "Do you get shortness of breath, wheezing, or severe cough: a) during exercise, b) in cold weather, c) during exercise in cold weather (at temperatures below freezing point)?"

Working conditions were assessed by the question "Are you nowadays working mainly at a) outdoor, or b) indoor work?", and skiing habits by the question "Are you, or have you been a regular recreational skier?"

Analyses

The chi-square test was used for bi-variate comparisons. One-way ANOVA (analysis of variance) was used to test for trends. Odds ratios (OR) for various independent variables were calculated using multiple logistic regression analysis. In order to assess regional differences, the study area was divided in the logistic regression model into coastal and inland areas. In the analyses of working condition effects those 437 subjects who reported to be working both in indoor and outdoor occupations were pooled together with 439 subjects who reported only outdoor work.

For the analysis of clinical conditions, in addition to single symptoms and diseases, a symptom combination was calculated: *adjusted chronic bronchitis*, which contains all those who reported a physician-diagnosed chronic bronchitis, or a chronic productive cough, with the exclusion of physician-diagnosed asthma.

RESULTS

Participation, working environment, skiing and smoking habits

The participation rate, smoking habits, outdoor work and recreational cross-country skiing for the different age groups, classed by gender, are shown in Table I. After exclusion of those who had moved away, or deceased before the start of the study, 7937 persons remained in the study sample, of whom 6633 (84%) responded to the questionnaire.

Women were more often lifetime non-smokers than men in all age groups. In the oldest age group, the difference was largest (73.9% vs. 34.3%, $p<0.001$), while it was smaller (50.3% vs. 43.6%), but still significant ($p<0.05$), in the youngest age group.

The proportion of outdoor workers among persons younger and

Table I. The study sample, responders, smoking categories, outdoor workers and recreational cross-country skiers, grouped by age and gender (m = males, f = females, ever-smokers = current + ex-smokers).

age cohort, years	20 - 29		30 - 39		40 - 49	
	m	f	m	f	m	f
study sample	806	709	945	932	1062	949
responders	587	585	741	802	845	826
% of the study sample	72.8	82.5	78.4	86.1	79.6	87.0
non-smokers (%)	43.6	50.3	41.0	43.9	32.9	54.1
ex-smokers (%)	8.2	8.7	12.4	17.5	23.1	15.6
current-smokers (%)	48.2	41.0	46.6	38.7	44.0	30.3
ever-smokers (%)	56.4	49.7	59.0	56.1	67.1	45.9
outdoor workers	95	28	184	24	232	46
% of responders	16.2	4.8	24.8	3.0	27.5	5.6
skiers	124	92	187	120	250	158
% of responders	21.1	15.7	25.2	15.0	29.6	19.1

age cohort, years	50 - 59		60 - 69		20 - 69		all
	m	f	m	f	m	f	m + f
study sample	683	698	528	625	4024	3913	7937
responders	582	635	464	566	3219	3414	6633
% of the study sample	85.2	91.0	87.9	90.6	80.0	87.2	83.6
non-smokers (%)	33.0	67.9	34.3	73.9	36.9	56.9	47.2
ex-smokers (%)	34.9	10.6	34.1	9.7	21.6	12.9	17.2
current-smokers (%)	32.1	21.6	31.7	16.4	41.4	30.2	35.6
ever-smokers (%)	67.0	32.1	65.7	26.1	63.1	43.1	52.8
outdoor workers	137	24	76	30	724	152	876
% of responders	23.5	3.8	16.4	5.3	22.5	4.5	13.2
skiers	186	137	133	110	880	617	1497
% of responders	32.0	21.6	28.7	19.4	27.3	18.1	22.6

older than 45 years of age was 13.7% and 12.7%, respectively. The total number of regular cross-country skiers was 1497. The proportion of regular skiers was 27% among men and 18% among women. Differences between the age groups in skiing habits, or in the proportion of outdoor workers, were small.

Respiratory conditions in relation to age, sex and smoking

The prevalence of asthma was lower in the 30- to 49-year-old age group than in the younger and older age groups, while the prevalence of chronic bronchitis increased with increasing age and smoking. The prevalence of *adjusted chronic bronchitis* was higher among current smokers than among non-smokers, or ex-smokers. Among lifetime non-smokers in the 60-69 years age group, the prevalence of *adjusted chronic bronchitis*, 9.0% was significantly higher ($p<0.01$), than in the 20-29 years age group (4.0%). The corresponding prevalence rates among current smokers were 24.6% and 9.4% ($p<0.001$). In each age group, the prevalence rates of *adjusted chronic bronchitis* were 2-3 times higher among current smokers than among non-smokers. Among current smoking men, the prevalence was 15.1% vs 6.1% among non-smoking men ($p<0.01$). In the female population, the corresponding values were 15.2% vs 6.8% ($p<0.01$), respectively.

Shortness of breath during exercise in cold weather increased significantly with smoking. The prevalence among current smokers, 32.2%, was significantly higher ($p<0.001$) than among non-smokers, 22.1%, or ex-smokers, 25.8%. Similarly, shortness of breath in cold weather was reported more frequently ($p<0.01$) by smokers than by ex-, or non-smokers.

Differences between sexes were small. However, among non-smokers, women had a significantly higher prevalence of shortness of breath during exercise, in cold weather, or during exercise in cold weather, than men, while among current smokers, men reported more frequent shortness of breath during exercise, or during exercise in cold weather, than women (Table II).

Shortness of breath in healthy, asthmatic, bronchitic and allergic persons

Among healthy, non-smoking men, the prevalence of shortness of breath during exercise was significantly higher ($p<0.001$) in the older age group (8.8%) than under 45 years of age (2.8%). Among women in the same categories, the values were 12.1% vs. 5.5% ($p<0.001$),

Table II. The prevalence (%) of asthma, chronic bronchitis, wheezing with SOB for reasons other than colds and breathlessness in cold weather, or during exercise, grouped by age and gender. SOB = shortness of breath, m = male, f = female, n-s = non-smokers, ex-s = ex-smokers, c-s = current smokers.

		age cohort, years					
		20 - 29		30 - 39		40 - 49	
		m	f	m	f	m	f
physician-	n-s	9.0	4.4	3.6	4.8	4.0	5.4
diagnosed	ex-s	8.3	9.8	6.5	4.3	4.1	7.8
asthma	c-s	7.1	5.0	3.5	4.8	2.2	4.4
physician-	n-s	1.2	1.0	2.0	1.1	1.1	1.1
diagnosed	ex-s	0.0	2.0	2.2	0.7	1.5	3.1
chr. bronchitis	c-s	0.4	0.4	1.2	3.5	3.5	3.6
wheeze and SOB	n-s	7.0	6.8	3.6	4.3	4.3	3.1
apart from colds	ex-s	8.3	9.8	6.5	3.6	5.1	4.7
last 12 months	c-s	8.5	10.8	7.2	11.3	6.7	8.0
adjusted	n-s	4.7	3.4	5.3	3.7	5.4	5.6
chronic	ex-s	2.1	2.0	5.4	7.9	8.2	7.0
bronchitis	c-s	9.9	8.8	12.8	12.6	14.8	16.4
	n-s	10.5	13.9	7.9	8.0	7.6	10.7
SOB at exercise	ex-s	18.8	15.7	18.5	12.1	13.3	15.5
	c-s	28.6	17.1	22.9	15.2	20.4	26.4
	n-s	10.5	13.3	6.9	8.8	8.6	9.8
SOB in cold weather	ex-s	16.7	13.7	9.8	8.6	9.2	11.6
	c-s	13.4	15.8	11.3	13.5	12.9	18.0
SOB at exercise	n-s	19.5	23.8	16.1	16.2	13.3	18.6
in cold weather	ex-s	33.3	27.5	22.8	18.6	17.9	26.4
	c-s	36.4	32.1	26.7	27.7	29.0	32.8

		age cohort, years					male vs. female	
		50 - 59		60 - 69		20 - 69	difference	20 - 69
		m	f	m	f	m	(p-value)	f
physician-	n-s	8.9	6.3	9.4	10.5	6.5	ns	6.4
diagnosed	ex-s	6.4	9.0	12.0	9.1	7.2	ns	7.2
asthma	c-s	5.3	5.1	10.9	6.5	4.9	ns	5.0
physician-	n-s	3.6	3.2	6.3	4.1	2.4	ns	2.2
diagnosed	ex-s	3.9	9.0	11.4	5.5	4.5	ns	3.4
chr. bronchitis	c-s	5.9	8.0	14.3	9.7	3.7	ns	4.0
wheeze and SOB	n-s	6.8	7.0	10.1	7.7	5.9	ns	5.7
apart from colds	ex-s	6.9	7.5	8.9	7.3	6.9	ns	5.7
last 12 months	c-s	6.4	9.5	17.0	9.7	8.3	ns	10.0
adjusted	n-s	7.8	11.1	9.4	8.9	6.1	ns	6.8
chronic	ex-s	10.8	9.0	13.3	16.4	9.3	ns	8.1
bronchitis	c-s	19.8	24.8	25.2	23.7	15.1	ns	15.2
	n-s	17.7	20.2	20.1	23.2	11.6	p<0.01	15.5
SOB at exercise	ex-s	21.2	22.4	25.9	29.1	19.5	ns	17.2
	c-s	32.6	26.3	41.5	32.3	26.8	p<0.01	21.4
	n-s	16.1	15.1	13.2	21.5	10.4	p<0.01	13.9
SOB in cold weather	ex-s	16.7	14.9	20.3	29.1	14.5	ns	13.6
	c-s	20.9	21.2	27.2	25.8	15.3	p<0.01	17.3
SOB at exercise	n-s	19.8	30.2	23.3	34.0	17.7	p<0.01	24.8
in cold weather	ex-s	29.1	28.4	31.0	38.2	25.9	ns	25.8
	c-s	38.0	33.6	46.3	30.1	33.1	p<0.01	31.0

respectively. Among healthy men under 45 years of age, shortness of breath during exercise was reported by 18.5% of current smokers vs. 2.8% of non-smokers ($p<0.001$). The corresponding values among women were 11.4% vs. 5.5% ($p<0.001$). Subjects with physician-diagnosed asthma frequently reported shortness of breath during exercise, even if they were lifetime non-smokers.

On average, shortness of breath during exercise in cold weather (below the freezing point) was more common than only during exercise (at normal room temperature), or simply during exposure to cold air.

Among persons with adjusted chronic bronchitis, the prevalence of shortness of breath during exercise was high even in the 19- to 44-year-old non-smokers (23.5% for men and 22.6% for women), and increased significantly with smoking and age. Persons with allergic rhinitis, or conjunctivitis (asthma and adjusted chronic bronchitis excluded) reported shortness of breath in cold weather, or during exercise in cold weather more often than healthy persons (Table III).

Table III. The prevalence (%) of shortness of breath (SOB) during exercise, in cold weather, or during exercise in cold weather, in healthy, asthmatic, bronchitic, or allergic adults. Young adults (Y) = 19-44 years of age, older adults(O) 45-69 years of age. n-s=non-smokers, ex-s=ex-smokers, c-s=current smokers.

		healthy adults: asthma, chronic bronchitis and allergy excluded				physician-diagnosed asthma			
		Y male	O male	Y female	O female	Y male	O male	Y female	O female
SOB	n-s	2.8	8.8	5.5	12.1	69.2	81.6	65.1	59.8
during	ex-s	10.8	14.4	7.5	12.4	76.9	73.0	41.2	66.7
exercise	c-s	18.5	24.2	11.4	18.8	65.7	74.2	72.7	100
SOB	n-s	3.2	7.2	4.1	8.2	51.3	71.1	72.1	57.3
in	ex-s	6.3	9.6	5.2	5.8	61.5	59.5	47.1	66.7
cold weather	c-s	7.6	14.2	8.5	12.8	54.3	58.1	66.7	77.8
SOB	n-s	9.6	10.9	11.4	19.1	79.5	81.6	81.4	78.1
during exercise	ex-s	15.9	17.7	12.7	17.4	84.6	86.5	76.5	66.7
in cold weather	c-s	23.7	29.2	20.7	21.8	74.3	77.4	84.9	94.4

		adjusted chronic bronchitis: asthma excluded				allergic rhinitis, or conjunctivitis: asthma and adjusted chronic bronchitis excluded			
		Y male	O male	Y female	O female	Y male	O male	Y female	O female
SOB	n-s	23.5	53.9	22.6	33.3	6.9	17.9	11.2	25.3
during	ex-s	53.3	38.0	26.7	38.1	17.5	17.5	24.6	22.9
exercise	c-s	44.8	60.0	52.0	55.0	26.5	38.2	15.0	16.7
SOB	n-s	17.7	43.6	25.8	38.2	10.3	16.1	12.9	23.6
in	ex-s	26.7	36.0	20.0	42.9	12.5	12.7	16.4	20.0
cold weather	c-s	27.1	41.0	37.7	38.8	11.8	21.8	18.8	13.0
SOB	n-s	26.5	46.2	45.2	58.8	21.9	26.8	23.6	37.9
during exercise	ex-s	53.3	52.0	20.0	66.7	32.5	25.4	39.3	31.4
in cold weather	c-s	58.3	63.8	58.4	56.3	34.6	54.6	41.4	25.9

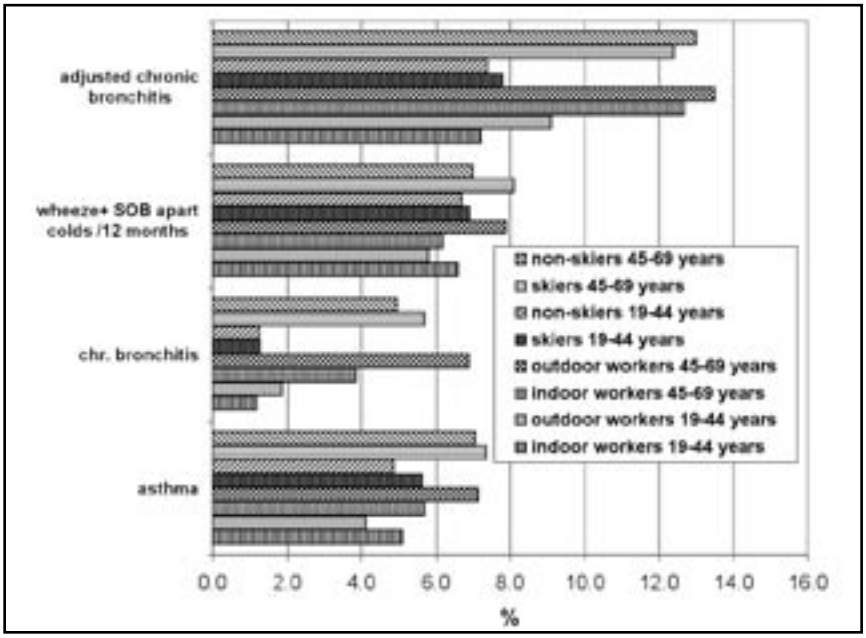

Fig 2. Prevalence (%) of asthma, chronic bronchitis and wheezing with shortness of breath among skiers, non-skiers, outdoor and indoor workers by age group.

Asthma, chronic bronchitis and shortness of breath in relation to outdoor work and skiing

The prevalence of asthma did not significantly differ between outdoor and indoor workers, or between skiers and non-skiers. Recreational cross-country skiing did not increase the prevalence of shortness of breath during exercise, or in cold weather, while the prevalence of these symptoms was higher among outdoor workers over 44 years of age who were current smokers. The prevalence of physician-diagnosed chronic bronchitis was significantly higher ($p<0.01$) among outdoor (4.1%) than among indoor workers (2.2%), while the prevalence in skiers (3.6%) did not differ significantly from that in non-skiers (2.9%) (Figures 2 and 3).

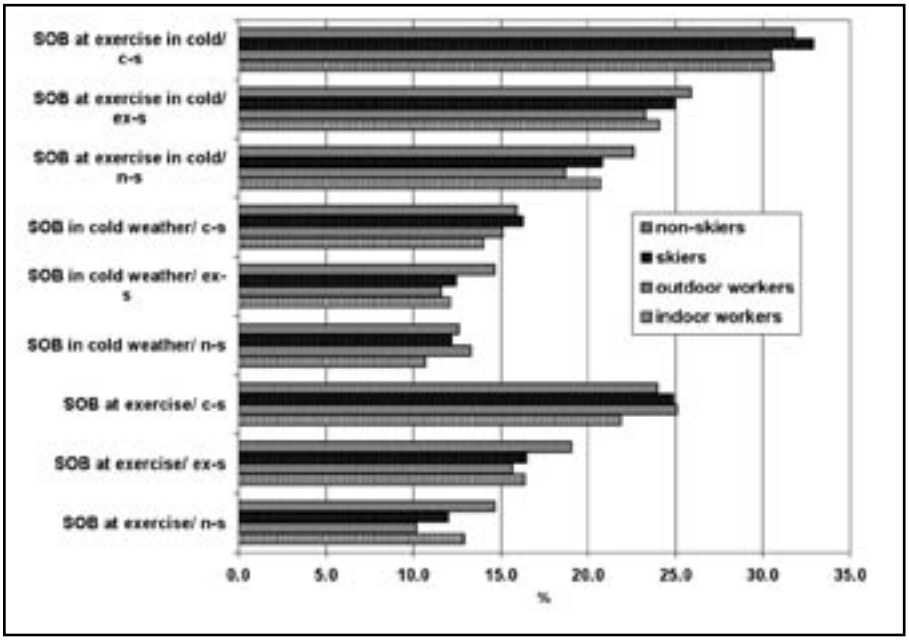

Fig 3. Prevalence (%) of shortness of breath (SOB) at exercise, in cold weather or at exercise in cold weather among non-skiers, skiers, outdoor and indoor workers by smoking habits (c-s = current smokers, ex-s = ex-smokers, n-s = non-smokers).

Multivariate relationships

According to the multiple logistic regression analysis, the OR for self-reported chronic bronchitis increased significantly with age. However, for asthma and shortness of breath during exercise, the OR was lower in the middle age groups than in the younger and older age groups. Gender did not influence the results significantly. Current smokers and ex-smokers had significantly higher ORs for chronic bronchitis, shortness of breath during exercise, and shortness of breath during exercise in cold weather, than non-smokers (Table IV). Family history of obstructive airways disease, or allergy, was associated with significantly higher ORs for asthma, chronic bronchitis, shortness of breath during exercise, and during exercise in cold weather. The area of domicile and cross-country skiing did not affect the odds ratios significantly, but outdoor work increased the odds ratios for chronic bronchitis, as well as for shortness of breath during exercise in cold weather.

Table IV. Risk factors for shortness of breath (SOB) during exercise, or during exercise in cold weather, self-reported asthma and chronic bronchitis, calculated by multiple logistic regression analysis. Risks in odds ratios (OR) with 95% confidence intervals (CI). OAD = obstructive airways disease. (*=p<0.05, **=p<0.01, ***=p<0.001).

Independent variables		Dependent variables SOB during exercise		Dependent variables SOB at exercise in cold weather	
	Categories	OR	95% CI	OR	95% CI
age	20-29y	1		1	
	30-39y	0.704**	0.556-0.892	0.690***	0.565-0.842
	40-49y	0.879	0.697-1.108	0.790*	0.647-0.963
	50-59y	1.633***	1.275-2.091	1.201	0.965-1.493
	60-69y	2.153***	1.615-2.870	1.594***	1.234-2.059
gender	men	1		1	
	women	0.965	0.813-1.147	1.157	0.996-1.343
smoking habits	non-smokers	1		1	
	ex-smokers	1.512***	1.231-1.857	1.420***	1.189-1.696
	current smokers	2.369***	1.990-2.821	1.915***	1.646-2.228
family history of OAD	no	1		1	
	yes	1.820***	1.539-2.152	1.964***	1.693-2.278
family history of allergy	no	1		1	
	yes	1.698***	1.434-2.009	1.657***	1.430-1.921
working environment	indoor	1		1	
	outdoor	1.158	0.946-1.417	1.229*	1.027-1.471
recreational skier	no	1		1	
	yes	0.936	0.783-1.118	1.008	0.864-1.176
area of domicile	coastal	1		1	
	inland	1.027	0.885-1.192	1.060	0.931-1.207

Independent variables		Dependent variables Self-reported asthma		Dependent variables Self-reported chronic bronchitis	
	Categories	OR	95% CI	OR	95% CI
age	20-29y	1		1	
	30-39y	0.544***	0.379-0.781	1,496	0.807-2.774
	40-49y	0.544***	0.378-0.783	1,683	0.914-3.099
	50-59y	0.809	0.553-1.186	4.321***	2.381-7.839
	60-69y	1.305	0.849-2.006	5.876***	3.108-11.112
gender	men	1		1	
	women	1.079	0.821-1.419	1,206	0.842-1.728
smoking habits	non-smokers	1		1	
	ex-smokers	1.360*	1.008-1.835	1.641**	1.128-2.388
	current smokers	0.840	0.627-1.127	1.844***	1.291-2.633
family history of OAD	no	1		1	
	yes	2.819***	2.190-3.628	2.613***	1.917-3.562
family history of allergy	no	1		1	
	yes	1.990***	1.542-2.568	1.868***	1.353-2.578
working environment	indoor	1		1	
	outdoor	0.900	0.637-1.270	1.773**	1.210-2.599
recreational skier	no	1		1	
	yes	1.303	0.997-1.704	1,211	0.874-1.678
area of domicile	coastal	1		1	
	inland	1.138	0.897-1.443	0,805	0.602-1.077

DISCUSSION

In the present study, respiratory symptoms and asthma in relation to cold air and exercise were investigated in a general adult population living in a cold climate area. The response rate was high (84%), and the quality of the answers was good (23). According to a separate non-response analysis of the original questionnaire study (25), no statistically significant non-response bias existed in the results concerning respiratory diseases and symptoms. These aspects influence the validity of the results.

A postal questionnaire study method has the advantage of obtaining relevant data about respiratory symptoms in large populations, but in the questionnaire, reported physician-diagnosed asthmas may have low sensitivity with respect to objective asthma. Thus, due to the lack of objective clinical parameters, it could be argued that the high prevalence of respiratory symptoms during exercise, or in cold weather, found in this study reflect undiagnosed asthma and COPD, rather than respiratory effects of exercise, cold weather, smoking habits, or of the working environment.

For example, some subjects with allergic conjunctivitis, or rhinitis, may have hyper-reactive airways (26), which might explain an increased shortness of breath during exercise, or in cold weather. Thus, some cases of undiagnosed asthma could be found in this group.

Objective clinical parameters were not used in the present study. However, some findings indicate that undiagnosed asthma does not explain the major part of the increased prevalence of shortness of breath during exercise or in cold weather. Firstly, the physician-diagnosed asthma reported in our study is closely associated with recurrent wheeze, and wheezing for reasons other than suffering from colds (23). Although the prevalence of asthma and recurrent wheeze, and non-colds-related wheezing with shortness of breath, did not differ between Lapland and Helsinki, the prevalence of shortness of breath during exercise, or during exercise in cold weather, was significantly higher in Lapland (which has a colder climate) than in Helsinki, located in the southernmost region of Finland, (27). Secondly, in an adult population, the prevalence of shortness of breath has been shown to increase with the number of cold days in the area of residence (28), i.e. cold exposure *per se* has an effect on the experienced respiratory symptoms.

On the other hand, it is very probable that undiagnosed chronic bronchitis, or COPD, are associated with the increased respiratory symptoms observed among many smokers. The proportion of undiagnosed COPD has been reported to be 54%-86% of all cases (29). In Finland, a patient with a diagnosis of COPD has more difficulty in getting compensation for the medication costs than a patient with a physician-diagnosed asthma, and this apparently increases the diagnostic bias towards a low prevalence of physician-diagnosed COPD. The wide gap between physician-diagnosed chronic bronchitis and *adjusted chronic bronchitis* in our data may reflect this bias. The respiratory symptoms reported by smokers in cold weather, or during exercise, reported in the present study, may indicate non-diagnosed chronic bronchitis, or COPD.

Current smokers reported shortness of breath more often than non-smokers, and the difference was significant in many categories. Our findings are in agreement with a cold air provocation study (30), which showed that airway resistance increased most in asthmatics, but lung function was also deteriorated in asymptomatic smokers when compared to healthy non-smokers.

According our multivariate analysis, outdoor work had an independent effect on the prevalence of chronic bronchitis and shortness of breath during exercise in cold weather. Unfortunately, smoking habits were recorded as non-, ex-, or current smokers, and pack-years data is not available. Thus, it can not be excluded that outdoor workers smoke more heavily and this could be one reason for the higher prevalence of chronic bronchitis and associated symptoms.

In the present study ex-smokers had a significantly higher prevalence of asthma than non-, or current smokers. The occurrence of adjusted chronic bronchitis was 2-3 fold higher among current smokers than among non-smokers in each age group, and this was found even in the youngest age group. Among current smokers, the prevalence of wheezing with shortness of breath for reasons other than colds was 1.5-2 times higher than among non-smokers.

The1.5-3 fold difference between current smokers and non-smokers with respect to the frequency of shortness of breath during exercise, or in cold weather, was found not only in asthmatic, bronchitic and allergic subjects, but also among healthy persons. These findings suggest that tobacco smoke – in addition to its long-term harmful effects – may act as a non-specific respiratory irritant and can enhance the effect of cold air and exercise in provoking respiratory symptoms

not only in subjects with asthma (31), but also in bronchitic, allergic and even healthy persons.

Increased frequencies of asthma, or asthma-like conditions, have been found among elite athletes (32-34), and especially among top level competitive cross-country skiers (20). Airway inflammation and bronchial hyper-responsiveness found in elite skiers seem to present different characteristics from "classical" asthma (35,36), and might be induced by repeated exposures of the airways to large amounts of inadequately conditioned air. In the present study, neither outdoor workers, nor regular recreational skiers, had a significantly increased risk for asthma. The ventilation volume and the duration of the exposure to cold air associated with recreational cross-country skiing and outdoor work are much smaller than those encountered during top level endurance training, which might explain the results of the current population based study: outdoor work and recreational cross-country skiing do not increase the risk for asthma.

Cold climates may cause a deterioration in lung function and contribute to the cold-related morbidity from chronic obstructive pulmonary disease (37). The present study reveals that outdoor work in a cold climate may increase the prevalence of respiratory symptoms and chronic bronchitis. This indicates that cold climates may play a role in the high prevalence of chronic bronchitis and bronchitic symptoms reported previously in Finland (38,39).

In conclusion, in a general adult population living in a cold climate, the high prevalence rates of shortness of breath provoked by exercise, or by cold weather, were found not only among subjects with asthma, but also among subjects with allergic rhinitis, conjunctivitis, or chronic bronchitis. Secondly, among healthy current smokers, the prevalence rates of wheezing with shortness of breath for reasons other than colds, and shortness of breath during exercise, or in cold weather, were significantly higher than among healthy non-smokers. *Thirdly*, the risk of chronic bronchitis was significantly higher among outdoor workers, but not among recreational skiers, when compared to indoor workers and non-skiers. *Lastly*, the risk for asthma was not significantly higher among recreational cross-country skiers and outdoor workers.

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Jyrki-Tapani Kotaniemi
Department of Pulmonary Medicine
Päijät-Häme Central Hospital
FIN-15850 Lahti
Finland
jyrki.kotaniemi@phks.fi