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Enviromental Asbestos Exposure as a Risk Factor for Small Airways Obstruction

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Abstract

Background: Tremolite is one of the six recognized types of asbestos, whose toxicity and carcinogenity is well-documented. Resident population in the area of Lagonegro (Basilicata, Italy) has been shown to be exposed to enviromental tremolite pollution, deriving from superficial rocks and asbestos caves. A branch of the ongoing health surveillance program for residents is evaluating the prevalence of pulmonary functional abnormalities.

Methods: The study group was composed by 655 long-term residents in the tremolite-exposed area of Lagonegro (age 49.35 ± 16.68, current smokers 109, ex-smokers 126) . The control group was composed by 653 individuals living in areas not tremolite-exposed (age 54.45 ± 17.16, current smokers 128, ex-smokers 137). All the participants to the study performed a lung function test.

Results: Prevalence of obstructive and restrictive diseases did not show significant differences between the two groups. Tremolite-exposed group showed a higher prevalence of small-airways disease compared to the non-exposed group ($p<0.01$). Odds Ratio for small-airways obstruction was 3.46 (95% CI, lower limit 2.55, upper limit 4.69). irrespective of smoking status.

Conclusions: According to our data, tremolite exposure may be a risk factor for small airways disease. It is mandatory to follow these subjects longitudinally by repeated measurements.

Keywords: Environmental exposure; Non-occupational asbestos; Tremolite; Small airways obstruction

Introduction

Tremolite is one of the six recognized types of asbestos, whose toxicity and carcinogenity is well-established [1]. It is considered an amphibole, a mineral group characterized by separable fibers that are thin, long and straight. The risks of occupational exposure to tremolite fibers especially in miners and millers are well documented [1]. Environmental tremolite exposure deriving from superficial rocks (ophiolites) and caves or the use of asbestos contaminated soil as whitewash or stucco is also hazardous. A number of case reports have associated both pleural calcification and Malignant Pleural Mesothelioma with environmental exposure to tremolite in several parts of Mediterranean Europe [2,3] and North America [1]. Basilicata, in southern Italy is also characterized by areas with natural outcrops of rocks containing tremolite. Several cases of Malignant Pleural Mesothelioma affecting local farmers without professional exposure to asbestos have been previously documented [4]. Therefore a health surveillance program of the resident population in the tremolite-polluted area of Basilicata has been carried out, including the prevalence of pulmonary functional abnormalities. Based on the above, we aimed in this study to evaluate the prevalence of obstructive or restrictive functional patterns in a group of residents in an environmentally tremolite-polluted area of Basilicata, compared to a group of subjects living in areas not tremolite-contaminated.

Methods

Study population

The study group was composed by 673 long-term residents (for at least 20 years) in the documented tremolite-exposed area of Lagonegro, Basilicata. The control group was composed by 673 subjects, matched for age and sex, living in areas not tremolite-polluted. A total number of 18 subjects from the exposed and 20 subjects from the not exposed group were excluded from the study because of incomplete or unreliable clinical or demographic information. The final sample was 1308 subjects, 655 in the exposed and 653 in the not exposed group.

Study design

All the participants to the study were asked to perform a lung function test. For each subject we carefully collected demographic information, clinical history, anthropometric data, smoking habits, history of occupational and environmental exposure to mineral fibers. Measurements of tremolite fibers in ambient air were previously described. Approval was gained from the National Superior Institute of Health and all subjects provided written consent.

Lung function test

Spirometry was performed following the current recommendations [5]. The same spirometer (Pony FX, Cosmed, Italy) was used for all the participants to the study. Obstructive pattern was defined as a value of Forced Expiratory Volume in the first second/ Forced Vital Capacity (FEV1/FVC) ratio <70. Restrictive pattern was defined as values of FEV1 and FVC lower than 70%pred and FEV/FVC ratio >70. Small airways obstruction was defined as values of Forced Expiratory Flow at 25-75% of FVC (FEF25-75%) <70%pred.

Statistical analysis

Qualitative data were summarized as count and percentage and comparisons were performed with χ-square test. The percentage of obstructive, restrictive and small airways obstruction patterns were determined as outcome of the study. Each outcome was evaluated in a logistic regression model to fit the risk related to tremolite exposure and other covariate as: age, sex, smoking habits and body mass index. All analysis were performed with SAS 9.3 software for PC and results were considered statistically significant if p-value<0.05.

Results

Main characteristics of study sample, compared by exposed and not exposed group, are shown in Table 1.

		Exposed		Not Exposed		χ^2	p-value
		N=655		N=653			
Age (yrs)	<25	70	10.69	69	10.57		
	25 - 34	80	12.21	79	12.1	0.2313	0.9987
	35 - 44	113	17.25	111	17		
	45 - 64	255	38.93	251	38.44		
	65 - 74	85	12.98	87	13.32		
	≥ 75	52	7.94	56	8.58		
Sex	M	298	45.5	301	46.09	0.0472	0.828
	F	357	54.5	352	53.91		
BMI	<25	178	27.18	266	40.74	51.9193	<0.0001
	25 - 29	274	41.83	286	43.8		
	≥ 30	203	30.99	101	15.47		
Smoke	Smokers	109	17.19	128	20.65	4.395	0.111
	EX smokers	126	19.87	137	22.1		
	No smokers	399	62.93	355	57.26		
	missing	21		33			
Obstructive pattern		2	0.31	13	1.99	8.1943	0.0042
Restrictive pattern		36	5.5	35	5.36	0.0118	0.9134
Small airways obstruction		229	34.96	110	16.85	55.896	<0.0001

Table 1: Main characteristics of study sample.

Age class and sex was not statistically significant different between the two groups (χ^2=0.2313 and 0.047, respectively; p=0.9987 and 0.828, respectively). Obese people were 30.99% (203/655) in the exposed group and 15.47% (101/653) in the not exposed group, the association resulted statistically significant (χ^2=51.9193, p<0.0001). Smokers were not statistically different between exposed and not exposed group resulting 17.19% (109/634) in the first and 20.65% (128/620) in the latter group (χ^2=4.395, p=0.111). The prevalence of obstructive pattern in the exposed group was 0.31% (2/655) whereas it reached 1.99% (13/653) in the non-exposed group. The difference between the two groups was statistically significant (χ^2=8.1942, p=0.0042). The logistic model fitted to assess the risk of obstructive pattern resulted not statistically significant (Wald $\chi^2$7.3669, p=0.7686). The prevalence of restrictive pattern did not show significant difference between exposed and not exposed groups (5.5% [36/655] and 5.36 [35/653], respectively, χ^2=0.0118, p=0.9134). The frequency of small airways obstruction was 34.96% (229/655) in the exposed group and 16.85% (110/653) in the not exposed group (χ^2=55.896, p<0.0001). The logistic model to evaluate the risk of small airways obstruction reached the statistically significance (Wald χ^2=174.7, p<0.0001) including the following variables: age group (χ^2=129.3, p<0.001), with higher risk in older age; sex (χ^2=3.3, p=0.0685); BMI class (χ^2=0.77, p=0.68); smokers and ex-smokers compared to not-smokers (χ^2=25.2, p<0.0001); tremolite exposure (χ^2=64.2, p<0.0001). The odds ratio for tremolite exposure, adjusted for other covariates in the model, was 3.46 (95% CI 2.55-4.68, see Table 2).

Effect		**OR**	**95%Confidence Limits**		**p-value**
			Lower	Upper	
Tremolite	EXP vs.. Not EXP	3.46	2.55	4.69	<0.0001
BMI group		1.19	0.8	1.77	0.6801
	Obese vs normal				
	Obese vs. overweight	1.09	0.78	1.53	

Table 2: Adjusted OR and their CI 95% resulting in a multivariate logistic regression model.

Discussion

According to our data, enviromental tremolite exposure may be a risk factor for small airways obstruction. To the best of our knowledge this is the first study investigating the effects on lung function of long term environmental exposure to tremolite in a large cohort of subjects. Our knowledge on the roles of small airways in pulmonary diseases is still limited. Although small airways have a little contribution to airway resistance in healthy subjects, several studies have shown that small airways are the major site of airflow limitation in diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD) [6]. FEF 25-75% is the most commonly cited indicator of small airways obstruction although its utility in reflecting airflow limitation is still a matter of debate due to the variable lower limit of normality depending on age range [6]. However age distribution was not different in the two groups and the large sample size minimizes the risk that our results could be explained by accident or by error. Asbestos has not been directly linked to the presence of obstructive diseases, but asbestos exposure may be one of the factors that contribute to the development of the condition. Lungs with a pre-existing obstructive condition may be much more susceptible to additional lung damage caused by asbestos. Nevertheless, various scientific studies have reported a statistically significant incidence of COPD among those exposed to toxic materials such as asbestos and silica [7]. It has also been shown that long-term occupational asbestos exposure reduced flows and produced air trapping even in workers who never smoked [8]. Despite the lower levels of fibers compared to an occupational setting, prolonged environmental exposure to tremolite may have caused an inflammatory condition in the airway lumen and/or a modification in the thickness of submucosa and smooth muscle mass which resulted in a functional small airways obstruction. Therefore, it is mandatory to follow these subjects longitudinally by repeated lung function measurements and to monitor their inflammatory status by performing exhaled nitric oxide and induced sputum analysis. Research of asbestos bodies in sputum should also be considered.

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