Original Articles

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Respiratory effects from industrial talc exposure among former mining workers

ABSTRACT

OBJECTIVE: To evaluate late respiratory effects from occupational inhalation of talc contaminated with asbestos.

METHODS: This was a case series study on 29 former talc mining workers with asbestos contamination, in the municipality of Carandaí, Southeastern Brazil, who were attended at the State Workers' Health Reference Center in 2004 and 2005. Their clinical and occupational histories were obtained and they underwent spirometry and chest radiography. An exposure score was created; multiplying this by duration produced a cumulative talc exposure index. To confirm the association between the cumulative exposure index and the presence of radiological abnormalities suggestive of pneumoconiosis and/or pleural abnormalities, an exact logistic regression model was fitted to this.

RESULTS: All the former workers were males, with an average age of 48.2 years. Chest radiographs showed pleural abnormalities in three of them; parenchymatous opacity compatible with pneumoconiosis in one; and suspected pneumoconiosis in six. Spirometric abnormalities were found in three workers. Logistic regression showed an odds ratio of 1.059 (95% CI: 1.012; 1.125) for the cumulative exposure index, i.e. each unit increase in the index resulted in an increase of 5.9% in the chance of presenting radiological abnormalities compatible with or suspicious of pneumoconiosis. With regard to the median estimated latency period between the start of exposure and the diagnosing of pleural plaque, there was a significant difference (p = 0.013) between the cases (27.0 years) and non-cases (14.3 years).

CONCLUSIONS: These findings indicate the need for clinical control among workers who have been exposed to asbestos, particularly because of the late effects from exposure to this mineral.

DESCRIPTORS: Talc, adverse effects. Mining. Occupational Exposure. Asbestosis. Respiratory Tract Diseases.

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INTRODUCTION

Diseases relating to talc exposure can be divided into four main categories, with marked differences in their nature and in the radiological abnormalities found. These are as follows: talco-silicosis (inhalation of talc associated with free silica), talco-asbestosis (inhalation of talc contaminated with asbestos), pure talcosis (inhalation of talc in the absence of other minerals) and pulmonary disease secondary to use of injected talc among intravenous drug users. Benign pleural abnormalities and obstructive pulmonary disease have also been reported in individuals exposed to talc dust.[8,14,18]

The term talc is applied to a heterogeneous group of hydrated magnesium

silicates that are commonly found in mineral deposits containing varying quantities of other minerals, including carbonates, quartz, amphiboles and serpentines.[9] Thus, highly selective processing work is needed in order to separate out pure talc from what is considered impure, because of the abovementioned other minerals. Talc is the softest of all minerals, and this term is also used for steatite and soapstone, which are varieties of massive compact talc associated with other minerals.

Talc is used in a variety of industrial processes. After milling, it is used mainly in the textile, ceramic and pharmaceutical industries, and for producing insecticides, cosmetics, soaps, paints, rubber products, paper and heat-resistant products.[3] Occupational exposure can occur during the mining, milling, sacking up and distribution, in secondary industries (ceramics and rubber) and in contact with the final product (cosmetic talc).[12] Cases of pulmonary diseases related to these three forms of exposure have been described.[9,10,18] Talcosis caused by daily use of talc as a cosmetic, in closed environments, has also been reported.[14]

In Brazil, talcosis has been little studied. There is one report on seven cases of disease due to occupational inhalation among talc millers,[5] and the prevalence of pneumoconiosis among soapstone craftsmen in the city of Ouro Preto, southeast region, was found to be 4.3%.[3]

The aim of the present study was to identify the late respiratory effects resulting from occupational inhalation among former industrial talc workers with asbestos contamination.

METHODS

A talc mining company in the city of Carandaí, Southeastern Brazil, was carrying out extraction activities in the rural zone of this municipality, and processing activities (milling) in a shed located in the urban area. The company had been subject to monitoring by the Regional Work and Employment Superintendency of Minas Gerais State (SRTE/MG) since 1993, after a case of pleural disease had been diagnosed in an artistic restoration worker in the state of São Paulo, southeast region, who had been using molding plaster containing talc that came from this company. According to data from SRTE/MG,[a] between 1994 and 1999, the employee turnover at the company was 48 individuals. Of these, 33 worked in processing, 11 in mining and four in both.

Between 1993 and 2000, this company was inspected five times by SRTE/MG. The process and the working conditions varied little over this period, despite notifications issued by SRTE/MG to the employer. The mineral was extracted using rudimentary mining methods, with the use of explosives under very unsafe conditions. The rock thus obtained was broken up manually, using mallets. It was then removed from the work front using scoop loaders and deposited into trucks, which transported the rock to the processing shed. There, after milling, it was transported to silos and subsequently put into sacks. The dust picked up by the air extraction system was added to the silos using manual shovels. The precariousness of the work process and the low effectiveness of the air extraction system resulted in deposition of dust throughout the installations. Despite the existence of masks with mechanical filters, there were not used. There were no bathrooms, showers, adequate canteens or laundries. The drinking water came from an artesian well and was untreated. The unsafe mining conditions led to official suspension of the company's activities by SRTE/MG in 2000, without subsequent reactivation. The industrial installations have started to be used for processing other types of minerals that are free from asbestos.

In February 2000, after visits to the worksite, a team of professionals from the State Health Department of Minas Gerais, the University of São Paulo and the Workers' Health and Safety Division of SRTE/MG observed that the company had considerably diminished its mining and milling activities.[b] Mineral samples were collected, and analyses on these confirmed that the talc was contaminated with amphibole asbestos (actinolite-tremolite). In Carandaí, talc is a product from metamorphic action on basic and ultrabasic rocks, forming compact lenticular minerals that present in light green layers of talc, distributed in talcous masses with rare dissemination of biotite and sometimes with nuclei of acicular actinolite crystals.

Given that there was no trustworthy information about the health of the former workers who had been exposed, and the potential seriousness of the clinical conditions caused by asbestos, it was decided to evaluate the health of these workers at the Workers' Referral Center of the State of Minas Gerais (CEREST/MG), which functions at the Clinical Hospital of the Federal University of Minas Gerais (UFMG).

A case series study was conducted based on primary data gathered from evaluations on former workers who had been exposed to talc at the company that mined and processed the mineral. Former workers living in the municipality of Carandaí were evaluated at CEREST-MG in Belo Horizonte, Minas Gerais, between September 2004 and April 2005. Out of the 48 former workers at the company, 29 came to the clinic

and were included in the study. Of these, 19 had worked there between 1994 and 1999, representing 40% (19/48) of the workers during this period, while the other ten had worked there prior to 1994. Ten workers did not accept the invitation to undergo medical evaluation.

All of the workers were former employees of the main company, named "A" in the present study, which had two worksites: a talc extraction (mining) site and a talc processing (milling) site. However, eight workers had also been employed by two other companies, named "B" and "C". Both of these companies had processes and working conditions that were very similar to the mining operations of company "A", but they did not have processing activities and company C (where three workers were exposed) extracted limestone instead of talc.

At CEREST-MG, the patients underwent the clinic's routine examinations to investigate their exposure to mineral dust, which included the following:

1. Clinical and occupational anamnesis;

2. Chest radiographs, which were produced and classified in accordance with the standards of the International Labor Organization (ILO)[c] by three experiences readers, independently from each other. The classification was based on the median from these readings. The profusion of small opacities was classified into 12 subcategories (0/-; 0/1; 1/0; 1/1; 1/2; 2/1; 2/2; 2/3; 3/3; 3/+), and the lesions were classified as regular (p, q or r) or irregular (s, t or u). The diagnosis of pneumoconiosis was taken to be a median profusion of greater than or equal to 1/0, while suspected cases had profusion of 0/1 and non-cases had profusion of 0/0. For statistical analyses, considering the small size of the sample, all individuals with profusion greater than or equal to 0/1 were put together in one subgroup. Those who presented pleural plaque (in the chest wall and/ or diaphragm) that was compatible with asbestos exposure formed another subgroup.

3. Spirometry, which was performed at the pneumonology clinic of a university hospital, in accordance with the Guidelines for Pulmonary Function Tests of the Brazilian Society of Pneumonology and Tisiology. The parameters of pulmonary function, forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) were expressed as percentages in relation to the expected values for Brazilians.[16]

4. Exposure assessment: exposure scores were created from qualitative information on the environment and working conditions, which was obtained from

the most experienced and longest-standing former employee of company A. A score of 2 was attributed to the locations with the greatest production of dust: all the work positions in the milling shed (which were considered to present similar intensity of exposure since this was an enclosed area without an efficient air extraction system), and for the function of jackhammer operator in the extraction activities. The other functions received scores of 1. The scores followed an ordinal scale, i.e. 2 did not mean twice the score of 1. It was assumed that the dust levels did not change over the time during which the company was in operation, since there were no significant changes in the production process and no measures aimed at reducing the amount of dust in the environment were implemented. It was also assumed that companies B and C did not differ from A in terms of exposure.

To obtain an index for cumulative exposure to talc, the exposure score was multiplied by the length of time (in years) of exposure duration in each work position. The resultant values were summed and the result obtained was representative of individuals' work histories. The time elapsed (years) between the start of exposure and time of the evaluation was used to obtain the estimated latency time for occurrences of radiological changes, since the exact date on which such changes arose was not available.

Univariate and bivariate descriptive analyses were performed. To investigate whether the data presented normal distribution, the Kolmogorov-Smirnov test was used, with Lilliefors significance correction. To compare means, among variables with normal distribution, Student's t test for independent samples was used. To compare medians, the Mann-Whitney test was used. Because of the small sample size and rarity of the event of pneumoconiosis (confirmed or suspected) and/ or pleural abnormalities, an exact logistic regression model was fitted for binary response data, in order to investigate associations between the index of worker exposure to talc and the presence of such events. The odds ratios obtained from the model were used to quantify the association. The analyses were performed using the SPSS statistical package, version 12.0 for Windows, and LogXact 2.0.

RESULTS

Among the 29 former workers, all of them were male and their ages ranged from 33.7 to 68.5 years, with a mean of 48.2 years (standard deviation, SD = 9.1), at the time of the first consultation. The length of their exposure ranged from 0.3 to 28.1 years, with a median

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[c] International Labour Office. Guidelines for use of ILO International Classification of Radiographs of Pneumoconioses. Geneva, 1980. (Occupational Safety and Health Series n. 22).

Table. Distribution of workers' functions, taking all the possible work sectors into account. City of Carandaí, Southeastern Brazil, 2004-2005.

Function	Processing	Extraction	Both	n	%
Detonation assistant	0	2	0	2	6.9
Mechanical maintenance auxiliary	0	2	0	2	6.9
Foreman	1	1	0	2	6.9
Jackhammer operator	0	7	0	7	24.1
Driver	0	5	0	5	17.2
Maintenance mechanic	1	1	0	2	6.9
Machine operator	0	1	0	1	3.4
Handyman	4	10	3	17	58.6

of 3.0 years. During the period of their exposure, some workers performed more than one function at the worksites. Considering all the possible positions, the numbers of employees in each position and respective percentages of the whole group (n = 29) were as follows: talc mine A: 26 (89.7%); processing mill A: 9 (31.0%); talc mine B: 5 (17.2%); and mine C (limestone): 3 (10.3%). The distribution of the workers' functions is presented in the Table.

The mean cumulative exposure index (CEI) was 15.6 (SD = 22.0), with a minimum of 0.3, maximum of 93.2 and median of 4.9, as shown in the Figure.

At the time of the evaluation, all of the workers had already ceased to be exposed. The length of time since their last exposure ranged from 1.2 years to 26.0 years, with a mean of 9.8 years and median of 10.5 years. The estimated latency time (ELT) for occurrences of lesions (time elapsed from the start of exposure to the time of the evaluation) ranged from 6.1 to 31.1 years, with a mean of 16.7 and median of 15.5.

In relation to the classification of the profusion of small opacities, 22 were 0/0, six were 0/1 and one was 1/1. By summing the last two classifications, it was considered that there were seven patients with parenchymal abnormalities or suspected parenchymal abnormalities. The main types of opacity recorded were "p" in four cases and "s" in three cases. Regarding secondary opacities, type "p" was found in three individuals, type "s" in three and type "t" in one. None of the patients presented large opacities.

Because of the non-normal distribution of the variable CEI, the Mann-Whitney test was used to compare the medians. Furthermore, because the number of workers with radiological abnormalities was small, these workers were grouped for the purposes of statistical analyses.

The median CEI according to the profusion of small opacities was 4.6 for the 22 patients classified as 0/0 and 28.0 for the seven patients in the subgroup classified as greater than or equal to 0/1 (p = 0.013). Regarding the

pleural abnormalities, the median CEI was 4.8 for the individuals without pleural abnormalities and 19.0 for those with pleural abnormalities (p = 0.56).

There was a significant difference (p = 0.013) in the median ELT between the cases with pleural abnormalities alone (27.0) and those without such abnormalities (14.3), but not between those with profusion greater than or equal to 0/1 (19.0) and the others with profusion 0/0 (13.3).

There were nine smokers (31.0%), six former smokers (20.7%) and the remaining 14 had never smoked (48.3%). For the 15 smokers and former smokers, the mean and median for the year/pack index were 24.4 and 25.0, respectively.
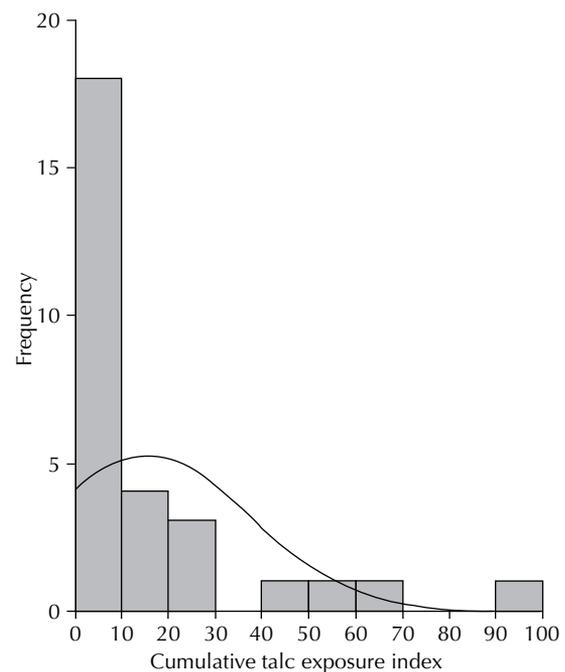

Figure. Distribution of the cumulative exposure index among the sample studied (n=29). City of Carandaí, Southeastern Brazil, 2004-2005.

Among the 29 workers, 22 underwent spirometry. Of these, 19 (86.4%) presented normal results, while the other three (13.6%) presented obstructive ventilatory disorders. All of the patients had FVC greater than 80%, and two had FEV1 less than or equal to 80%. The medians of the FVC% and FEV1% values found were 111.5 and 109.0, respectively. There were no statistically significant differences in the spirometric variables (FVC and FEV1) in relation to the subgroups with or without pleural abnormalities, or in relation to subgroups with or without parenchymal abnormalities.

An exact logistic regression model was fitted to the data, in which the response variable was the presence of "radiological abnormalities of the pulmonary parenchyma" that were compatible with the presence or suspicion of pneumoconiosis, represented by abnormalities that were classified as greater than or equal to 0/1. The explanatory variables were the ELT and the CEI. The ELT was not significant and was withdrawn from the model, such that only the CEI remained in the final model. The result from the model showed an odds ratio of 1.059 (95% CI: 1.012;1.125), i.e. for every increase of one unit in the CEI, there was an increase of 5.9% in the chance that the worker would present these radiological abnormalities.

DISCUSSION

The median length of exposure to talc was 3.0 years, which was a relatively short time for respiratory symptoms, radiological abnormalities and diminished pulmonary function to be developed due to exposure to mineral dust. The rate of occurrence of pneumoconiosis in our sample was low (only one case) and the cases that were considered suspect corresponded to around 20% of the study group. This is probably related to the short durations of exposure observed. In other studies involving talc miners and millers, who had been exposed for more than 15 years, the prevalence found was higher.[9,18] Exposure to talc seems to be associated both with the presence of opacities and with the presence of irregular or mixed opacities,[3,8,18] as observed in the present study.

The finding of pleural thickening in the form of plaque in three former workers (bilaterally in two of them) is compatible with exposure to actinolite-tremolite asbestos fibers, which are present in the composition of industrial talc. In a study on morbidity among 121 talc miners and millers exposed to talc containing tremolite and anthophyllite, Gamble et al[9] (1979) reported pleural thickening in 31% of the workers with more than 15 years of exposure. Pleural plaque is the most common asbestos-related disease,[15] since it can appear even after intermittent and weak exposure. Its prevalence grows with increasing latency period: 20 years after the initial exposure, around 10% of exposed individuals will

develop plaque.[4,11] In our study, the ELT was relatively short, with a median of 15.5 years, which may mean that this occurrence could still increase over the coming years. The ELT was greater than 20 years among the former workers with pleural plaque, and there was no significant association between the presence of plaque and the CEI. This was in agreement with the other studies cited. Pleural plaque, especially when unilateral, may have non-occupational origin, and a differential diagnosis with other causes should be included.[2] Its presence in individuals exposed to asbestos does not necessarily imply simultaneous occurrence of asbestosis and does not have any predictive value for this disease or for malignant diseases such as lung cancer or malignant pleural mesothelioma.[2,11] According to Feigin (1986), there is insufficient evidence to affirm that talc in its pure form could cause pleural abnormalities of any nature.[8]

Clinically, the most common symptoms of talcosis are coughing and chronic dyspnea, to varying degrees. Talc causes granuloma formation, both in the inhaled form and in the injected form. The pathological condition consists basically of an interstitial inflammatory reaction composed of phagocytes, multinucleated giant cells of foreign body type and numerous birefringent needle-shaped crystals. The inflammatory reaction may progress to interstitial fibrosis and emphysema, and the granulomas may join together to form areas of massive progressive fibrosis. The initial radiological abnormalities consist of a diffuse micronodular pattern, with disseminated well-defined small nodules.[8]

The pulmonary pleural abnormalities induced by asbestos may be partially shown up by conventional radiography, but high-resolution computed tomography (HRCT) is superior as a noninvasive diagnostic method.[19] In a study involving workers exposed to asbestos among whom normal chest radiography showed profusion < 1/0, Staples et al[17] (1988) found that HRCT indicated abnormalities suggestive of asbestosis in 34% of them. Thus, for better evaluations on pulmonary parenchyma and pleura among individuals exposed to asbestosis, it would be important to include HRCT in the propaedeutics, which was not done in the present study.

In the group studied, there were no significant abnormalities in pulmonary function, as evaluated using spirometry. Among the 22 former workers who underwent this examination, only three were considered to present mild obstructive ventilatory disorders. This may have occurred partially because only patients with mild pleural-parenchymatous abnormalities were found, i.e. cases classified between 0/1 and 1/1, and delineated pleural plaque. The presence of normal pulmonary function does not rule out the possibility of pulmonary disease associated with asbestos, as shown by HRCT.[4] Normal spirometric findings during the initial stages of

the disease are also common in other forms of pneumoconiosis. The small number of spirometry examinations in the present study was a limiting factor in relation to interpreting the results found and analyzing possible associations with other variables (exposure index, smoking or symptoms). With regard to smoking, the mean year-pack index for smokers and former smokers was 24.4, which was considered relatively high. There are reports in the literature regarding synergic effects between smoking and mineral dust, especially among workers exposed to asbestos.[13]

Interpretation of the findings from the present study includes the problems inherent to non-sampled studies, in that the findings did not represent all the individuals who worked in the company but, rather, those who were attended at CEREST-MG. The small sample made it difficult to estimate chronic effects and dose-response relationships. The inclusion of information on work at another two mines, producing talc and limestone respectively, may have been a confounding factor in interpreting the data. Another limitation related to the difficulty in estimating past exposure in localities without any type of environmental surveillance and without any quantitative analysis on talc dust over the period during which the company was in operation. In this respect, the exposure index that was created, based on information from experienced former workers, was found to be useful as an estimate for cumulative exposure and as a measure of exposure that was more complete than simply the number of years of exposure.

The abnormalities observed in the group studied emphasize the need for greater clinical and radiological control among these workers, particularly for surveillance of changes that might occur over the long term. Such changes include malignant lesions such as lung cancer and pleural mesothelioma, for which the latency time is generally longer than that of benign lesions. The morbidity and mortality caused by asbestos, and particularly by amphibole asbestos, have led to measures restricting its use in 45 countries. Other countries present projections of increasing mortality rates due to diseases related to this mineral.[6]

Thus, occupational and environmental exposure to asbestos in its pure form or as a contaminant constitutes an important public health problem. For the Brazilian state, the challenge posed is to modernize its legal statutes relating to extraction and processing of this mineral. This scenario also requires the implementation of concerted actions relating to care, surveillance, inspection of working environments and health education, in order to reduce the harmfulness of these environments and achieve early identification of individuals with health abnormalities related to asbestos exposure.

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