

# Original Article

## Occupational exposure and occurrence of pneumoconioses in Campinas, Brazil, 1978–2003\*

Exposição ocupacional e ocorrência de pneumoconioses na região de Campinas (SP) Brasil, 1978–2003

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### Abstract

**Objective:** To develop and consolidate a comprehensive database on the occurrence of pneumoconioses in an industrialized region of Brazil, with a special focus on the activities most frequently related to these diseases. **Methods:** A retrospective, observational study was conducted in order to gather data on cases of pneumoconioses treated at the outpatient clinic of the State University at Campinas *Hospital das Clínicas* between 1978 and 2003. Individuals diagnosed with pneumoconiosis, based on their occupational history and on chest X-ray findings of abnormalities consistent with interstitial lung disease involving the parenchyma, in accordance with the 1980 and 2000 recommendations of the International Labour Organization, were included in the study. **Results:** A total of 1147 cases of pneumoconiosis were identified (1075 in males and 72 in females); 1061 cases of silicosis (92.5%); 51 cases of mixed-dust pneumoconiosis (4.45%); 15 cases of asbestosis (1.31%); 13 cases of phosphate rock-related pneumoconiosis (1.13%); and 7 cases of other types of pneumoconiosis (0.6%), including those related to exposure to coal, graphite and hard metals. The most common chest X-ray findings were 1/0, 1/1 or 1/2 profusion and small regular opacities (p, q or r), although 192 patients (16.74%) presented large opacities. There has been a substantial decline in the occurrence of the disease since the 1990s, and the duration of exposure was typically shorter than that observed in a study conducted in the United States. **Conclusions:** Our findings have been compiled into a comprehensive database for the investigation of pneumoconiosis in an industrialized area of Brazil. These data make it possible to conduct follow-up studies and develop health policies related to occupational respiratory disorders.

**Keywords:** Occupational medicine; Respiratory tract diseases/epidemiology; Pneumoconiosis; Epidemiology.

### Resumo

**Objetivo:** Desenvolver e consolidar uma ampla base de dados acerca da ocorrência das pneumoconioses numa região industrializada do Brasil, com especial referência às atividades mais frequentemente relacionadas a essas doenças. **Métodos:** Numa avaliação retrospectiva observacional, coletaram-se dados referentes à casuística ambulatorial das pneumoconioses no Hospital das Clínicas da Universidade Estadual de Campinas, entre o período de 1978 e 2003. Incluíram-se os indivíduos com diagnóstico de pneumoconiose, com base no histórico ocupacional e no radiograma do tórax, segundo recomendações da Organização Internacional do Trabalho, de 1980 e 2000, com anormalidades compatíveis com comprometimento intersticial do parênquima pulmonar. **Resultados:** Foram identificados 1.147 casos de pneumoconiose (1.075 homens e 72 mulheres), sendo 1.061 casos (92,5%) de silicose, 51 (4,45%) de pneumoconiose por poeira mista, 15 (1,31%) de asbestose, 13 (1,13%) de pneumoconiose por rocha fosfática e 7 (0,61%) de outras pneumoconioses (por carvão, grafite e metais duros). As alterações radiológicas com profusão 1/0, 1/1 e 1/2 e as pequenas opacidades regulares p, q e r foram as mais frequentes, tendo sido identificados 192 casos (16,74%) com grandes opacidades. Observou-se redução pronunciada da ocorrência dos casos a partir da década de 1990; adicionalmente, o tempo de exposição foi caracteristicamente mais breve do que o observado em série norte-americana. **Conclusões:** Os dados do presente estudo estabelecem uma ampla base de dados para a investigação da ocorrência de pneumoconioses numa região industrializada brasileira, tornando factível a realização de estudos de seguimento e a elaboração de políticas de saúde relacionadas aos agravos respiratórios ocupacionais.

**Descritores:** Medicina do trabalho; Doenças respiratórias/epidemiologia; Pneumoconiose; Epidemiologia.

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## Introduction

The inhalation of dust in the workplace was described as a causative agent of respiratory symptoms and pulmonary diseases by Hippocrates in 460 BC, who observed such health alterations in miners.<sup>(1)</sup> The term pneumoconiosis, coined by Zenker in 1866, characterizes the pulmonary parenchymal alterations that result from the inhalation of dust.<sup>(1)</sup> Similarly, at the Fourth International Conference on Pneumoconiosis, held in 1971 in Bucharest, pneumoconiosis was defined as “the accumulation of dust in the lungs and the tissue response to its presence”.<sup>(2)</sup>

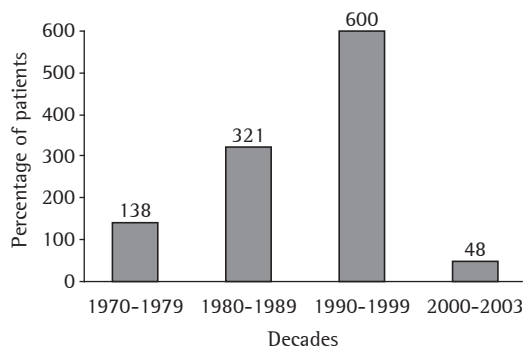
Worldwide, thousands of new cases of pneumoconiosis are diagnosed each year, predominantly in developed countries, since they have a great number of workers engaged in activities that put them at risk, and since they have work-related lung disease surveillance programs that register and analyze all diagnosed cases. However, pneumoconiosis has presented a pronounced decline in such countries, in which correlation statistics are calculated by organs specialized in the collection, registry and processing of these data, which are used in the surveillance and control of occupational diseases.<sup>(3-5)</sup>

In Brazil, however, few data on the occurrence of pneumoconiosis and the characteristics of related occupational exposures are available, since these diseases are underdiagnosed and underreported by companies and health professionals, as well as since there is a lack of comprehensive epidemiological studies and occupational health surveillance programs for workers exposed to disease-causing agents.<sup>(6)</sup> Therefore, the objective of this study was to consolidate and structure systematized information based on the outpatient demand of individuals diagnosed with pneumoconiosis at a tertiary referral center in the region served by the *Hospital das Clínicas da Universidade Estadual de Campinas* (HC-Unicamp, State University at Campinas Hospital das Clínicas), a highly populated area with a large industrial park. Such data would allow the determination of the number of patients diagnosed at HC-Unicamp, constituting an original database that would make it possible to conduct further studies and develop health policies.

## Methods

This was a retrospective, observational study of patients diagnosed with pneumoconiosis at the HC-Unicamp outpatient clinics of Occupational Medicine and Pulmonology. In addition, we analyzed data from the registry of workers diagnosed with pneumoconiosis, available in the database of the Occupational Health Sector of the Unicamp *Faculdade de Ciências Médicas* (FCM, School of Medical Sciences) and based on epidemiological investigations carried out between 1978 and 2003. The criteria for the diagnosis of pneumoconiosis established in this study follow the recommendations of the International Labour Organization (ILO): compatible clinical and occupational history; and chest X-ray with profusion of small opacities in the pulmonary parenchyma equal to or greater than 1/0.<sup>(7)</sup> The study protocol was approved by the FCM-Unicamp Ethics in Research Committee.

In order to determine occupational histories, the professional backgrounds of the workers were obtained, together with descriptions of the fields of activity of the companies, occupational duties of the patients and length of time working at each activity, as well as descriptions of the chemical, physical and biological agents to which the patients were exposed in the workplace. These data were gathered through occupational anamnesis performed by physicians (residents and graduate students) supervised by experienced professors. The information provided by the patients was also verified through the analysis of the entries in their official work permits.



**Figure 1** - Pneumoconiosis: distribution of diagnosed cases, by decade, among the patients treated at the State University at Campinas *Hospital das Clínicas*.

Patients were divided into smokers and nonsmokers. The consumption of cigarettes was quantified in pack-years. Patients who currently smoked were classified as smokers, as were all those with a history of smoking of at least one cigarette a day for more than one year.

Chest X-rays were interpreted, jointly, by two or more readers with specific experience in such interpretation, according to the criteria established in the ILO International Classification of X-Ray Findings in Pneumoconiosis, revisions of 1980 and 2000.<sup>(7)</sup> In the event of disagreement, a third reader was recruited in order to limit the intra- and inter-rater variability.<sup>(8,9)</sup> The information gathered was registered on a standard form, in accordance with the ILO model. When the X-rays could not be located, we considered the data from the radiological findings registered in clinical charts, in standard form, using the ILO technique standardized in 1980 and 2000, with quality X-rays interpreted by two or more experienced readers.

The radiological alterations were classified as: simple (with small radiographic opacities of less than 10 mm in diameter); or complicated, also known as progressive massive fibrosis (with large opacities, of more than 10 mm in diameter, resulting from the coalescence of small opacities).

Based on the information collected on the standardized forms, a database was created using the Microsoft Access program, version 2000. The descriptive study of the information was summarized through measurements of central tendency and dispersion (mean and standard deviation or median and variation).

## Results

Data from 1147 patients were obtained, 1075 males (93.72%) and 72 (6.28%) females. The mean age was  $47 \pm 10$  years (median, 46 years). The mean duration of exposure to causative agents of pneumoconiosis was  $17 \pm 8$  years, (median, 16 years). Analyzing the distribution of pneumoconiosis by age bracket, 88 patients (9.12%) were diagnosed before the age of 34, and 743 patients (77%) were diagnosed at between 35 and 59 years of age. Patients had been referred, variously, from 52 cities in the states of São Paulo, Minas Gerais, Bahia and Paraná, comprising a total population of 5,273,358 inhabitants, according to the 2000 census

conducted by the Brazilian Institute of Geography and Statistics.

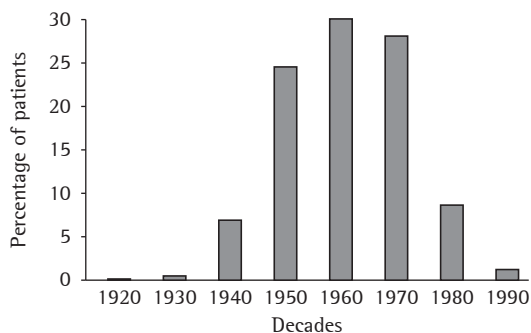
As shown in Figure 1, most cases were diagnosed in the 1980s and 1990s, with a tendency toward decline in the following decade. The duration of exposure was less than 5 years in 55 cases (4.8%), from 5 to 9 years in 170 cases (14.8%) and greater than 9 years in 780 cases (68%). In most cases, the duration of exposure was between 10 and 24 years, although only 6.5% of the patients had been exposed for more than 30 years. These data are in contrast with those obtained in the American states of Michigan, New Jersey and Ohio,<sup>(4)</sup> where only 7% of patients with pneumoconiosis had been exposed for less than 10 years, whereas 32.3% had been exposed for more than 30 years (Table 1). In Figure 2, we observe that the initiation of exposure, in Brazil, was concentrated in the 1950s, 1960s and 1970s, with a pronounced decline beginning in the 1980s.

In the analysis of the quality of the X-rays, we found 623 (54.3%) to be of quality 1 and 524 (45.7%) to be of quality 2. According to the predominant profusion, chest X-rays were grouped into categories 0, 1, 2 and 3, as follows: in 1, 1/0, 1/1 and 1/2 profusions; in 2, 2/1, 2/2 and 2/3 profusions; and in 3, 3/2, 3/3 and 3/+ profusions. The radiological alterations with profusion 1 and small regular opacities p, q, or r were the most frequent,

**Table 1** - Distribution of duration of exposure, in years, of the patients with pneumoconiosis treated at the State University at Campinas *Hospital das Clínicas* between 1978 and 2003 and of the cases identified in the United States by the National Institute for Occupational Safety and Health, from 1989 to 1999.

Duration of exposure	American states of Michigan, New Jersey and Ohio (1989 to 1998)*		Unicamp patients (1978 to 2003)	
	n	%	n	%
<10 years	83	7.0	225	19.6
10-20 years	227	19.2	378	33.0
21-30 years	324	27.5	328	28.6
>30 years	381	32.3	74	6.5
Unknown	165	14.0	142	12.4
Total	1180	100.0	1147	100.0

\*Work-related lung disease surveillance report 2002, National Institute for Occupational Safety and Health, 2003.<sup>(2)</sup>



**Figure 2** - Pneumoconiosis: distribution of the time of initial exposure, by decade, among the patients treated at the State University at Campinas *Hospital das Clínicas*.

and 192 cases (16.74%) with large opacities were identified (Table 2).

Table 3 shows the occupational exposure to causative agents of pneumoconiosis: free crystal silica accounted for 1061 cases (92.5%); mixed dust, composed of corundum and carborundum, for 51 cases (4.5%); asbestos, for 15 cases (1.3%); phosphate rock, for 13 cases (1.1%); and other agents (coal, graphite and metals), for 7 cases (0.6%). Mean duration of exposure to causative agents of pneumoconiosis, in years, was  $17.1 \pm 8.4$ , with a median of 16, a minimum of 1 and a maximum of 45.

Through the occupational history, we identified the occurrence of pneumoconiosis in workers engaging in 21 types of industrial activities. Exposure to silica occurred in 821 patients (77.67%) working in the ceramic industry, 17 (1.6%) working in the production of glass, 11 (1.04%) working in the production of decorative stones and 50 (4.7%) working in the metallurgical industry: in metal foundry operations in sand boxes; sandblasting; or emery polishing of parts. However, we found that 44 patients (4.16%) had a history of exposure to mixed dust, in the production of abrasive material of the corundum and carborundum type, 15 (1.43%) had been exposed to asbestos during the manufacture of fiber cement, brake pads and industrial thermal insulation, and 3 (0.3%) had been exposed to graphite dust during the manufacture of electrodes. In metallurgy, 2 patients (0.2%) were exposed to metallic dust from specialized grindstones. In surface and deep mining, including quarries, 52 patients (4.91%) with pneumoconiosis were exposed to silica, 2 patients (0.2%) were exposed to mineral coal and 2 (0.2%) were exposed to mixed dust. We found 43 types of occupations related to the occurrence

**Table 2** - Classification of the quality of the X-rays. profusion, shape and size of small and large opacities, according to the International Classification of X-Ray Findings in Pneumoconiosis (International Labour Organization, revisions of 1980 and 2000).

	n	%
Profusion		
1	663	57.8
2	339	29.6
3	145	12.6
Total	1.147	100.0
Shape and size		
p/p	295	26.2
p/q	221	19.6
p/r	3	0.3
Total	519	46.1
q/p	21	1.9
q/q	299	26.6
q/r	105	9.3
Total	425	37.8
r/p	0	0
r/q	7	0.6
r/r	117	10.4
Total	124	11.1
s/s	8	0.7
s/t	13	1.2
s/u	0	0
Total	21	1.9
t/s	0	0
t/t	23	2.0
t/u	11	0.1
Total	34	3.0
u/s	0	0
u/t	1	0.1
u/u	1	0.1
Total	2	0.2
Large opacities		
A	58	5.0
B	72	6.3
C	62	5.4
Total	192	16.7

of pneumoconiosis, and noticed a higher frequency among the following workers: stampers, who mold ceramic pieces manually (248 cases; 29.42%); furnace operators (72; 8.54%) and enamelists (69; 8.19%), who prepare ceramic pieces in kilns; and millers, who operate grinders used in the trituration of raw materials in the ceramic industry (85; 10.08%).

**Table 3** - Distribution of causative agents of pneumoconiosis and median (variation) of duration of exposure in the study population.

Agent	n	%	Duration of exposure, in years (median; variation)
Asbestos	15	1.3	16.7 (3.3; 27.2)
Mineral coal	2	0.2	7.0 (2.0; 12.0)
Graphite	3	0.3	18.3 (16.0; 20.5)
Metallic dust	2	0.2	21.7 (13.0; 30.4)
Mixed dust	51	4.5	13.0 (1.6; 26.0)
Phosphate rock	13	1.1	7.0 (2.5; 16.7)
Silica	1061	92.5	20.6 (1.0; 53.0)
Total	1147	100.0	-

## Discussion

Located in the city of Campinas, in the state of São Paulo, HC-Unicamp founded its outpatient clinic in 1978 in order to provide tertiary care through the public health care system. In the same period, with the implementation of the Occupational Health Sector of the FCM-Unicamp Department of Preventive and Social Medicine, the Occupational Medicine Outpatient Clinic was created. It has since become a referral center for the diagnosis and treatment of workers with occupational diseases in the Campinas region, as well as a center for teaching and research in the field of occupational diseases.

Chief among the first studies on silicosis carried out in Brazil are those conducted in the early 1970s in the cities of Pedreira and Jundiaí, in the state of São Paulo.<sup>(10,11)</sup> Those studies demonstrated a high occurrence of silicosis in ceramic workers, investigating it in a more comprehensive manner from the time of its diagnosis in such workers, engaged in an occupation which, at the time, was considered of little importance to the genesis of the disease. A study published in 1995 reported the occurrence of 818 cases of silicosis in several fields of industrial activity in Campinas, and the creation of a program of epidemiological surveillance was recommended in order to better monitor these work environments.<sup>(12)</sup> Few studies have investigated populations of exposed workers using epidemiological methods. One study conducted in 1998 assessed 4279 workers employed at ceramic industries in the city of Pedreira and found 159 diagnosed cases of silicosis, the prevalence among all exposed individuals in the area

being 4.7%.<sup>(13)</sup> Another study, evaluating 828 former fiber cement industry workers, found that 74 (5.9%) had asbestosis and 246 (29.7%) presented pleural alterations.<sup>(14)</sup> In addition, the authors reported worsening of pulmonary function in the cases in which X-rays showed greater profusion.<sup>(14)</sup> Another group of authors conducted a cross-sectional study of morbidity among 4220 miners exposed to asbestos between 1940 and 1996.<sup>(15)</sup> Based on clinical data, occupational histories, pulmonary function test results, chest X-ray findings and high-resolution computed tomography findings, the authors identified 17 cases of fibrosis (0.4%), 18 cases of fibrosis with platelets (0.43%) and 71 cases presenting pleural platelets (1.68%).<sup>(15)</sup>

Such studies have provided specific information on the epidemiology of pneumoconiosis in Brazil. However, using the information obtained in the present study, we have attempted to create a comprehensive database for future investigations, correlating them with information derived from other epidemiological investigations. A particularly interesting finding of the present study was the difference in the duration of exposure in relation to a sample evaluated in the United States (Table 1).<sup>(4)</sup> As can be seen, most of the workers in our sample were exposed to silica at a later date in comparison with those included in the American sample. This is probably attributable to the delayed development of the Brazilian industrial sector. Therefore, the duration of exposure was shorter in our study than that found in the American study, although the concentration of silica in the workplace was greater. The lower incidence of silicosis in women, 6.28% of the cases diagnosed in the present study, is related to the limited participation of women in these work activities, principally in the 1950s, 1960s and 1970s, a critical period for the generation of the disease, due to the high level of exposure to dust. The participation of women in the workforce was concentrated in light, manual activities of finishing, quality control and packaging of ceramic whitewares.

Regarding the field of activity and function, we identified stampers of domestic and sanitary ceramics, followed by workers in foundries, mines and quarries, as the professional categories in which there is the greatest occurrence of silicosis, similarly to the findings of a study carried out in the American state of New Jersey,<sup>(3)</sup> as well as to the Sentinel Event Notification System for Occupational



Risks data for the period from 1989 to 1998 in the United States.<sup>(4)</sup>

The chest X-ray is considered one of the basic instruments for the diagnosis of pneumoconiosis when used in conjunction with the taking of an occupational history. In our case sample, we highlight the presence of 192 large opacities (in 16.74%), progressive massive fibrosis—classified as A in 58 cases (5.05%), B in 72 (6.28%) and C in 62 (5.41%)—on the chest X-rays of patients with a mean duration of exposure of  $17 \pm 8.4$  years. In 1989,<sup>(16)</sup> a study was conducted involving 276 ceramic workers diagnosed with silicosis, in the United Kingdom, with mean duration of exposure of  $35 \pm 10$  years, which identified the presence of large opacities in the X-rays of 115 individuals with silicosis (41.65%): 67 type A (24.3%); 44 type B (15.9%); and 4 type C (1.45%).<sup>(16)</sup> This great difference in relation to the present study is possibly due to the longer duration of exposure or to the conditions related to the period of exposure.

In conclusion, the findings of the present study have been compiled into a comprehensive database for the investigation of pneumoconiosis in an industrialized area of Brazil. These data make it possible to conduct follow-up studies and develop health policies related to occupational respiratory disorders.

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