Original Article

Chronic Dyspnea and Altered Respiratory Function in Former Workers with Asbestosis Evaluated to Determine Pension Benefits*

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Background: Dyspnea is a symptom that is difficult to evaluate, especially in occupational diseases.

Objective: To evaluate the relationship between chronic dyspnea, in its varying degrees of severity, and the functional repercussions for dysfunction or incapacitation in former workers with asbestosis.

Method: A total of 40 former workers diagnosed with asbestosis were evaluated. Dyspnea scores were determined using the modified Medical Research Council scale, the 1984 and 1993 American Medical Association scales, and the Baseline Dyspnea Index. Spirometry, measurement of diffusion capacity for carbon monoxide and cardiopulmonary exercise tests (incremental and submaximal) were also performed.

Results: Based on scores obtained using the Medical Research Council and 1984 American Medical Association scales, respectively, 72.5% and 67.5% of the subjects were classified as dyspneic, compared with 37.5% and 31.6%, respectively, using the 1993 American Medical Association and Baseline Dyspnea Index scales. There was greater concordance between the Medical Research Council and 1993 American Medical Association scales, as well as between the 1984 and 1993 American Medical Association scales, when the categories of "absent" and "mild" were grouped. No significant relation was found between dyspnea, as determined by each of the scales, and functional abnormalities – either at rest or during exercise.

Conclusion: In individuals with asbestosis, the degree of concordance among the available dyspnea scales varies significantly. There is a real need for dyspnea indices that evaluate respiratory dysfunction at rest and during exercise.

J Bras Pneumol 2004; 30(6) 528-34

Key words: Asbestosis/diagnosis. Dyspnea/physiopathology. Spirometry/methods.

*Study carried out in the Setor de Função Pulmonar e Fisiologia Clínica do Exercício (SEFICE, Pulmonary Function and Clinical Physiology of Exercise Sector) of the Pulmonology Department of UNIFESP-EPM
Study partially sponsored by FAPESP – Grant no. 96/10415-6
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Submitted: 5 October, 2003. Accepted, after review: 17 June, 2004.

INTRODUCTION

Asbestosis is an interstitial lung disease related to asbestos exposure. The most clinically relevant symptom is dyspnea[1,2]. Dyspnea is a symptom that is difficult to evaluate and measure, especially in occupational diseases, in which other factors such as age, sedentary lifestyle, smoking and concomitant cardiopulmonary diseases, may cause it to be misunderstood[3]. In addition, workers seeking to obtain pension benefits may overestimate dyspnea in their everyday activities[4-6].

Various studies have been conducted in attempts to evaluate dyspnea in workers exposed to asbestos and its relationship to functional abnormalities in respiration. However, due to the difficulty in obtaining reliable data and the subjectivity of the information, results have varied considerably[3,7-9]. The degree of functional impairment in the patients studied appears to be lower than that observed in other interstitial diseases, thereby making physiological reproducibility of subjective patients complaints uncertain[10,11].

Although previous studies assessing chronic dyspnea in laborers working with fiber-cement have been carried out in our milieu[12], we are unaware of any studies conducting comparative evaluations of the various dyspnea scales or of their functional repercussions in former workers with asbestosis who seek to obtain pension benefits.

The aim of this study was to analyze chronic dyspnea according to commonly used scales: the 1976 modified Medical Research Council (MRC) scale[13], the 1984 and 1993 American Medical Association (AMA) scales[14,15], and the baseline dyspnea index (BDI)[16], relating the disease to possible functional alterations in respiration. The study involved a group of former workers with asbestosis sent for evaluation of dysfunction and incapacity.

METHODS

A population of 40 male individuals was studied. They had formerly worked in fiber-cement factories located in the state of São Paulo (n = 37) or in an asbestos factory in Minaçu, a city located in the north of the state of Goiás (n = 3). These individuals were sent for clinical and occupational evaluation in order to decide whether they were entitled to pension benefits. Based on the International Classification of Radiographs of Pneumoconiosis (International Labour Organization, 1980)[17], 26 individuals were found to present profusion e” 1/0, and the remaining 14 presented 0/0 or 1/0 profusion. In the latter group, the diagnosis of asbestosis was based on the results obtained in a high-resolution computed tomography[18,19]. Evidence of discrete pleural involvement was seen in 31 individuals, although, due to the specific aim of this study, they were not a target of analysis.

Exclusion criteria included comprehension disorders that prevented individuals from answering the questionnaires, difficulties cooperating on the proposed exams, movement disorders (neuromuscular, rheumatic and orthopedic diseases), inability to perform pulmonary function tests, concomitant pulmonary or systemic disease, and moderate to severe obstructive pulmonary disorders. All participants gave written informed consent, previously approved by the ethics committee of the institution.

Occupational histories were obtained through review of personal data, comments in work registry cards and notes in employer records regarding beginning and end of employment. These data were used to identify the type and length of exposure, as well as the latency period (time from the beginning of exposure to the day of the test) (Table 1). The clinical assessment consisted of a physical exam, investigation of clinical complaints and evaluation of previous morbidity and habits (including smoking, assessed in pack-years). A total of 28 individuals (70%) were considered either smokers or former smokers, and 12 (30%) were considered nonsmokers.

Four discriminating scales were used to analyze the presence and intensity of dyspnea: the MRC scale[13], the 1984[14] and 1993[15] AMA scales and the BDI[16]. Those instruments, except for the BDI, were originally described as self-applicable. However, due to social and cultural traits of the target population, they instruments were administered verbally. The same researcher interviewed all of the individuals, and, for a given individual, the entire questionnaire was administered over the course of the same day. The questionnaire sequence was not random (BDI, followed by 1984 AMA, 1993 AMA and MRC scales). The MRC, 1984 AMA and 1993 AMA scales have been translated into Portuguese and have been used in other studies carried out in our milieu[12,20]. In the present study, the BDI questionnaire was translated into Portuguese by two medical professionals, both fluent in English. A subsequent re-translation of their Portuguese version back into English presented no changes from the original. Although none of scales have been formally validated in Brazil, interobserver reproducibility of the most complex scale (the BDI) was tested in 11 individuals (Paired t-test, $t = 0.53$; $p = 0.60$). It should also be emphasized that this scale has been used in our milieu[11,21]. A cutoff point for normality determined by the BDI has not been described. In this study, however, based on our experience[11], a cutoff point of e”9 was used.

All of the scales used evaluate the domain of task magnitude. The BDI[16] also assesses functional incapacity and exertion magnitude. As for the degrees of dyspnea intensity, the MRC[13] and 1984 AMA[14] scales classify it as either absent, mild, moderate or severe, whereas the 1993 AMA scale[15], in addition to degrees mentioned above, includes the extremely severe category. The BDI[16] assesses dyspnea only as present or absent.

Spirometry was performed using the Multispiro system (Creative Biomedics, San Clement, CA, USA) and flow measurements were taken using a calibrated pneumotacograph. All individuals performed al least three forced expiratory maneuvers, in accordance with technical procedures and acceptability and reproduction criteria established by the *Sociedade Brasileira de Pneumologia e Tisiologia* (Brazilian Society of Pulmonology and Phthisiology)[22]. The following variables were corrected for conditions of body temperature and pressure saturated with water vapor: forced vital capacity (FVC); forced expiratory volume in one second (FEV_1); FVC/FEV_1 ratio; and forced expiratory flow between 25% and 75% of FVC. The values were analyzed comparatively to the predicted values for Brazilians, as determined by Pereira et al.[23]

Diffusion lung capacity for carbon monoxide was measured using the modified Krogh (single-breath) technique and a computerized system (PF-DX, Medical Graphics Corporation, St. Paul, MN, USA). At least two tests were performed since the variation between them was smaller than 10% or 3 mL of $CO/min^{-1}/mmHg^{-1}$. Absolute values were obtained by correcting for corrected for conditions of body temperature and pressure but not saturated with water vapor and were then compared to theoretical values for Brazilians, as described by Neder et al.[24]

Cardiopulmonary exercise tests were performed on an electronically-braked cycle ergometer (CPE

TABLE 1
Anthropometric, clinical and functional data of the studied population

	Mean ± SD
Age (years)	64.1 ± 9.4
Weight (kg)	73.4 ± 12.8
Height (cm)	165.7 ± 5.7
BMI (kg/cm^2)	26.7 ± 3.9
Tobacco Smoking (pack-years)	23.0 ± 17.5
Exposure to asbestos (years)	14.3 ± 10.7
Latency period (years)	37.8 ± 10.7
FVC (% predicted)	96.6 ± 13
FEV_1 (% predicted)	93.9 ± 16.4
FEV_1/FVC	74.7 ± 7.7
$FEF_{25-75\%}$ (% predicted)	80.3 ± 31.9
DLCO (% predicted)	82.5 ± 19.4
VO_2max (% predicted)	73.5 ± 15.9

BMI: body mass index; FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; $FEF_{25-75\%}$: forced expiratory flow between 25% and 75% of FVC; DLCO: diffusion lung capacity for carbon monoxide; VO_2max: maximal oxygen uptake; SD: standard deviation

2000, Medical Graphics Corp.), and gas exchange and ventilatory variables were analyzed at every breath (CPX-D $Cardio_2$ System, Medical Graphics Corp.) Initially, all participants performed an incremental test to the maximum limit of their tolerance, following the linear increase (“ramp”) in load protocol. Maximum oxygen consumption was considered the value obtained at peak oxygen uptake (average of 15 seconds) and was compared to that predicted by Neder et al. for sedentary adult Brazilians[25]. Anaerobic threshold was estimated noninvasively through gas exchange (V-slope)[26] and ventilatory techniques[27]. After an hour at rest, the participants performed an exercise test using the same load applied to the anaerobic threshold. Radial artery puncture to measure arterial oxygen tension (PaO_2) was performed in a stable-state condition, that is, between the fifth and sixth minutes of exercise.

To analyze the degree of agreement among the scales, we used the Kappa agreement statistic, which designates the following levels of concordance: 0 = absent; 0 to 0.2 = minimal; 0.2 to 0.4 = reasonable; 0.4 to 0.6 = moderate; 0.6 to 0.8 = substantial; 0.8 to 1.0 = near-perfect[28]. Fisher’s exact test was applied to analyze correlations between the characteristics of two or more variables. Student’s t-test for independent samples was used to compare mean values of physiological variables in the groups of individuals with or without dyspnea. One-way ANOVA was employed in order to compare the mean values of the physiological variables in the different degrees of dyspnea according to each of the different scales. Student's *t*-test for independent variables was used to compare mean interobserver BDI values[29]. A risk of 5% was adopted for all tests ($p < 0.05$).

RESULTS

Anthropometric, clinical and functional data of the studied population are shown in Table 1. In terms of mean values, alterations in respiratory function were minimal. In individual analyses, only 2 (5%) of the individuals presented lower-than-normal FVC values, and 10 (25%) presented diffusion lung capacity for carbon monoxide below 70% of the predicted value.

Within the study sample, dyspnea was not found to correlate with radiographic profusion or with smoking (Fisher's exact test $p > 0.05$) (Table 2). According to MRC and 1984 AMA scale scores, the incidence of dyspnea was similar: the disease affected 72.5% and 67.5% of the individuals, respectively ("near-perfect" concordance, Kappa agreement statistic). In contrast, only 37.5% and 31.6%, respectively ("substantial" concordance), were classified as dyspneic based on 1993 AMA scale and BDI scores (Tables 3 and 4).

In the majority of individuals classified as dyspneic based on MRC scale scores, the majority (20/29; 68.9%) presented the mild form, whereas 55.6% (15/27) and 60% (9/15) of those categorized as dyspneic according to 1984 and 1993 AMA scale scores, respectively, presented the moderate or severe form (Table 3). Therefore, when mild dyspnea was grouped with absence of dyspnea, comparability increased between the MRC and 1993 AMA scale scores and between the 1984 and 1993 AMA scale scores (Table 4). Characteristics of the BDI impeded a broader analysis concerning the degree of symptoms.

No significant correlation was found between smoking and dyspnea analyzed using the different scales ($p > 0.05$). However, when smokers and nonsmokers were compared, mean FVC and FEV_1 values – considered as percentages of the predicted values – were significantly lower in current or former smokers (unpaired *t*-test, $p < 0.05$).

Concerning functional variables obtained at rest and during exercise, no statistically significant difference was found between individuals with or without dyspnea (Table 5), or even among the different degrees of dyspnea severity.

DISCUSSION

The present study demonstrated that determination of the presence and degree of chronic dyspnea varies substantially depending on the specific scale used. The MRC and 1984 AMA scales classified more individuals as dyspneic than did the AMA 1993 scale and the BDI. The intensity of this symptom also had a tendency to be greater when the MRC and 1984 AMA scales were used. However, there was dissociation between the lower frequency of objective functional findings and the most common patient

TABLE 2
Analysis of the percentage of dyspnea in relation to radiographic profusion and smoking according to the different scales of dyspnea (Fisher's exact test)

Dyspnea scale	% Dyspnea vs. Profusion ≥ 1/0	% Dyspnea vs. Profusion 0/0 e 0/1	p
MRC/76	42.5%	30%	0.159
1984 AMA	37.5%	30%	0.071
1993 AMA	22.5%	15%	0.429
BDI *	18.4%	13.2%	0.472
Dyspnea scale	Dyspnea vs. Former Smokers and Smokers	Dyspnea vs. Nonsmokers	p
MRC/76	50%	22.5%	0.570
1984 AMA	45%	22.5%	0.391
1993 AMA	22.5%	15%	0.237
BDI *	18.4%	13.2%	0.293

* n = 38

MRC: modified Medical Research Council scale; AMA: American Medical Association scale; BDI: baseline dyspnea index complaints. These data show that the classification of chronic dyspnea can be influenced by the specific scale used to assess former workers with asbestosis. In addition, the clinical and functional dissociation observed suggests that, in respiratory evaluations of workers, symptoms such as dyspnea should be cautiously interpreted.

The criteria used to choose the discriminating instruments were based on the previous use of the instruments in other studies and their operational ease of application[7,8,16,20,30]. The MRC questionnaire and the AMA scales, specifically, are the principal instruments of assessment used in both international and Brazilian clinical and epidemiologic studies[12,20,31]. The BDI was initially used within a nonoccupational clinical context[16]. In fact, it is a more comprehensive scale, although its application may be questionable in large population studies.

It is well known that dyspnea is the most relevant symptom in the assessment of interstitial pulmonary diseases, especially asbestosis. In addition to the complexity of evaluation and classification, confounding factors hinder the establishment of a relationship between a subjective complaint and physiopathological alterations of the underlying disease[3]. Various authors have employed the MRC and 1984 AMA scales to evaluate dyspnea in workers exposed to asbestos[8,30,32]. In these previous studies, dyspnea prevalence varied from 15% to 66%. In the present study, chronic dyspnea was found to be more common and intense when the MRC and 1984 AMA scales were used than when the 1993 AMA scale and the BDI were applied (Table 3). A substantial portion of the differences seems attributable to discrepancies among the instruments in distinguishing between the absence of dyspnea and mild dyspnea (Table 4). However, we must admit that, due to the definition of dyspnea intensity itself, the scales are not immediately comparable.

The results showed that smoking was not correlated with dyspnea in any of the scales (Table 2). These data are not in accordance with data obtained in previous studies, which showed a significant correlation between smoking and dyspnea in workers exposed to asbestos[3,8,30]. However, it is important to emphasize that, in the present study, obstructive disorder – moderate or severe – was considered an exclusion factor. Although this exclusion reduced the influence of confounding comorbidities such as chronic obstructive pulmonary disease and asthma, it seems probable that the prevalence of dyspnea would have been higher in a more heterogeneous sample. Since radiographic alterations were discrete, no correlation was observed between these alterations and dyspnea (Table 2).

There was no evidence that dyspnea or degree of dyspnea intensity correlate significantly with spirometric, gas exchange and metabolic alterations, either at rest or during exercise. These results are in contrast to those obtained by, for example, Schwartz et al. and Brodkin et al. The authors found that dyspnea correlates with spirometric alterations, decreased lung volume and abnormalities in gas exchange in workers exposed to asbestos (with or without pleuropulmonary abnormalities)[8,30]. These differences may be related to functional homogeneity of the group assessed in the present study, in which the majority of patients presented slight alterations. It is also reasonable to assume that other physiopathological alterations were clearly revealed by the functional tests applied. Patients with asbestosis, for instance, can present increased

TABLE 3
Frequency and percentage of the incidence of dyspnea and dyspnea degree according to the different scales

	MRC	1984 AMA	1993 AMA	BDI *
PRESENCE (%)	29 (72.5)	27 (67.5)	15 (37.5)	12 (31.6)
ABSENCE (%)	11 (27.5)	13 (32.5)	25 (62.5)	26 (68.4)**
MILD (%))	20 (68.9%)	12 (44.4%)	6 (40%)	
MODERATE (%)	1 (3.5%)	12 (44.4%)	6 (40%)	
SEVERE (%)	8 (27.6%)	3 (11.2%)	2 (13.3%)	
VERY SEVERE (%)***	-	-	1 (6.7%)	

*It was not possible to obtain total BDI in two individuals, **Cutoff point for normality: ≥ 9
***Valid only for the 1993 AMA scale
MRC: modified Medical Research Council scale; AMA: American Medical Association scale; BDI: baseline dyspnea index

neural control of breathing by stimulation of pulmonary receptors or even through factors related to peripheral muscles or to the cardiovascular system[20,33]. On the other hand, studies evaluating dyspnea in workers seeking to obtain pension benefits may have overestimated, to some degree, the incidence of the symptom[4-6]. Although dyspnea has been correlated with reduced static lung volumes[8,30], this parameter was not measured in the present study.

Our study naturally presents various limitations that are worthy of note. The scales used have yet to be formally validated in Brazil, although they are easily translated and have been widely used in previous studies carried out in our milieu[11,12,20,21]. However, concerning the BDI in particular, interobserver reproducibility was high. Another potential limitation concerns the systematic application of the scales, that is, the fact that they were applied over the course of a single day and in a nonrandom order. Finally, the results may not be applicable in populations with greater functional involvement or in workers not seeking to obtain pension benefits.

We can conclude that, in former workers with asbestosis, the presence and degree of dyspnea may vary substantially depending on the specific scale used. These results, when considered in view of the lack of a correlation with objective functional data, suggest that such chronic dyspnea indices should be interpreted with caution in evaluations of dysfunction and incapacity in asbestosis.

ACKNOWLEDGMENTS

The authors would like to thank Doctor Sandra Mara Lima Guimarães for performing the majority of the cardiopulmonary exercise tests. We are also thankful to Luiza Hashimoto for performing the functional tests and to Vera Lúcia Rigoni for her collaboration on the exercise tests.

TABLE 4
Analysis of interscale concordance in relation to the presence or absence of dyspnea, absent/mild dyspnea vs. moderate/severe dyspnea

Dyspnea	Scales	Kappa value	Degree of concordance
Absence	MRC vs. 1984 AMA	0.763	Substantial*
vs.	MRC vs. 1993 AMA	0.371	Reasonable
Presence	MRC vs. BDI+	0.283	Reasonable
	1984 AMA vs. 1993AMA	0.448	Moderate
	1984AMA vs. BDI+	0.351	Reasonable
	1993 AMA vs. BDI+	0.883	Near-perfect*
Absent/Mild	MRC vs. 1984 AMA	0.652	Substantial
vs.	MRC vs. 1993 AMA	1.000	Perfect*
Moderate/Severe	1984 AMA vs. 1993 AMA	0.652	Substantial

+ (*n* = 38)
MRC: modified Medical Research Council scale; AMA: American Medical Association scale; BDI: baseline dyspnea index

TABLE 5
Physiological responses to the presence or absence of dyspnea according to the different scales

	MRC		1984 AMA		1993 AMA		BDI	
DYSPNEA	YES (n = 29)	NO (n = 11)	YES (n = 27)	NO (n = 13)	YES (n = 15)	NO (n = 25)	YES (n = 12)	NO (n = 26)
FVC (% predicted)	96.1 ± 13.3	97.7 ± 12.7	96.3 ± 13.9	97.3 ± 11.5	101 ± 10.7	94 ± 13.7	100.4 ± 11.1	94.6 ± 14
FEV_1/FVC	76.2 ± 6.1	70.6 ± 10.4	75.9 ± 6.1	72.3 ± 10.3	75.4 ± 6.4	74.3 ± 8.5	74.9 ± 7.1	74.3 ± 8.3
$FEF_{25-75\%}$(% predicted)	84 ± 28.5	70.5 ± 39.4	81.9 ± 28.6	76.8 ± 39	84.2 ± 28.7	77.9± 34	82.7 ± 31.7	77.8± 33.2
DLCO (% predicted)	83.9 ± 20.9	78.8 ± 15	85.2 ± 20	76.8 ± 17.5	85 ± 19	81± 19.8	87.1 ± 19.4	81.4 ± 19.6
$PaO_{2\ exerc}$ (mmHg)	84.4 ± 10.9	82.5 ± 12.2	85.2 ± 10.7	81.1 ± 11.9	86.9 ± 11.1	82± 10.9	85.7 ± 11.8	83.4 ± 11.3
VO_2max (% Prev)	73.4 ± 15.1	69.2 ± 14.9	72.3 ± 15.3	72 ± 14.8	70.7 ± 16.4	73.1 ± 14.5	68.6 ± 14.5	75.3 ± 14.6

MRC: modified Medical Research Council scale; AMA: American Medical Association scale; BDI: baseline dyspnea index; FVC: forced vital capacity; FEV1: forced expiratory volume in one second; FEF25-75%: forced expiratory flow between 25% and 75% of FVC; DLCO: diffusion lung capacity for carbon monoxide; PaO2 exerc.: arterial oxygen tension during exercise; VO2: maximal oxygen uptake

REFERENCES

1. Kamp DW, Weitzman AS. Asbestosis: clinical spectrum and pathogenic mechanisms. Proc Soc Exp Biol Med. 1997;97:12-26.
2. Lordi GM, Reichman LB. Pulmonary complications of asbestos exposure. Am Fam Phys. 1993;48:1471-7.
3. Agostini P, Smith DD, Schoene RB, Robertson HT, Butler J. Evaluation of breathlessness in asbestos workers. Am Rev Respir Dis. 1987;135:812-6.
4. Brasil. Ministério do Trabalho. Consolidação das leis do trabalho (CLT): norma regulamentadora 7. Brasília; 1994.
5. Bagatin E, Nery LE, Jardim JRB. Considerações críticas da concessão do benefício previdenciário. Estudo retrospectivo de trabalhadores expostos à sílica. Rev Bras Saúde Ocup. 1989;17:14-7.
6. Neder JA, Nery LE, Bagatin E. Avaliação da disfunção, incapacidade e dos aspectos legais da doença ocupacional respiratória. In: Atualização e reciclagem-Sociedade Paulista de Pneumologia e Tisiologia. 2a ed. São Paulo: Atheneu; 1998. p.57-67.
7. Waage HP, Vatten LJ, Opedal E, Hilt B. Lung function and respiratory symptoms related to changes in smoking habits in asbestos-exposed subjects. J Occup Environ Med. 1996;38:178-83.
8. Schwartz DA, Davis CS, Merchant JA, Bunn B, Galvin JR, Fossen DSV, et al. Longitudinal changes in lung function among asbestos-exposed workers. Am J Respir Crit Care Med. 1994;150:1243-9.
9. Becklake MR. Symptoms and pulmonary functions as measures of morbidity. Ann Occup Hyg. 1994;38:569-80.
10. Sette AA, Nápolis LM, Neder JA, Kawakama JI, Terra Filho M, Nery LE, et al. Relationship between high-resolution computed tomography (HRCT) and pulmonary gas exchange abnormalities in patients with asbestosis. Am J Respir Crit Care Med. 2000;161:A50.
11. Guimarães SML, Duarte SR, Sette AA, Pereira CAC, Neder JA, Nery LE. Prediction of maximal exercise tolerance in patients with idiopathic pulmonary fibrosis (IPF). Am J Respir Crit Care Med. 2000;161:A528.
12. Algranti E, Mendonça EM, De Capitani EM, Freitas JB, Silva HC, Bussacos MA. Non-malignant asbestos-related diseases in Brazilian asbestos-cement workers. Am J Ind Med. 2001;40:240-54.
13. Cotes JE, Steel J. Work related lung disorders. Oxford: Blackwell Scientific Publications; 1987. p.82-4.
14. American Medical Association. Guides to the evaluation of permanent impairment. 2nd ed. Chicago; 1984. p.86.
15. American Medical Association. Guides to the evaluation of permanent impairment. 4th ed. Chicago; 1993. p.5/154.
16. Mahler DA, Weinberg DH, Wells CK, Feinstein AR. The measurement of dyspnea. Chest. 1984;85:751-8.
17. International Labor Organization. Guidelines for the use of the ILO international classification of radiographs of pneumoconioses. Geneva: International Labor Office; 1980.
18. Webb WR, Muller NL, Naidich DP. High-resolution CT technique. In: Webb WR, Muller NL, Naidich DP. High-resolution CT of the lung. New York: Raven Press; 1992. p.4-13.
19. Gamsu G, Salmon JC, Warnock ML, Blanc PD. CT quantification of interstitial fibrosis in patients with asbestosis: a comparison of two methods. AJR Am J Roentgenol. 1995;164:63-8.
20. Florêncio RT, Nery LE, Campos LB, Bagatin E, Jardim JR, Santos ML. Testes de exercício na avaliação funcional de ceramistas com silicose pulmonar. Rev Bras Saúde Ocup. 1989;65:33-42.
21. Martinez JAB, Martinez, TY, Gallhardo FPL, Pereira CAC. Dyspnea scales as a measure of health-related quality of life in patients with idiopathic pulmonary fibrosis. Med Sci Monit. 2002;8:CR405-410.
22. Sociedade Brasileira de Pneumologia e Tisiologia. Consenso Brasileiro de Espirometria. J Pneumol. 1996;22:105-64.
23. Pereira CAC, Barreto SP, Simões JG, Pereira FWL, Gerstler JG, Nakatami J. Valores de referência para espirometria em uma amostra da população brasileira adulta. J Pneumol. 1992;18:10-22.
24. Neder JA, Andreoni S, Peres C, Nery LE. Reference values for lung function tests. III - Carbon monoxide diffusing capacity (transfer factor). Braz J Med Biol Res. 1999;32:729-37.
25. Neder JA, Nery LE, Castelo A, Andreoni S, Lerario MC, Whipp BJ, et al. Prediction of metabolic and cardiopulmonary responses to maximum cycle ergometry: a randomised study. Eur Respir J. 1999;14:1304-13.
26. Wasserman K. Anaerobiosis, lactate and gas exchange during exercise: the issues. Fed Proc. 1986;45:2904-9.
27. Reinhard U, Muller PH, Schmulling RM. Determination of anaerobic threshold by the ventilation equivalent in normal individuals. Respiration. 1979;38:36-42.
28. Meade MO, Guyatt GH, Cook RJ, Groll R, Kchura JR, Stewart TE, et al. Agreement between alternative classifications of acute respiratory distress syndrome. Am J Respir Crit Care Med. 2001;163:490-3.
29. Munro BH. Statistical methods for health care research. 4th ed. Philadelphia: Lippincott; 2000.
30. Brodkin CA, Barnhart S, Anderson G, Checkoway H, Omenn GS, Rosenstock L. Correlation between respiratory symptoms and pulmonary function in asbestos-exposed workers. Am Rev Respir Dis. 1993;148:32-7.
31. Samet JM. A historical and epidemiologic perspective on respiratory symptoms questionnaires. J Epidemiol Commun Health. 1978;108:435-44.
32. McDonald JC, Becklake MR. Respiratory symptoms in chrysotile asbestos mine and mill workers of Quebec. Arch Environ Health. 1972;24:358-63.
33. Neder JA, Nery LE, Bagatin E, Lucas SR, Anção MS, Sue DY. Differences between remaining ability and loss of capacity in maximum aerobic impairment. Braz J Med Biol Res. 1998;31:639-46.