COALWORKER'S PNEUMOCONIOSIS AND RESPIRATORY FUNCTION IN CHILEAN MINERS

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INTRODUCTION

Coal mining began in Chile in 1882. The coalfields are located in the central part of the country, under the sea, having the collieries an extension of 5 to 25 kilometers from the shore. Their total workforce has been between 5,000 to 10,000 miners that extracts bituminous coal by means of the "long wall" mining method.

In 1979 an Occupational Health Program was established, and this study was developed with the goal of showing the results of the first three years of medical assessment of underground miners. The main objectives were to know the prevalence of Coalworkers Pneumoconiosis (CWP), the respiratory manifestations related to the exposure to coal mine dust, and the probable cause of the respiratory complaints in these coalminers.

MATERIAL AND METHODS

Between 1979 and 1983 a population of 3,754 underground coal miners, actives and retired, were examined at the Occupational Health Department. The mean age of these miners was 45.4 ± 9.4 years, with an average mining working life of 20.6 ± 11 years. The mean weight was 69.4 ± 11.7 kg and their beight 163.5 ± 12.4 cm. Most of the retired workmen were referred as claimants for occupational disease benefits, representing a selective group.

The medical assessments include a chest X-ray study consisting in full size postero-anterior radiographs, that were read by a single reader and classified according to ILO/UC International Classification of Radiographs of Pneumoconiosis.[8] Pulmonary function tests were offered to 1,905 coalminers, the physiological techniques used were those described in previous publications.[2,18] The spirographic data obtained from the tracings included the forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and the mean forced expiratory flow 25% to 75% of FVC ($FEF_{25-75\%}$). The ratio $FEV_1/FVC \times 100$ (FEV%) was also calculated; if its value was lower than 70%, the subject was considered to suffer a bronchial obstruction to airflow. All volumes were expressed in BTPS. The estimated normal values were obtained from Kory, R.C.[9]

In 294 coalminers the lung volume was studied. The subdivisions considered were the residual volume (RV), functional residual capacity (FRC) and total pulmonary capacity (TPC), measured by means of the closed circuit helium dilution method.[7] Normal values were taken from those published by Bates, D.V.[1]

An adapted questionnaire of chronic bronchitis and smoking habits was applied to the coalminers with spirometry function tests.[13] The smokers were classified according to Brinkman, G.L.[3]

RESULTS

The results of the chest X-ray reading are presented in Table I.

In the 1,905 coalminers tested there were 20.8% with bronchial obstruction, 1% with a restrictive ventilatory insufficiency and 41.6% with chronic bronchitis. Only 3.6% of those with bronchial obstruction showed an abnormal FEV_1 (less than 80% of the estimated normal). In these miners 29% were smokers and only 1.7% of them were heavy smokers. These low figures prevent the effects of smoking in our results.

Figure 1 shows the prevalence of bronchial obstruction in the non-smoking coalminers, with and without CWP, distributed by age.

The mean values of FVC, FEV_1 and FEV%, expressed in percent of the expected normals, were not altered in these miners and the different CWP categories didn't show any effect over them. The $FEF_{25-75\%}$ and the RV/TPC proportion showed, on the other hand, a progressive deterioration in relation to the increased severity of CWP. The differences observed between categories 0/0 and 2/2 were statistically significant. The low number of cases in category 3/3 prevent its statistical comparison.

Table I

Resultados de Radiografias de Torax de Mineros Activos y Retirados
Mineria del Carbon (1979–1983)

I.S.T.	0/0	0/1	1/0	1/1	1/2	2/1	2/2	2/3	3/3	A-B-C	TOTAL
ENACAR	2872	343	161	191	84	11	61	15	8	8	3754
			N=436 (11,6 %)			N= 531 (14,1 %)					

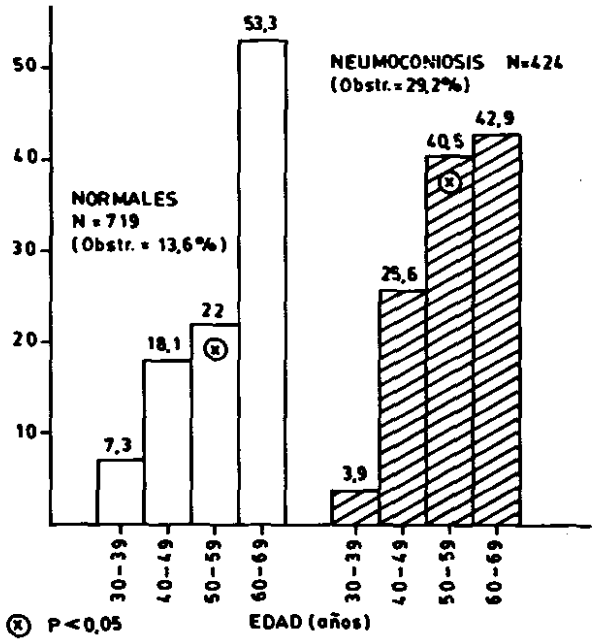

Figure 1. Proporcion de casos obstructivos en mineros sin y con neumoconiosis que no fuman.

Table II illustrates the mean values of FRC, RV, and TPC, expressed as the percentage of observed values to predicted normal in relation to CWP categories.

In Table III the effect of bronchial obstruction on the lung volumes can be observed.

DISCUSSION

The prevalence of CWP found in this study (14.1%) was influenced by the selected group of retired miners seeking for compensation, by the fact that they were older and that, at the time of the examination, they already had a presumed diagnosis of CWP. For this reason it is most probable that the prevalence in our active miners is lower.

PMF was until now an unknown entity in our coalminers. The observed prevalence (0.22%) in this sample was very similar to what has been published elsewhere,[16,12] and points out the similarities of the lung reactions to coal dust.

Bronchial obstruction was more prevalent (20.8%) than what has been found in non-smoking not exposed workers (7.8%) ($P<0.001$).[2] The prevalence in the non-smoking coalminers with CWP (29.5%, was higher than what was found in those without CWP (15.6%); but when compared by

Table II

Volumenes Pulmonares Obtenidos por el Metodo de Dilucion de Helio por Categoria Radiologica

CATEGORIA RADIOLOGICA	N	$\bar{X}$ C.F.R. % obs / est.	$\bar{X}$ V.R. % obs / est.	$\bar{X}$ C.P.T. % obs / est.
0/0	104	98,0 ±21,3	117,5 ±30	112,4 ±13
0/1	37	94,6 ±20,8	111,2 ±28	111,4 ±14
1/1	123	97,1 ±20	117,3 ±30	112,9 ±13
2/2	25	109,7 ±30	145,5 ±62	118,7 ±22
3/3	5	105,4 ±16	126,2 ±11	118,0 ±9

Table III

Volumen Residual (yr) y Capacidad Pulmonar Total (CPT) en % de lo Observado/Estimado Normal Segun Categoria Radiologica y Funcion Ventilatoria

CATEGORIA RADIOLOGICA	NO OBSTRUCTIVOS			OBSTRUCTIVOS		
	N	CPT %	VR %	N	CPT %	VR %
0/0	83	112,2 ± 13	110,9 ± 25	21	114,9 ± 13	133,7 ± 34
0/1	31	110,9 ± 13	105,5 ± 19	6	114,2 ± 20	140,2 ± 47
1/1	78	109,6 ± 12	106,8 ± 22	45	118,0 ± 13	131,4 ± 34
2/2	17	113,5 ± 17	127,5 ± 28	8	129,8 ± 28	187,5 ± 92
3/3	2	110,5	126,0	3	123,0	126,3

age groups only those between 50 to 59 years continue to show a significant difference. This low involvement of the larger airways in CWP is in agreement to what has been published.[20,14,19,5]

Coincident with other studies, these coalminers had increased RV, TPC, and RV/TPC when compared to the estimated normal values in the general population.[17,15] CWP was demonstrated to have a significant effect in the increased RV when comparing categories 2/2 with 0/0 coalminers. Morgan, W.K.C.,[14] Lapp, N.L.,[10] and Churg, J.L.[4] has suggested that the anatomical changes attached to the localization of the coal macule at the respiratory bronchioles can explain these abnormalities. It is almost certain that the increased small airways resistance in these cases play a major role in the increased RV;[15] and the significant deterioration of the $FEF_{25-75\%}$ in relation to the severity of CWP observed in this study is also in keeping with these suggestions.[5,11]

The absence of an important involvement of bronchial airflows and the proved late emergence of emphysema in CWP, makes it unlikely as an important factor in the etiology or the ventilatory abnormalities in these miners.[6]

The influence of bronchial obstruction on the results of RV was evident, but it was also clear that the non obstructed coalminers continue to show the same lung volumes abnormalities described with lower values. As in the study of Morgan, W.K.C.,[15] it was noteworthy that bronchial obstruction didn't show the same trend in relation to CWP categories as that observed with RV. Again we are inclined to the view that the increased resistance in the peripheral airways is probably the most important factor in these results.

The low prevalence of abnormal values of FEV_1 in these workers is according to what has been described as a functional parameter unrelated to simple CWP,[20] and it points out the scant influence of this disease in the respiratory impairment seen in a proportion of these miners. The main offender has always been related with complicated CWP or other severe lung disease.

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Proceedings of the VIIth International Pneumoconioses Conference *Part*
Transactions de la VIIe Conférence Internationale sur les Pneumoconioses *Tome*
Transaciones de la VIIa Conferencia Internacional sobre las Neumoconiosis *Parte*

II

Pittsburgh, Pennsylvania, USA—August 23–26, 1988
Pittsburgh, Pennsylvanie, Etats-Unis—23–26 aout 1988
Pittsburgh, Pennsylvania EE. UU—23–26 de agosto de 1988

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November 1990

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DHHS (NIOSH) Publication No. 90-108 Part II