STUDY OF THE EFFECTS OF NON-SILICEOUS MINERAL DUSTS ON CHRONIC RESPIRATORY DISEASE

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This study was performed on the miners from lignite and brown coal mines and on the workers employed in the production of cement. The basis for a study in these two industries we have had in literature. The authors such as Carstens (2), Hyatt (11) and some others suggested that occupational exposure in miners, particularly the exposure to dusts, besides producing pneumoconiosis, may also induce nonspecific respiratory impairment. Later on, Higgins, et al. (9) came to a conclusion that smoking habit represents a more significant factor in the development of respiratory impairment than occupation. Enterline and Lainhart (5), like Higgins, et al. (8) found a higher rate of respiratory symptoms in miners than in control workers, but found the same for miners' wives. The problem of chronic bronchitis and occupation was dealt with in a Medical Research Council's Report in Great Britain in 1966.

The results of the so far performed clinico-epidemiological studies into the frequency of chronic nonspecific lung disease in cement workers also differ. Guilliani and Belli (7) report that 84% of workers in a cement plant in Italy suffered from lung emphysema, chronic bronchitis or other chronic respiratory disorders. Vyskocil (19) points out that by examining 104 workers he found nasopharyngitis in almost each worker, chronic bronchitis in 75 and lung emphysema in 21 workers. The Soviet authors Tarnopoljskaja and Ostenskij (18) also report a high rate of lung emphysema in male and female cement workers. The high rate of emphysema, chronic bronchitis, chronic pharyngitis and chronic rhinitis in these workers was equally pointed out by some other authors including the Yugoslav authors Karajovic, et al. (14), and Popovic (16). Gardner and collaborators (6) on the contrary, did not find chronic respiratory infections in cement workers any more frequently than in the rest of the population. The same experience was reported by Jenny, et al. (13) as well as by Sander (17) and Hudson (10).

More or less controversial opinions in the literature concerning the role of exposure in coal mines and cement production in the occurrence of chronic nonspecific lung disease led us to examine the problem in a group of miners and cement workers in Yugoslavia. In either case i.e., among both the cement workers and miners a selection was made among those with five or more years of work experience in underground work and cement production.

The investigation was planned and carried out as a cross sectional study. As controls served the workers from the same area, of corresponding age and socio economic structure who had never been occupationally exposed to dusts or chemical irritants. The examinations were performed in the same season (spring). The method of examination consisted of the questionnaire of the Committee on the Aetiology of Chronic Bronchitis of the British Medical Research Council, FVC and $FEV_{1.0}$ determinations, clinical examination, X-ray of the lungs and analysis of the volume and consistency of the early morning sputum. Beside, basic anthropometric measures were taken, electrocardiography was performed and blood pressure measured.

Examinations also included miners' and cement workers' wives as well as the wives of the corresponding control workers. These examinations were planned as an attempt to evaluate the influence of nonoccupational factors on the rate of respiratory impairment.

Data were analyzed according to criteria worked out by the authors of the questionnaire (Lancet, 1965). Chronic bronchitis was defined as phlegm production in the morning in winter or during day and/or night for at least three months per year, in the course of the last two years or longer. Exacerbations were defined as periods of increased phlegm or cough lasting three weeks or more during the last three years. Categories of smokers were determined according to the number of years of smoking and the number of cigarettes smoked per day (Brinkman and Coates) (1).

The obtained values of forced expiratory volumes are expressed as percentage of the values expected with regard to age and height of subjects (12) For women they are presented in relation to normal values established by Kory et al. (15).

As far as $FEV_{1.0}/FVC(\%)$ values are concerned as reduced were regarded the values of 79% and lower for the 20-29 age group, 76% and lower for the 30-39 age group, 74% and lower for the 40-49 age group and 71% and lower for the 50-59 age group.

The study has been in its final stage.* In this paper the most important results are presented separately for groups of miners and cement workers.

Miners

A group of 904 miners from 3 lignite and brown coal mines was examined. All examined miners are presented together and not separately by mines because there was no essential difference in the method of work or working conditions. The excavating of coal was relatively mechanized. The problem of exposure to free SiO_2 did not exist in any of the mines. As control served a group of 342 workers.

Besides, 418 miners' wives and 122 control workers' wives were also examined.

In Table 1 are presented general data about examined miners and control workers.

In Table 9 are presented data about the prevalence of different respiratory symptoms in nonsmokers-miners and nonsmokers-control workers.

Tables 10 and 11 show the prevalence of the same respiratory symptoms in miners - nonsmokers and smokers by length of mining experience.

Table 12 summarizes $FEV_{1.0}$ values expressed as percentage of those expected for respective age and height in control workers and miners according to years of mine work and smoking habit.

Table 13 shows $FEV_{1.0}$ data expressed as percentage of expected values in control workers and miners grouped by smoking categories and years of mine work.

Table 14 shows $FEV_{1.0}$/FVC (%) ratio in control workers and miners by length of mining experience and smoking habit.

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* The results obtained earlier have been presented in two theses and several papers: Ivo Kalacic: Chronic nonspecific lung disease in cement workers, Ph.D. Thesis, Zagreb, 1970.
Slavica Palaic: Nonspecific respiratory impairment in coal miners, M.Sc. Thesis, Zagreb, 1970.
Kalacic, I.: Ventilatory lung function in cement workers, International Occupational Safety and Health Congress, Geneva, 1969.
Saric, M., and Slavica Palaic: The prevalence of respiratory symptoms in a group of miners and the relationship between symptoms and some functional parameters, III. International Symposium on Inhaled Particles, London, 1970, Preprints, 11.1 1.

Discussion

From the data presented in the above tables it is evident that respiratory symptoms and their combinations which have been dealt with occur as a rule more frequently in miners than in control workers. Data from Table 1 and 2 show a good agreement with regard to main characteristics between the group of miners and control workers.

Chronic bronchitis has been found to occur more often in older age groups (miners) and particularly in smokers. However, it is important to note that among miners - smokers the rate of chronic bronchitis is higher than among control workers - smokers. The same is valid for the nonsmoking miners as compared to nonsmoking control workers (Tables 6-8).

The rate of chronic bronchitis is also associated with the length of work experience in the mine (Table 5). Here, however, age is a factor that should be taken into consideration - older miners usually have longer work experience in the mine.

Individual respiratory symptoms presented separately for nonsmokers (Table 9) also show a higher prevalence in miners than in control workers. Some of them were associated at the same time with the length of mining experience. Cough, phlegm production, shortness of breath and wheezing were found at the highest rate in miners with the longest duration of work in mine, more often in those who smoked than in nonsmokers (Tables 10 and 11).

The presented functional parameters do not show such a good correlation with the length of work experience in the mine, smoking habit and the number of cigarettes smoked.

As shown in Table 12 $FEV_{1.0}$ values are not greatly reduced if compared with those expected. However, in the miners with longest exposure (more than 20 years) who are also smokers considerably reduced $FEV_{1.0}$ values were found with the exception of light smokers (Table 13).

$FEV_{1.0}/FVC$ (%) ratio was also lowest in miners with the longest mining experience (Table 14). It is interesting to mention that the mean $FEV_{1.0}/FVC$ (%) values were very similar in smokers and nonsmokers with the exception of the group of miners with mining experience from 10 to 19 years in which this functional parameter showed lower mean value in smokers than in nonsmokers. However in none of the groups or subgroups compared was the $FEV_{1.0}/FVC$ (%) ratio greatly reduced.

A certain disproportion between the rate of respiratory symptoms indicative of chronic bronchitis and the spirometric values indicative of obstructive impairment might be due to a certain selection which occurred in the examined groups. Namely ill workers quit the job and retired with a disability pension without having been included in the examined groups. Records of disability pension insurance indicate that particularly in the coal mines which have recently been through economic difficulties a relatively great number of workers retire with a disability pension. On the other hand it should be taken into consideration that a number of workers with recorded bronchitic symptoms need not instantly develop obstructive disorders. Besides, the applied tests represent relatively rough functional parameters so that a number of slighter changes were probably not recorded at all.

The wives of miners and control workers had considerably less respiratory symptoms than their husbands and there was no significant difference in the prevalence of chronic bronchitis between miners' and control workers' wives. Among functional parameters the mean $FEV_{1,0}$ value expressed as percentage of expected value was somewhat reduced in miners' wives. In spite of the fact that - due to technical difficulties - we could not examine all the miners' and control workers' wives we think that those examined represent the actual relationship between the two groups.

It is important to note that among miners' as well as the control workers' wives there is only a small percentage of smokers - 5.3% miners' and 10.6% control workers' wives are present smokers. Among miners' wives four smoked for more than 20 years and only one more than 20 cigarettes per day; among control workers' wives all smoked for less than 20 years and only one smoked more than 20 cigarettes per day.

The results of the examinations performed agree with a number of observations cited in the introduction about the association between the prevalence of various symptoms indicative of chronic nonspecific lung disease and occupation. In spite of the observed association between the prevalence of respiratory symptoms and mine work (in addition to smoking habit and age to some extent) it is not possible to make a definite conclusion about the causal relationship between mine work and respiratory impairment. The fact that miners' and control workers' wives do not significantly differ in this respect supports the assumption about the potential role of the occupational factor, though the possibility that some other factors besides those observed and controlled might also contribute to the differences found cannot be excluded.

Cement Workers

This part of the study was conducted in three cement-manufacturing plants. In total 847 cement workers were examined. The control group consisted of 460 workers. The cement plants from which the workers were selected manufacture portland cement while one of them also manufactures white cement.

Since among the examined groups of workers there were no great mutual differences regarding the prevalence of respiratory disorders, the conditions of production showing no essential difference either, the groups are presented together.

Besides cement and control workers their wives were also examined.

In Table 17 are presented general data about examined exposed and control workers.

Tables 27 and 28 show the prevalence of the same respiratory symptoms in nonsmokers and smokers respectively with various length of exposure in the manufacture of cement.

In Table 29 are shown FVC values (expressed as percentage of expected values) in the control and exposed group according to the length of work experience and smoking habit.

Table 30 shows the $FEV_{1.0}/FVC$ (%) in control and exposed workers by length of work experience and smoking habit.

In Table 31 are shown the values of the mean air velocity in the third fourth of FVC (E_{50-75}) expressed in ml/sec in nonsmoking control and exposed workers.

Discussion

If it is assumed that selective factors did not differ in the exposed and control group, the higher rate of symptoms and some objective findings characteristic of chronic nonspecific lung disease in exposed workers should be regarded as expression of an association between the exposure in cement production and the occurrence of the disease. However, it is not possible to give a definite answer to the question whether the connection is causal as it is not known whether the two groups of workers were comparable with regard to all factors with the exception of the factor of incriminated exposure.

Smoking as one of these factors appeared at a somewhat higher rate in the exposed group, what might have contributed to the higher rate of the disease in this group (Table 18). However, in nonsmokers too chronic bronchitis as well as some of the separately presented respiratory symptoms were more often found in the exposed group clearly indicating that smoking, even if it was a reason, could not have been the only one accounting for the differences found between the total sample of the control and experimental group (Table 22).

The mean age of the exposed workers was approximately the same as that of the controls (Table 17) so that it seems that the effect of age on the occurrence and frequency of respiratory symptoms may be disregarded.

From a rough estimate that the economic condition and medical welfare of control and exposed workers did not essentially differ and considering the fact that there were no basic differences in the rate of respiratory symptoms and findings between the wives of control workers and those of the exposed (Tables 32, 33), it is possible to assume that socio-economic, nonoccupational factors did not affect significantly the results obtained. Naturally, the effect of some other factors which it was not possible to have under control in the course of examination cannot be eliminated with certainty.

In spite of the observed differences in the rate of respiratory impairment between the cement workers and their controls the connection between the rate of prevalence and the degree of exposure does not seem to be particularly close. The nonsmokers with longer exposure showed, it is true, a somewhat higher rate of symptoms and findings than the nonsmokers with shorter exposure (Table 27), but the differences were not statistically significant in spite of the older age of workers with longer exposure. These results led us to assume that the occurrence of the disease might depend more on hereditary predisposition than on the occupational factor. The workers predisposed to respiratory impairment may get ill already in the first years of exposure.

Still, with regard to the relatively small number of workers in the compared groups and the possibility of a stronger influence of the selective factor in workers with longer exposure, from the results obtained it cannot be claimed that the duration of exposure is not associated with the onset of the disease. In smokers the differences in the rate of symptoms with regard to the length of exposure were more noticeable and in most cases statistically significant (Table 28). In the evaluation of these differences the fact that smokers with longer exposure were advanced in age being also heavier smokers should by all means be taken into account. It might be therefore assumed that the observed differences are more a result of the additive effect of age, smoking habit and exposure than a sole result of the length of exposure. It is equally possible that they be a result of the interaction of all the three factors.

Considering which is the most probable causal factor of exposure in the cement production, cement dust should by all means be put in the first place followed by other factors such as kiln gases and possibly abrupt temperature changes to which the workers are exposed.

The functional tests showed that the ventilatory impairment of the obstructive type is more often found than that of the restrictive type (Tables 29 and 30). It appears already in the first years of exposure and seems to be directly associated with the length of exposure. This connection with the duration of exposure is more evident if the impairment is determined by measuring air velocity in the third fourth of the forced vital capacity (Table 31) than by measuring the volume in the first second of the forced expiration. It seems that the mechanism of ventilation is more impaired in workers with smaller than in those with larger lung volumes.

Analyzing the results of the functional tests it is interesting to note that by none of the three spirometric parameters used was it possible to prove the differences in the ventilatory impairment between nonsmoking and smoking cement workers. It is difficult to provide a convincing explanation of this phenomenon. It might be assumed however, that dust during work provokes cough and that expectoration helps clear the lungs of cement dust thus eliminating or decreasing its noxious effect on ventilatory function.

Conclusion

It is our opinion that it would be useful to continue i.e., to extend a part of investigations. After the completion of the studies of the cross sectional type the planning of follow-up investigations with detailed clinical analysis of particular categories of already examined workers seems desirable (workers without symptoms, those with respiratory symptoms, workers who quit the job, etc.).

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Table 1

General Data about Examined Miners and Control Workers

	Summoned for examination	Examined	Mean age		Mean height in cm		Mean weight in kg	
			$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Miners	967	904 (93.5%)	38.2	6.0	169.9	5.7	68.1	7.9
Controls	396	342 (86.4%)	35.2	6.9	171.1	5.6	70.1	9.6

Table 2

Smoking Habit in Miners and Control Workers

	Miners N=904	Controls N=342
Nonsmokers	213 (23.6)	94 (27.5)
Past smokers	106 (11.7)	41 (12.0)
Present smokers		
Light	180 (19.9)	76 (22.2)
Moderate	362 (40.0)	108 (31.6)
Heavy	43 (4.8)	23 (6.7)

Note: Numbers in parenthesis in this and the following tables are percentages.

Table 3

Miners by Length of Work Experience

	Miners N=904
< 10 yrs	185 (20.5)
10 - 19 yrs	488 (54.0)
> 20 yrs	231 (25.5)

Table 4

General Data about Examined Miners' and Control Workers' Wives

	Summoned for examination	Examined	Mean age		Mean height in cm		Mean weight in kg	
			$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Miners' wives	537	418 (77.8%)	40.1	7.3	158.4	5.6	65.2	12.2
Controls' wives	164	122 (74.4%)	36.9	8.1	159.0	4.8	66.6	10.3

Table 5

Chronic Bronchitis in Control Workers and Miners by Length of Mining Experience

		N	Chronic bronchitis I	Chronic bronchitis with exacerbations II	Chronic bronchitis with reduced $FEV_{1.0}/FVC(\%)$ III	Chronic bronchitis with mucopurulent or purulent sputum IV
Controls (1)		342	21 (6.1)	3	8 (2.3)	10 (2.9)
Miners	< 10 yrs (2)	185	34 (18.4)	5 (2.7)	17 (9.2)	18 (9.7)
	10-19 yrs (3)	488	116 (23.8)	16 (3.3)	40 (8.2)	69 (14.1)
	> 20 yrs (4)	231	84 (36.4)	13 (5.6)	40 (17.3)	41 (17.7)

I 1-2,3,4 $P<0.01$; III 1-2,3,4 $P<0.01$; IV 1-2,3,4 $P<0.01$

Note: In this and in the following tables percentages were not calculated for less than five cases

Table 6

Chronic Bronchitis in Miners and Control Workers by Age

	N	Chronic bronchitis I	Chronic bronchitis with exacerbations II
Miners			
39 yrs or less (1)	525	107 (20.4)	14 (2.7)
40 yrs or more (2)	379	127 (33.5)	20 (5.3)
Controls			
39 yrs or less (3)	245	13 (5.3)	1
40 yrs or more (4)	97	8 (8.2)	2

I 1-2 $P < 0.01$; 1-3 $P < 0.01$; 2-4 $P < 0.01$

Table 7

Chronic Bronchitis in Miners by Smoking Habit

		N	Chronic bronchitis I	Chronic bronchitis with exacerbations II
Nonsmokers (1)		213	22 (10.3)	2
Past smokers (2)		106	23 (21.7)	9 (8.5)
Present smokers	Light (3)	180	47 (26.1)	6 (3.3)
	Moderate (4)	362	119 (32.9)	13 (3.6)
	Heavy (5)	43	23 (53.5)	4

I 1-2 $P<0.05$; 1-3 $P<0.01$; 1-4 $P<0.01$;
1-5 $P<0.01$

Table 8

Chronic Bronchitis in Control Workers by Smoking Habit

		N	Chronic bronchitis I	Chronic bronchitis with exacerbations II
Nonsmokers (1)		94	2	-
Past smokers (2)		41	2	-
Present smokers	Light (3)	76	5 (6.6)	1
	Moderate (4)	108	7 (6.5)	2
	Heavy (5)	23	5 (21.7)	-

Table 9

Respiratory symptoms in Miners and Control Workers: Nonsmokers

	Miners N=213	Controls N=94	
Cough - part day[x]	24 (11.3)	6 (6.4)	-
Cough - whole day[xx]	30 (14.1)	1	-
Phlegm - part day[x]	22 (10.3)	5 (5.3)	-
Phlegm - whole day[xx]	27 (12.7)	3	-
Shortness of breath			
Grade 2-5	119 (55.9)	24 (25.5)	$P<0.01$
Grade 3-5	12 (5.6)	2	-
Wheezing			
Only occasionally	73 (34.3)	17 (18.1)	$P<0.01$
Most days (or nights)	9 (4.2)	-	-
With attacks of shortness of breath	8 (3.8)	-	-
Nasal cathar 3 months per year	38 (17.8)	8 (8.5)	$P<0.05$
Chest illness during the last 3 years	19 (8.9)	7 (7.4)	-
Shortness of breath due to the effect of weather	48 (22.5)	4	-

[x]Part day - in the morning or during the day (or night) on most days for 3 months (in winter).

[xx]Whole day - in the morning and during the day (or night) on most days for 3 months or longer (in winter).

Table 10

Respiratory Symptoms in Miners - Nonsmokers by Length of Mining Experience

	Length of mining experience					
	<10 yrs N=51 (1)	10-19 yrs N=110 (2)	> 20 yrs N=52 (3)	1-2	1-3	2-3
Cough - part day[x]	5 (9.8)	13 (11.8)	6 (11.5)	-	-	-
Cough - whole day[xx]	9 (17.6)	9 (8.2)	12 (23.1)	-	-	$P<0.05$
Phlegm - part day[x]	2	8 (7.3)	12 (23.1)	-	-	$P<0.05$
Phlegm - whole day[xx]	10 (19.6)	12 (10.9)	5 (9.6)	-	-	-
Shortness of breath						
Grade 2-5	21 (41.2)	61 (55.5)	37 (71.2)	-	$P<0.01$	$P<0.05$
Grade 3-5	2	6 (5.5)	4	-	-	-
Wheezing						
Only occasionally	16 (31.4)	32 (29.1)	25 (48.1)	-	-	$P<0.05$
Most days (or nights)	-	5 (4.5)	4	-	-	-
With attacks of shortness of breath	-	4	4	-	-	-
Nasal cathar 3 months per year	11 (21.6)	14 (12.7)	13 (25.0)	-	-	-
Chest illness during the last 3 yrs	2	12 (10.9)	5 (9.6)	-	-	-
Shortness of breath due to the effect of weather	3	27 (24.5)	18 (34.6)	-	-	-

[x]Part day - in the morning or during the day (or night) on most days for 3 months (in winter).

[xx]Whole day - in the morning and during the day (or night) on most days for 3 months or longer (in winter).

Table 11

Respiratory Symptoms in Miners-Smokers by Length of Mining Experience

	Length of mining experience					
	<10 yrs N=134 (1)	10-19 yrs N=378 (2)	>20 yrs N=179 (3)	1-2	1-3	2-3
Cough - part day[x]	28 (20.9)	65 (17.2)	19 (10.6)	-	P<0.05	P<0.05
Cough - whole day[xx]	36 (26.9)	119 (31.5)	92 (51.4)	-	P<0.01	P<0.01
Phlegm - part day[x]	27 (20.1)	67 (17.7)	25 (14.0)	-	-	-
Phlegm - whole day[xx]	33 (24.6)	116 (30.7)	81 (45.2)	-	P<0.01	P<0.01
Shortness of breath						
Grade 2-5	72 (53.7)	240 (63.5)	149 (83.2)	P=0.05	P<0.01	P<0.01
Grade 3-5	11 (8.2)	35 (9.2)	38 (21.2)	-	P<0.01	P<0.01
Wheezing						
Only occasionally	63 (47.0)	206 (54.5)	130 (72.6)	-	P<0.01	P<0.01
Most days (or nights)	17 (12.7)	58 (15.3)	58 (32.4)	-	P<0.01	P<0.01
With attacks of shortness of breath	14 (10.4)	35 (9.2)	28 (15.6)	-	--	P<0.05
Nasal cathar 3 months per year	29 (21.6)	91 (24.1)	43 (24.0)	-	-	-
Chest illness during the last 3 years	25 (18.6)	55 (14.6)	30 (16.8)	-	-	-
Shortness of breath due to the effect of weather	29 (21.6)	124 (32.8)	88 (49.2)	P<0.01	P<0.01	P<0.01

[x]Part day - in the morning or during the day (or night) on most days for 3 months (in winter).

[xx]Whole day - in the morning and during the day (or night) on most days for 3 months or longer (in winter).

Table 12

$FEV_{1.0}$ (% of expected values) in Control Workers and Miners by Length of Mining Experience and Smoking Habit

		Smokers I			Nonsmokers II			Total		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Controls (1)		248	98.9	14.6	94	99.6	14.3	342	99.1	14.4
Miners	< 10 yrs(2)	134	101.6	15.7	51	101.7	13.9	185	101.6	14.8
	10-19 yrs(3)	378	98.9	14.6	110	100.6	15.7	488	99.3	15.2
	> 20 yrs(4)	179	91.2	15.3	52	96.0	12.6	231	92.3	14.0

I 1-4 $P<0.01$

III 1-4 $P<0.01$

I-II : 4 $P<0.05$

Table 13

$FEV_{1.0}$ (% of expected values) in Control Workers and Miners by Smoking Categories and Length of Mining Experience

		Past smokers I			Light smokers II			Moderate smokers III			Heavy smokers IV		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Controls (1)		41	103.3	13.2	76	101.5	15.5	108	96.6	16.7	23	93.1	13.2
Miners	< 10 yrs (2)	18	103.9	15.0	48	101.7	14.3	68	101.0	17.8	-	-	-
	10-19 yrs (3)	69	100.7	16.7	105	97.7	17.3	189	99.7	15.4	15	89.8	9.1
	> 20 yrs (4)	19	87.5	16.2	27	96.1	13.9	105	91.4	18.4	28	88.5	12.7

I 1-4 $P<0.01$

III 1-4 $P<0.05$

Table 14

$FEV_{1.0}/FVC$ (%) in Control Workers and Miners by Length of Mining Experience and Smoking Habit

		Smokers I			Nonsmokers II			Total III		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Controls (1)		248	79.1	7.6	94	81.5	7.3	342	79.8	7.4
Miners	< 10 yrs (2)	134	79.4	8.0	51	81.7	7.2	185	80.0	7.6
	10-19 yrs (3)	378	76.8	8.2	110	79.8	7.0	488	77.5	7.6
	> 20 yrs (4)	179	74.0	8.6	52	75.1	9.3	231	74.2	9.0

I 1-3 $P<0.01$; 1-4 $P<0.01$

II 1-4 $P<0.01$

III 1-3 $P<0.01$; 1-4 $P<0.01$

I-II 3 $P<0.01$

Table 15

Chronic Bronchitis in Miners' and Control Workers' Wives

	N	Chronic bronchitis	Chronic bronchitis with exacerbations
Miners' wives	418	14 (3.3%)	3
Control workers' wives	122	7 (5.7%)	1

Table 16

Forced Expiratory Volumes in Miners' and Control Workers' Wives

	N	FVC *I		$FEV_{1.0}$ II		$FEV_{1.0}$/FVC (%) III	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Miners' wives	418	109.7	15.4	89.6	15.5	79.2	6.8
Control workers' wives	122	111.3	13.5	101.0	16.6	80.4	8.4

II $P < 0.01$

Table 17

General Data about Examined Cement and Control Workers

	Summoned for examination	Examined	Mean age		Mean height in cm		Mean weight in kg	
			$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Cement workers	914	847 (92.7%)	39.9	6.8	172.4	5.8	76.0	11.0
Controls	526	460 (87.5%)	37.6	8.1	172.8	6.2	75.0	10.8

Table 18

Smoking Habit in Cement Workers and Control Workers

	Cement workers N=847	Controls N=460
Nonsmokers	197 (23.3)	137 (29.8)
Past smokers	155 (18.3)	75 (16.3)
Present smokers		
Light	89 (10.5)	63 (13.7)
Moderate	290 (34.2)	141 (30.6)
Heavy	116 (13.7)	44 (9.6)

Table 19

Cement Workers by Length of Work Experience

	Cement workers N=847
<10 yrs	329 (38.8)
10 - 19 yrs	371 (43.8)
>20 yrs	147 (17.4)

Table 20

General Data about Examined Cement Workers' and Control Workers' Wives

	Summoned for examination	Examined	Mean age		Mean height in cm		Mean weight in kg	
			$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Cement workers' wives	274	214 (78.2%)	40.6	8.4	160.9	5.8	69.4	11.6
Controls' wives	164	133 (81.1%)	37.7	9.2	160.3	4.6	67.4	11.2

Table 21

Smoking Habit in Cement Workers' and Control Workers' Wives

	Cement workers' wives N=214	Controls' wives N=133
Nonsmokers	203 (94.8)	126 (94.7)
Past smokers	1	1
Present smokers		
Light	8 (3.7)	5 (3.8)
Moderate	1	1
Heavy	1	-

Table 22

Chronic Bronchitis in Control Workers and Cement Workers by Length of Work Experience

		N	Chronic bronchitis I	Chronic bronchitis with exacerbations II	Chronic bronchitis with reduced $FEV_{1.0}/FVC\%$ III	Chronic bronchitis with mucopurulent or purulent sputum IV
Controls (1)		460	44 (9.6)	8 (1.7)	20 (4.3)	22 (4.8)
Cement workers	< 10 yrs (2)	329	44 (13.4)	4 (1.2)	29 (8.8)	33 (10.0)
	10-19 yrs (3)	371	80 (21.6)	8 (2.2)	47 (12.7)	56 (15.1)
	> 20 yrs (4)	147	37 (25.2)	2	19 (12.9)	27 (18.4)

I 1-3 $P<0.01$; 1--4 $P<0.01$

III 1-2 $P<0.01$; 1-3 $P<0.01$; 1-4 $P<0.01$

IV 1-2 $P<0.01$; 1-3 $P<0.01$ 1-4 $P<0.01$

Table 23

Chronic Bronchitis in Cement Workers and Control Workers by Age

	N	Chronic bronchitis I	Chronic bronchitis with exacerbations II
Cement workers			
39 yrs or less (1)	463	60 (13.0)	7 (1.5)
40 yrs or more (2)	384	101 (26.3)	7 (1.8)
Controls			
39 yrs or less (3)	288	18 (6.2)	5 (1.7)
40 yrs or more (4)	172	26 (15.1)	3

I 1-2 $P<0.01$; 3-4 $P<0.01$; 1-3 $P<0.01$; 2-4 $P<0.01$

Table 24

Chronic Bronchitis in Cement Workers by Smoking Habit

			N	Chronic bronchitis I	Chronic bronchitis wirh exacerbations II
Nonsmokers		(1)	197	23 (11.7)	2
Past smokers		(2)	155	18 (11.6)	1
Present smokers	Light	(3)	89	15 (16.8)	1
	Moderate	(4)	290	64 (22.1)	5 (1.7)
	Heavy	(5)	116	41 (35.3)	5 (4.3)

I 1-3 $P>0.10$; 1-4 $P<0.01$; 1-5 $P<0.01$

Table 25

Chronic Bronchitis in Control Workers by Smoking Habit

		N	Chronic bronchitis I	Chronic bronchitis with exacerbations II
Nonsmokers		137	3	-
Past smokers		75	6 (8.0)	2
Present smokers	Light	63	6 (9.5)	3
	Moderate	141	18 (12.8)	1
	Heavy	44	11 (25.0)	2

Table 26

Respiratory symptoms in Cement Workers and Control Workers: Nonsmokers

	Cement workers N=197	Controls N=137	
Cough - part day[x]	22 (11.2)	7 (5.1)	$P < 0.05$
Cough - whole day[xx]	27 (13.7)	5 (3.6)	$P < 0.01$
Phlegm - part day[x]	18 (9.1)	8 (5.8)	
Phlegm - whole day[xx]	29 (14.7)	5 (3.6)	$P < 0.01$
Shortness of breath			
Grade 2-5	78 (39.6)	34 (24.8)	$P < 0.01$
Grade 3-5	11 (5.6)	-	-
Wheezing			
Only occasionally	50 (25.4)	35 (25.5)	-
Most days (or nights)	9 (4.6)	3	-
With attacks of shortness of breath	6 (3.0)	1	-
Nasal cathar 3 months per year	20 (10.2)	17 (12.4)	-
Chest illness during the last 3 years	35 (17.8)	26 (19.0)	-
Shortness of breath due to the effect of weather	16 (8.1)	4 (2.9)	$P < 0.05$

Table 27

Respiratory Symptoms in Cement Workers - Nonsmokers by Length of Work Experience

	Length of work experience					
	< 10 yrs N=74 (1)	10-19 yrs N=85 (2)	> 20 yrs N=38 (3)	1-2	1-3	2-3
Cough - part day[x]	7 (9.4)	9 (10.6)	6 (15.8)	-	-	-
Cough - whole day[xx]	7 (9.4)	13 (15.3)	7 (18.4)	-	-	-
Phlegm - part day[x]	7 (9.4)	7 (8.2)	4 (10.5)	-	-	-
Phlegm - whole day[xx]	10 (13.5)	12 (14.1)	7 (18.4)	-	-	-
Shortness of breath						
Grade 2-5	22 (29.7)	34 (40.0)	22 (57.9)	-	$P<0.05$	$P<0.05$
Grade 3-5	3	5 (5,9)	3	-	-	-
Wheezing						
Only occasionally	20 (27.0)	19 (22.4)	11 (28.9)	-	-	-
Most days (or nights)	2	4	3	-	-	-
With attacks of shortness of breath	1	3	2	-	-	-
Nasal cathar 3 months per year	8 (10.8)	5 (5.9)	7 (18.4)	-	-	-
Chest illness during the last 3 years	11 (14.9)	15 (17.6)	9 (23.7)	-	-	-
Shortness of breath due to the effect of weather	3	8 (9.4)	5 (13.2)	-	-	-

Table 28

Respiratory Symptoms in Cement Workers - Smokers by Length of Work Experience

	Length of work experience					
	< 10 yrs N=255 (1)	10-19 yrs N=286 (2)	> 20 yrs N=109 (3)	1-2	1-3	2-3
Cough - part day[x]	44 (17.2)	55 (19.2)	17 (15.6)	-	-	-
Cough - whole day[xx]	52 (20.4)	90 (31.5)	45 (41.3)	P<0.01	P<0.01	-
Phlegm - part day[x]	46 (18.0)	52 (18.2)	18 (16.5)	-	-	-
Phlegm - whole day[xx]	49 (19.2)	77 (26.9)	31 (28.4)	P<0.05	-	-
Shortness of breath						
Grade 2-5	99 (38.8)	147 (51.4)	70 (64.2)	P<0.01	-	P<0.05
Grade 3-5	21 (8.2)	28 (9.8)	12 (11.0)	-	-	-
Wheezing						
Only occasionally	105 (41.2)	127 (44.4)	59 (54.1)	-	P=0.05	-
Most days (or nights)	16 (6.3)	26 (9.1)	12 (11.0)	-	-	-
With attacks of shortness of breath	7 (2.7)	9 (3.1)	3	-	-	-
Nasal cathar 3 months per year	45 (17.6)	45 (15.7)	25 (22.9)	-	-	-
Chest illness during the last 3 years	41 (16.1)	50 (17.5)	23 (21.1)	-	P<0.01	-
Shortness of breath due to the effect of weather	24 (9.4)	38 (13.3)	23 (21.1)	-	P<0.01	-

Table 29

FVC (% of expected values) in Control Workers and Cement Workers by Length of Work Experience and Smoking Habit

		Nonsmokers I			Smokers II			Total III		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Controls (1)		132	92.4	13.6	308	93.0	12.5	440	92.8	13.0
Cement workers	< 10 yrs (2)	71	94.5	12.2	246	95.9	13.7	317	95.6	13.0
	10-19 yrs (3)	80	91.9	15.1	263	92.5	14.2	343	92.4	14.6
	> 20 yrs (4)	36	86.2	9.6	104	87.7	14.8	140	87.3	12.2
	Total (5)	187	91.8	12.3	613	93.0	14.2	800	92.8	13.3

I 1-4 $P < 0.05$; 3-4 $P < 0.05$

II 1-4 $P < 0.01$; 3-4 $P < 0.01$

III 1-2 $P < 0.01$; 1-4 $P < 0.01$; 2-3 $P < 0.01$; 2-4 $P < 0.01$;
2-5 $P < 0.01$; 3-4 $P < 0.01$; 4-5 $P < 0.01$

Table 30

$FEV_{1.0}/FVC(\%)$ in Control Workers and Cement Workers by Length of Work Experience and Smoking Habit

		Nonsmokers I			Smokers II			Total III		
		N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Controls	(1)	132	77,7	9.3	308	76.8	8.3	440	77.1	8.8
Cement workers	< 10 yrs (2)	71	74.4	8.8	246	74.3	9.3	317	74.3	9.0
	10-19 yrs (3)	80	75.0	9.7	263	72.6	10.0	343	73.2	9.8
	> 20 yrs (4)	36	72.4	7.0	104	72.1	10.2	140	72.2	8.6
	Total (5)	187	74.3	8.5	613	73.2	9.8	800	73.5	9.1

I 1-2 $P < 0.05$; 1-4 $P < 0.01$; 1-5 $P < 0.01$
II 1-3 $P < 0.01$; 1-4 $P < 0.01$; 1-5 $P < 0.01$
III 1-3 $P < 0.01$; 1-4 $P < 0.01$; 1-5 $P < 0.01$

Table 31

E_{50-75} in Control Workers and Cement Workers by Length of Work Experience and Smoking Habit

		Nonsmokers I				Smokers II			
		N	Age	Height	E_{50-75}	N	Age	Height	E_{50-75}
Controls	(1)	50	36.2	174.2	3.070	104	37.6	173.2	2.650
Cement workers	< 10 yrs (2)	28	36.0	173.8	2.580	83	36.4	171.9	2.380
	10-19 yrs (3)	39	39.0	172.0	2.510	91	40.9	173.2	2.420
	> 20 yrs (4)	14	50.8	171.0	1.620	40	46.7	171.5	1.960
	Total (5)	81	40.0	172.4	2.380	214	40.2	172.4	2.320

I 1-2 $P < 0.05$; 1-5 $P < 0.05$; 2-4 $P < 0.05$; 3-4 $P < 0.05$
II 1-3 $P < 0.01$; 2-4 $P < 0.01$; 3-4 $P < 0.01$
I-II 1 $P < 0.05$

Table 32

Chronic Bronchitis in Cement Workers' and Control Workers' Wives

	Chronic bronchitis	Chronic bronchitis with exacerbations
Cement workers' wives	3	-
Control workers' wives	6 (4.5)	2

Table 33

Forced Expiratory Volumes in Cement Workers' and Control Workers' Wives

	FVC I		$FEV_{1.0}$ II		$FEV_{1.0}/FVC$ (%) III	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Cement workers' wives	106.2	15.0	94.5	14.3	77.1	6.6
Control workers' wives	104.7	16.2	94.1	15.2	78.9	7.7

DISCUSSION AFTER DR. SARIC'S PAPER:

Dr. Szymczykiewicz:

This is a very interesting question that the cement and coal dust are much more irritating agents than the cotton dust and the prevalence in these industries is very similar to the prevalence of chronic bronchitis in the cotton industry; comparison with my results to results of Dr. Saric.

Dr. Saric:

It's very difficult to say whether this is only the question of the exposure to dust, for example, in mines. As I already mentioned the study is still in progress. So we haven't completed the analysis of data about the working environment in mines. But from some of the preliminary results I can say that the concentration of dust was a little bit higher than the maximum allowable concentration here in this country. But in mines there is also the problem of exposure, at least in some cases, to irritating gases also. And perhaps the problem of climatic condition in mines has to be taken into consideration, as well. As you probably realized from this paper and from the tables I showed, I always avoided speaking about the exposure to dust but used instead the term underground work experience in mines because I don't really know whether the dust exposure is the main factor. In the case of cement production if there is any relationship between the prevalence rate of chronic bronchitis and the occupation, I think that dust is probably the most important factor. But even in this case, for example, climatic conditions have to be taken into consideration and there may be to some extent exposure to gases also.

Dr. Lainhart:

Do either you or possibly Dr. Szymczykiewicz have an idea on how the knowledge that dust may produce disease, may affect the way a miner answers questions regarding his health? May the fact that a man may be a farmer or a small businessman or some such other control who may already know that he doesn't have to worry about dust causing him disease, effect the way he may answer a question.

Dr. Saric:

It is not easy to answer this question. The coal mines from which we took coal miners for examination had economic difficulties in the last years. There was a tendency to reduce a number of workers. So, the miners answered the questionnaire probably under rating their conditions, because they didn't want to leave mines. This is probably one of the selective factors in our case. But on the other hand, of course, there is possibility that some of them prefer to leave the mine and to get a pension because some of them are still connected with land. They work in the mine and to some extent they are at the same time farmers. So this is a complicated question and this, I agree, has to be taken into account. But it's difficult to give a very definite answer.

Dr. Potkonjak:

I should like to ask you whether you have examined lung function, particularly FEV test or some other test, after having applied bronchodynamic drugs? It is considered that subjects exposed to cement dust particularly, show bronchial instability.

Dr. Saric:

We didn't use this but we plan to do this especially if we continue with this study.

Dr. Potkonjak:

I just wanted to say the reason for asking. Perhaps, you will have the same difficulties that I have had. Also, for example, how are the results to be interpreted. There are great disagreements. Some authors consider that positive bronchospasm can be diagnosed if more than 10% difference of FEV is obtained. Some others consider the test as positive if the difference is more than 20% and there are some in Germany who consider the difference of 35% as positive.

Dr. Lainhart:

You may have to make you own standards. Since this literature doesn't agree, you may just have to develop your own, then let them disagree with you.

Dr. Rafalski:

On one of your slides I saw differences between the control group and examined group according to the age, weight, and height. May I know whether those differences also apply to the genetics or economical status of populations?

Dr. Saric:

It is very difficult to find corresponding controls, especially in the case of miners. We tried to get for controls those people living in the same areas with similar social-economical conditions, with similar housing conditions and so on. And this was a difficult problem, because we utilized people who weren't working in the mines. But later we realized that some of them had a certain period of mining experience, so we had to exclude them from the control groups. Because these are areas with long mining tradition, it's very difficult to find people who never have worked or do not work in the mines. We couldn't take farmers as controls for one simple reason; we do not have the same health insurance system for private farmers and employees and their families and this, of course, may influence the result.

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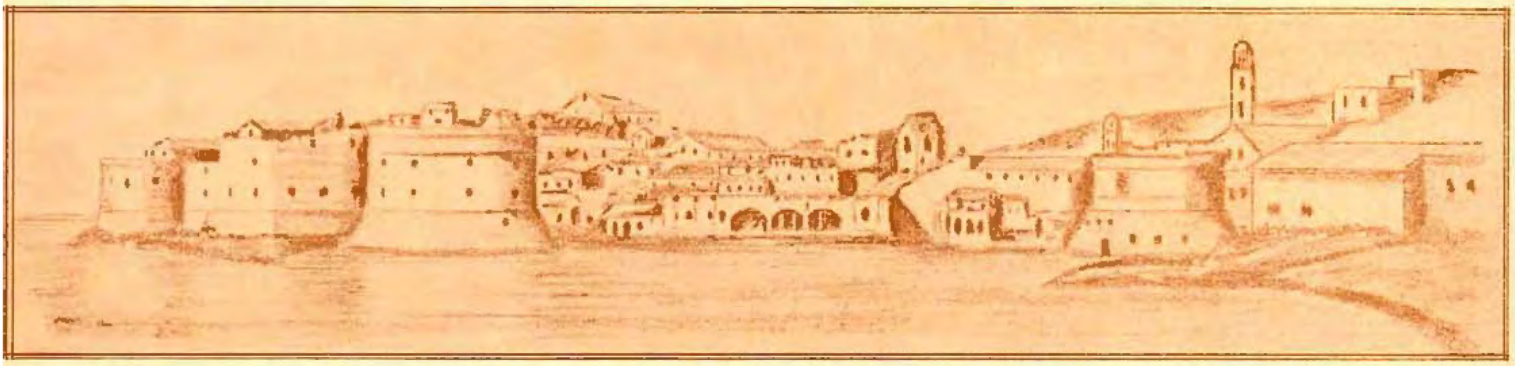

OCTOBER 1970

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