PULMONARY FUNCTION CHANGES IN VERMONT GRANITE WORKERS

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ABSTRACT

Previous studies have suggested that excessive losses of FVC and FEV_1 were occurring in Vermont granite workers despite the fact that quartz levels existing in the industry were below the current OSHA standards. We re-examined these losses in granite workers over an eight year period, testing the workforce semiannually from 1979 to 1987. All workers, including stone shed, quarry and office were offered forced spirometry using a 10 L. Collins water sealed spirometer. In the peak year of participation (1983), 887 workers out of a total of approximately 1400 were tested. Estimates of longitudinal loss were based on 711 workers who participated in at least 3 of the surveys. The mean age of this group was 42.9 years, and the mean years employed was 19.3 yrs. 21.4% were non-smokers (NS), 34.2% ex-smokers (ES), and 44.4% current smokers (CS). Average annual losses of FVC were .025 ±.055 L. (CS: .032 L.; NS: .014 L.; ES: .024 L.). Average annual losses of FEV_1 were .036 ±.040 L. (CS: .044 L.; NS: .027 L.; ES: .033 L.). Analysis of covariance indicated that losses were related to the initial values for FVC or $FEV_{1.0}$, height, age, and smoking history. The losses of both FVC and $FEV_{1.0}$ were not correlated with years employed in the granite industry. The losses of pulmonary function were significantly smaller than those estimated previously, which were .070-.080 L in FVC, and .050-.070 in $FEV_{1.0}$. We conclude that current dust levels in the Vermont granite industry do not accelerate pulmonary function loss.

BACKGROUND

A cross-sectional analysis of pulmonary function loss in Vermont granite workers suggested a small loss in the forced vital capacity (FVC) and FEV_1 due to dust exposure, amounting to 2 ml/year, compared with a 30 ml loss annually due to aging, and a 9 ml loss due to smoking.[1] Although these results were criticized as resulting in a negligible loss over a working lifetime,[2] a later longitudinal study[3] stated that annual losses of FEV_1 were between 50-70 ml, and FVC losses were between 70-80 ml. These studies suggesting excessive pulmonary function loss related to granite dust exposure (average dust-year 523 micrograms/cubic meter, average quartz year of exposure 50 micrograms/cubic meter) were influential in the current NIOSH recommended exposure limit of 50 micrograms/cubic meter for crystalline silica. The operative OSHA limit is 100 micrograms/cubic meter.

In 1981, we published data[4] concluding that the predicted losses of pulmonary function had not occurred, based on a follow-up study of the same individual workers who had been tested previously. Large increases had occurred in vital capacity values (106 ml year), and there were essentially no losses annually in FEV_1 values. The authors of the previous papers agreed[5] that the FVC measurements were invalid because of short expiratory times, though the decrements of FEV_1 values continue to be discussed.[6]

This study presents further longitudinal data on pulmonary function losses in the Vermont granite population. The initial survey, done in 1979, was the basis for our 1981 publication. Follow-up industry-wide surveys were carried out semi-annually to 1987, giving an eight year period of observation. The purpose of the study was to characterize the rate of pulmonary function change and to determine whether exposure to the relatively low levels of granite dust prevailing in the industry significantly affect pulmonary function loss.

METHODS

All employees in the Vermont granite industry, which includes approximately 70 stone sheds and 6 quarries in 5 different communities, were offered forced spirometry semiannually from 1979 to 1987. In 1983 these tests were carried out in conjunction with a chest radiographic survey. Job categories included the various stone shed jobs (polisher, cutter, planer, wire saw, etc.) as well as outdoor quarry workers and office workers. Spirometry was performed on a 10 L. water-sealed Collins spirometer according to recommendations of the Epidemiology Standardization Project.[7] Values for FVC and FEV_1, ambient temperature, age, years employed in the industry, and smoking history were recorded for each worker. In addition, analysis of total gravimetric dust levels was carried out using personal breathing zone samplers. Data were analyzed using basic univariate analysis, as well as analysis of covariance.

RESULTS

The numbers of workers tested in the semi-annual surveys is given in Table 1. The numbers listed for 1979 are artifactually low, since the initial 150 workers tested were excluded because they had been tested on a different instrument which was not precisely calibrated. Subsequent spirometries were performed on the Collins spirometer used by the previous workers from 1970-74. In addition, approximately 100 tracings have been lost and are not available for analysis. Only 173 workers were tested on all five occasions over an eight year period, reflecting the fact that new workers were coming into the work force, others were retiring or were unavailable for testing because of vacation, sick leave or a mobile van at the work place for the first time since 1976. There were 711 workers who were tested 3 times or more. The basic statistics of this group are listed in Table II. Nearly 80% of the workers were either ex-smokers or current smokers; only 21.4% were never smokers. The average number of years in granite was nearly 20.

Longitudinal pulmonary function changes are based on the 711 subjects, both shed and quarry workers, who were tested three or more times. This data is summarized in Table III. Yearly decrements in FEV_1, FVC and $FEV_1/FVC \times 100$ were estimated for each worker as the slope of the fitted least squares regression line for each individual. These slopes were approximately normally distributed and smokers exhibited more function loss than non-smokers and ex-smokers. Overall annual losses were .025 L.for FVC, .036 L. for FEV_1, and 0.37% for the FEV_1/FVC ratio. Non-smokers have the lowest losses, ex-smokers intermediate, and current smokers the highest losses. Within different smoking categories (non-smoker, ex-smoker, and current smoker), there was no difference in losses between exposure categories we presume to be different, i.e. office, shed and quarry workers. Decrements in lung function appear to be similar to those reported in other working populations not exposed to dust in the occupational environment, and are clearly far lower than the estimates of longitudinal loss reported previously among Vermont granite workers.

To separate out the effects of independent variables (age, value of initial measurement, smoking status and granite working history), we carried out an analysis of covariance. For the FVC and FEV_1, the independent variables of initial FVC, height, age and smoking had a significant effect on pulmonary function changes ($p < .001$ or less), whereas "years in granite," used as an index of granite exposure, had no significant effect ($p = .144$ for FVC and .151 for FEV_1).

DISCUSSION

These results indicate that the previous estimates of pulmonary loss in Vermont granite workers were probably in error, and we attribute the conflicting results to the fact that our spirometric measurements were techically rigorous, with careful attention to duration of expiration, calibration of the spirometer, and assuring maximum voluntary effort. Our analysis of dust levels in the stone sheds suggest that no change has occurred in the industry since 1970-78. The mean dust concentration was 601 micrograms/cubic meter, which is quite similar to the results reported previously.[8] Accepting the quartz levels at 10%, as stated by the previous workers,[8] the average quartz exposure estimates are 60 micrograms/cubic meter, which is below the current OSHA limit, but above the recommended exposure limit of 50 micrograms/cubic meter proposed by NIOSH. We conclude that current pulmonary function losses are comparable to those seen in non-dust exposed working populations, and that current dust exposures in the granite industry do not contribute to pulmonary function loss. Further, the observed annual losses are approximately half the values reported by previous studies in Vermont granite workers.

Table 1

Number of Workers With Data Available
Years Tested

1979	1981	1983	1985	1987	3 or more	all 5
426	613	864	806	661	711	173

Table II

Basic Mean Data of Workers With 3 or More Tests
(All Subjects = 711)

Age in 1983	42.903
Height	68.3
Years in granite	19.336
Mean FEV 1.0., L.	3.687
Mean FVC, L.	4.804
Mean FEV 1.0/FVC	.766

Table III

Mean Annual Longitudinal Losses in Pulmonary Function Parameters in 711 Workers Tested 3 or More Times

	Smokers N=316	Ex-smokers N=243	Non-smokers N=152	All n=711
FVC, L.	.032	.024	.014	.025
FEV 1.0,L.	.044	.033	.027	.036
FEV 1/FVC x 100	.437	.318	.314	.370

No difference was found in annual losses of FEV 1.0 and FVC between office, quarry and stone shed workers overall or in different smoking categories.

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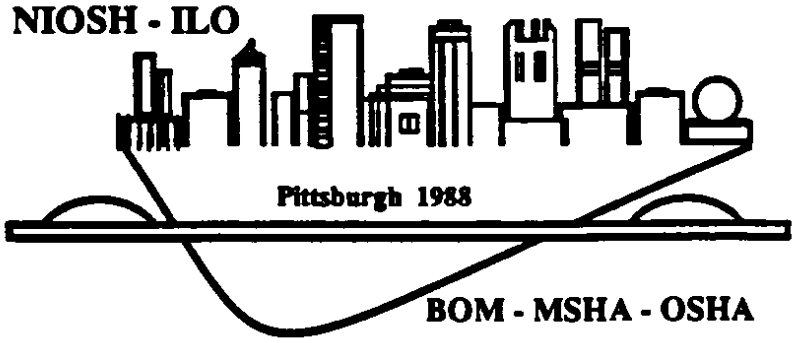

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