Respiratory Findings in Workers Employed in the Brick-Manufacturing Industry

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We studied 233 male workers employed in two brick-manufacturing plants and 149 matched control workers. The mean age of the brick workers was 35 years, with a mean duration of employment in this industry of 16 years. The prevalence of chronic respiratory symptoms as well as acute symptoms during the work shift were recorded. Lung function was measured on Monday during the work shift by recording maximum expiratory flow-volume (MEFV) curves, from which the forced vital capacity (FVC), the one-second forced expiratory volume (FEV_1) and flow rates at 50% and the last 75% of the FVC (FEF_{50}, FEF_{75}) were measured. The results of periodic chest roentgenograms were reviewed. There was a significantly higher prevalence of chronic cough (31.8%), chronic phlegm (26.2%), and chest tightness (24.0%) in exposed workers, compared with control workers (20.1%; 18.1%; 0%) ($P < 0.05$). This increased symptom frequency was also documented among nonsmokers studied by age and by length of employment, suggesting a work-related effect. Among work shift–related symptoms, high prevalences were noted for upper respiratory tract symptoms (eg, dry throat, eye irritation, throat irritation). The measured FVC and FEV_1 were significantly lower than predicted for brick workers and suggested a restrictive pattern. The mean FVC (as a percent of predicted) was 78.1% and FEV_1 was 88.1%. The FEF_{50} and FEF_{25} were not significantly decreased. A multiple regression analysis with age, exposure, and smoking as predictors and lung function parameters as response variables showed a significant effect between exposure and FVC. Significant chest roentgenographic abnormalities were not documented. These findings of a restrictive lung function pattern in brick workers with normal chest roentgenograms may suggest early interstitial disease. Additionally, a bronchitic component, as suggested by the respiratory symptoms, may also be present.

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Reports about the health of workers employed in the brick-manufacturing and related industries suggest potential environmental health hazards. Serov et al[1] and Kverenchkhiladze et al[2] indicated that the main workplace factors contributing to illness in this industry are dust exposure and an unfavorable (hot) microclimate. Peshev and Petrova[3] showed that work in the clay-processing industry exposes workers to numerous complex agents—primarily as a result of dust pollution. Kurashvili et al[4] described that working conditions in the production of reinforced concrete products were characterized by a number of unfavorable factors, including complex occupational aerosols. Additional authors have reported that the clays used in the manufacture of brick contain free silica and vary in silica composition from 10% to 58%.[5–7] Rajhans and Budlovski[5] found that shales and clays used in brick manufacture contain free silica, which accounted for as much as 28% of the inorganic dust. However, the authors did not document silicosis among workers in this brick industry. By contrast, Hodel et al[8] diagnosed silicosis in workers who specialized in brick and concrete drilling. Oldham[9] reported that there was a significant reduction in vital capacity among china clay workers. Ogle et al[10] studied workers in the china clay industry and reported a reduction of ventilatory capacity (FVC and FEV_1) in a restrictive pattern. Recently, Liou et al[11] described a dose-response relationship in brick workers between the estimated dust exposure levels and the prevalence of pneumoconiosis/pulmonary function defects. Puntoni et al[12] documented that there was an increased risk for nonmalignant respiratory and cardiovascular disease, as well as for laryngeal and lung tumors, among brick workers. Recently, Merlo et al[13] reported that the relative risk of mortality from chronic lung disease and lung cancer increased with years of employment in the brick industry. All of these observations suggest that the manufacture of bricks is associated with excess morbidity, predominantly as a result of respiratory injury.

In the investigation presented here, we studied a group of workers employed in two brick-manufacturing plants in Zagreb, Croatia, in order to determine if work in this industry is associated with acute and chronic respiratory disease.

Subjects and Methods

Working Conditions

In the two brick-manufacturing plants studied, workers were exposed to clay dust that contained a mixture of inorganic compounds, including free silica, iron oxide, lime, magnesium carbonate, alkalis, calcium carbonate, calcium sulphate, sodium chloride, and varying amounts of organic materials and elemental carbon compounds (coal). There was also exposure to gases, including sulphur dioxide, hydrogen sulfide, carbon dioxide, and carbon monoxide. Additionally, workers were subjected to a very uncomfortable environment with exposure to hot, dry air from the kilns.

The manufacturing process was similar in both plants. The initial step involves a mixing chamber, where sand and water are added to clay to form a stiff paste. Compression machines are then used to fill a series of molds with this mixture. The "clots" are then automatically pressed into bricks. All machines need lubrication, both for the molds and for the press dies, to prevent the adhesion of the clay paste to the metal surface. A continuous spray of oil is used for this purpose. In the second step, the bricks are taken out of the machine by hand and loaded onto trolleys that transport the bricks to oven. The kilns are filled with bricks, which remain stationary in the kiln, and a fire circulates through the kilns over a three-week period. During this time, the kiln is closed for a three-day period of drying (temperature, 65°C -95°C), followed by a six- to seven-day period of pre-heating and three days of actual "firing" (temperatures between about 1000°C and 3000°C), followed by a five- to six-day period of cooling. Coal is used as the fuel to power the furnaces. The highest concentrations of dust are generated during the unloading of the "green" bricks (bricks before the firing process) and during the removal of fire bricks out of the kiln and the cleaning of the coke and ashes from the kiln. During these times, workers are exposed to high temperature, gases, brick dust, coal, and coal ash. The dust lodged on the surface of the bricks is largely the ash from the coal.

Subjects

This study included a group of 233 male brick-manufacturing workers. They represented 98% of all of the workers employed in the two brick-manufacturing plants. The mean age of the workers was 35 years (range, 21 to 61 years), their mean height was 172 cm (range, 155 to 188 cm), and their mean duration of employment was 16 years (range, 2 to 40 years). Half of the workers were smokers (114 of 233; 48.9%), smoking 20 cigarettes daily on average. Workers were involved in all phases of the manufacturing process during their 8-hour work shift and thus had similar exposures. Therefore workers could not be studied separately at different points during the process.

In addition, a group of 149 workers without significant environmental exposure, employed in packing food products in the food industry, were studied as a control for the prevalence of chronic respiratory symptoms. Age, duration of employment, and smoking habits were matched in exposed and control workers.

Respiratory Symptoms

Chronic respiratory symptoms were recorded using the British Medical Research Council questionnaire on respiratory symptoms,[14] with additional questions on occupational asthma.[15-17] In all workers, a detailed occupational history as well as questions about their smoking habit were recorded. The following definitions were used:

Chronic cough or phlegm: cough and/or phlegm for a minimum of three months a year;

Chronic bronchitis: cough and phlegm for a minimum of three months a year and for not less than 2 successive years;

Dyspnea grades: grade 3 - shortness of breath when walking with other people at an ordinary pace on level ground; grade 4 - shortness of breath when walking at their own pace on level ground;

Occupational asthma: recurring attacks of dyspnea, chest tightness, and pulmonary function impairment of the obstructive type, diagnosed by physical examination and spirometric measurements during exposure to dust at or after work (decrease of FEV_1 >15%) and confirmed by the medical records.

Acute symptoms that developed during the work shift were also recorded in all brick workers. Symptoms included cough, dyspnea, irritation or dryness of the throat, secretion, dryness or bleeding of the nose, eye irritation, and headache.

Ventilatory Capacity

Ventilatory capacity measurements were performed by recording the maximum expiratory flow-volume (MEFV) curves on a Pneumoscreen spirometer (Jaeger, Wurzburg, Germany). The same instrument and

TABLE 1

Chronic Respiratory Symptoms in Brick and Control Workers*

Group	Mean Age (yr)	Mean Employment (yr)	Chronic Cough	Chronic Phlegm	Chronic Bronchitis	Dyspnea	Occupational Asthma	Chest Tightness
Brick ($n = 233$)	35 ± 12	16 ± 11	74 (31.8%)	61 (26.2%)	52 (22.3%)	18 (7.7%)	5 (2.2%)	56 (24.0%)
			<0.05	<0.05	NS†	NS	NS	<0.01
Control ($n = 149$)	36 ± 13	17 ± 12	30 (20.1%)	27 (18.1%)	22 (14.8%)	8 (5.4%)	0 (0%)	0 (0%)

* Unless otherwise indicated, all values are shown as n (%).

† NS, difference statistically not significant ($P > 0.05$).

technicians were used in both factories. The forced vital capacity (FVC), the one-second forced expiratory volume (FEV_1), and the maximum flow rates at 50% and the last 25% of the vital capacity (FEF_{50} , FEF_{75}) were measured on the MEFV curves. Measurements were performed during the morning work shift. The spirometer was calibrated on a daily basis. Lung function testing was performed according to the recommendations of Quanjer et al.[18] At least three MEFV curves were recorded for each subject, and the best value of the three technically satisfactory MEFV curves was used as the result of the test (this was the curve with the greatest FVC and FEV_1). The measured values of ventilatory capacity were compared with the predicted normal values for the Croatian population,[19] which are based on sex, age, and height. The population studied included farmers and industrial workers. Studies were performed using the same instrument and by the same technicians.

Roentgenographic Examinations

Chest roentgenograms of the brick-manufacturing workers were performed periodically as part of a regular preventive medical examination, including roentgenograms before and every 4 years during employment Each worker had a full-size posteroanterior chest radiograph. The results of all films were read by specialized roentgenologists using the International Labour Office (ILO) classification.[20] Two experienced readers read each film independently.

Environmental Measurements

The dust in the work environment was collected by a two-stage Hexhlet apparatus and measured as the concentration of total and respirable dust particles. These dust measurements were performed over a typical 8-hour work shift. In addition, the concentrations of gases, such as carbon monoxide (CO) and carbon dioxide (CO_2) were measured by Drager tubes, which sampled over an 8-hour work shift. Dust and gas samples were collected during the 8-hour work shift in the workplaces while workers were present. A total of 7 samples of dust and 6 samples of gases were taken throughout the work shift in each brick-manufacturing plant. Temperature and the relative humidity of the working environment was measured during the 8-hour work shift. The process of manufacturing brick was identical in both plants. In each plant, the manufacture occurred in a large open space where all of the processes of brick preparation took place. There were no significant differences in the measured concentrations of dust and gas pollutants between these two brick-manufacturing plants, so the data were pooled.

Statistical Analysis

The results of ventilatory capacity measurements were analyzed by the paired t test when comparing baseline to predicted values. The chi-square test (or, when appropriate, Fisher's exact test) was used for testing differences in the prevalence of respiratory symptoms between groups. A level of $P < 0.05$ was considered statistically significant.

The results of pulmonary function studies were also analyzed by applying multiple regression analysis with age, exposure, and smoking as predictors and FVC, FEV_1, FEF_{50}, and FEF_{25} as response variables (SAS/STAT[21]).

Results

Respiratory Symptoms

Table 1 shows the prevalence of chronic respiratory symptoms among the 223 brick workers and in the 149 controls. Prevalences of chronic cough, chronic phlegm, and chest tightness were significantly higher in exposed than in control workers ($P < 0.01$ or $P < 0.05$). Typical symptoms of occupational asthma were found in 5 (2.2%) of the brick workers and none of the controls (not statistically significant [NS]).

The prevalences of chronic respiratory symptoms in the brick workers by smoking habit and age (≤40 years and >40 years) are presented in Table 2. Significantly higher prevalences of almost all chronic respiratory symptoms were recorded in older workers, compared with younger workers ($P < 0.01$ or $P < 0.05$). These differences were generally significant among the smokers and nonsmokers. Smokers, as anticipated, had higher prevalences of all chronic respiratory symptoms than did nonsmokers. Occupational asthma was recorded in 1 smoker (1

TABLE 2

Chronic Respiratory Symptoms in Brick Workers by Smoking Habit and Age*

Smoking Habit	Age (yr)	*n*	Chronic Cough	Chronic Phlegm	Chronic Bronchitis	Dyspnea Grades 3 and 4	Occupational Asthma	Chest Tightness
Smokers	≤40	70	22 (31.4%)	17 (24.3%)	12 (17.1%)	15 (21.4%)	1 (1.4%)	10 (14.3%)
			<0.01	<0.01	<0.01	<0.01	NS	<0.01
	>40	44	32 (72.7%)	26 (59.1%)	26 (59.1%)	28 (63.6%)	0 (0%)	22 (50.0%)
Nonsmokers	≤40	59	4 (6.8%)	2 (3.4%)	1 (1.7%)	0 (0%)	0 (0%)	4 (6.8%)
			<0.01	<0.01	<0.01	<0.05	NS	<0.01
	>40	60	16 (26.7%)	16 (26.7%)	13 (21.7%)	5 (8.3%)	4 (6.7%)	20 (33.3%)

* Unless otherwise indicated, all values are shown as *n* (%).

TABLE 3

Chronic Respiratory Symptoms in Brick Workers by Smoking Habit and Duration of Employment*

Smoking Habit	Employment (yr)	*n*	Chronic Cough	Chronic Phlegm	Chronic Bronchitis	Dyspnea Grades 3 and 4	Occupational Asthma	Chest Tightness
Smokers	≤10	55	18 (32.7%)	13 (23.6%)	10 (18.2%)	2 (3.6%)	1 (1.8%)	7 (12.7%)
			<0.01	<0.01	<0.01	NS	NS	<0.01
	>10	59	36 (61.0%)	30 (50.9%)	28 (47.5%)	7 (11.9%)	0 (0%)	25 (42.4%)
Nonsmokers	≤10	44	4 (9.1%)	2 (4.6%)	1 (2.3%)	0 (0%)	0 (0%)	3 (6.8%)
			NS	<0.01	<0.05	NS	NS	<0.05
	>10	75	16 (21.3%)	16 (21.3%)	13 (17.3%)	5 (6.7%)	4 (5.3%)	21 (28.0%)

* Unless otherwise indicated, all values are shown as *n* (%).

of 114; 0.9%) and in 4 nonsmokers (4 of 119; 3.4%).

Table 3 shows the prevalences of chronic respiratory symptoms in brick workers by smoking habit and duration of employment (≤10 years and >10 years). Workers with longer exposures had significantly higher prevalences than did those with shorter exposures; this was particularly pronounced for chest tightness (smokers, 42.4% vs 12.7%, and nonsmokers, 28.0% vs 6.8%). Nonsmokers, in particular, had high prevalences of chronic respiratory symptoms, which increased with length of employment and age (Table 3).

There was a high prevalence of acute symptoms reported by workers during the 8-hour work shift. The highest prevalences were recorded for irritation of the nose (45.1%), followed by dryness of the throat (42.5%), eye irritation (40.3%), dyspnea (37.8%), throat irritation (36.1%), cough (35.2%), headache (27.9%), dryness of the nose (27.9%) and bleeding of the nose (8.6%), and wheezing (16.3%). These are considerably higher than those in a group of control nonexposed workers from previously reported multiple industries[22] (eg, cough, 5.2%; dyspnea, 2.3%; irritation or dryness of the throat, 3.7%).

Ventilatory Capacity

The ventilatory capacity data (measured and predicted) in brick workers by smoking habit and age (≤40 years and >40 years) are presented in Table 4. Significantly lower FVC and FEV_1 (compared with predicted) were recorded in all groups of workers ($P < 0.01$ or $P < 0.05$). The mean FVC as a percentage of predicted was 78.1% and the mean FEV_1 was 88.1%.

Table 5 presents results of the regression analysis of ventilatory capacity tests. These data indicate overall statistical significance of all regressions ($P < 0.001$). Age effects were seen for all lung function parameters. An effect of exposure was noted for FVC. There was no effect demonstrated for smoking.

By analyzing the individual data for ventilatory capacity tests in brick workers as percentage of predicted, 49 of 233 (21.0%) had an FVC, 40 of 233 (17.2%) had an FEV_1, 27 of 233 (11.6%) had an FEF_{50}, and 28 of 233 (12.0%) had an FEF_{75} lower than 70% of predicted.

Roentgenographic Examinations

No case of pneumoconiosis was diagnosed in any of the studied brick workers. Mean ILO scores of the reviewed films did not differ from those of controls.

Environmental Measurements

Results of dust measurements showed a high mean total dust concentration of 10 mg/m^3 (range, 5–19 mg/m^3) and a mean respirable fraction of 2 mg/m^3 (range, 0.9–2.9 mg/m^3). For most of the exposed workers, the range of total dust exposure was between 8 and 12 mg/m^3. These measurements are considerably

TABLE 4

Ventilatory Capacity in Brick Workers by Smoking Habit and Age*

Smoking Habit	Age (yr)	Mean Height (cm)	*n*	FVC (liters)	FEV_1 (liters)	FEF_{50} (liters/second)	FEF_{75} (liters/second)
Smokers	≤40	174 ± 5	70	4.51 ± 0.70	3.89 ± 0.60	5.61 ± 1.25	2.96 ± 0.99
				<0.01	<0.01	NS	NS
				5.36† ± 0.58	4.28† ± 0.44	6.06† ± 0.29	3.27† ± 0.30
	>40	171 ± 6	44	3.71 ± 0.72	3.16 ± 0.62	4.94 ± 1.46	2.23 ± 0.66
				<0.01	<0.05	NS	NS
				4.88† ± 0.56	3.60† ± 0.44	5.24† ± 0.30	2.28† ± 0.25
Nonsmokers	≤40	173 ± 6	59	4.49 ± 0.63	3.96 ± 0.57	6.03 ± 0.36	3.28 ± 1.08
				<0.01	<0.01	NS	NS
				5.34† ± 0.62	4.22† ± 0.50	6.14 ± 1.36	3.27† ± 0.32
	>40	173 ± 6	60	3.47 ± 0.64	2.98 ± 0.61	4.72 ± 1.65	2.24 ± 0.24
				<0.01	<0.01	NS	NS
				4.80† ± 0.56	3.54† ± 0.43	5.20† ± 0.28	2.26† ± 0.74

* Data are prepared as mean ± SD. FVC, forced vital capacity; FEV_1, forced expiratory volume in 1 second; FEF_{50} and FEF_{75}, flow rates at 50% and the last 75% of the FVC.

† Predicted values.

TABLE 5

Multiple Regression Analysis of Brick Worker Data Using Lung Function Parameters as Response Variables, and Age, Exposure, and Smoking as Predictors*

Test	Variable	DF	Parameter Estimate	Standard Error	T for HO (Parameter = 0)	Probability > (T)	*F*	DF1	DF2	*P*	R^2
FVC	Intercept	1	5.315387	0.16725061	31.781	0.0001					
	Exposure	1	−0.018546	0.00679291	−2.730	0.0068					
	Age	1	−0.025269	0.00645644	−3.914	0.0001					
	Smoking (yr)	1	0.001644	0.00398337	0.413	0.6801					
							46.797	3	229	<0.001	0.3719
FVC_1	Intercept	1	4.814031	0.14958841	32.182	0.0001					
	Exposure	1	−0.008610	0.00607556	−1.417	0.1578					
	Age	1	−0.030239	0.00577462	−5.237	0.0001					
	Smoking (yr)	1	0.000113	0.00356271	0.032	0.9747					
							49.561	3	229	<0.001	0.3857
FEF_{50}	Intercept	1	7.349022	0.36959801	19.884	0.0001					
	Exposure	1	0.019847	0.01501128	1.322	0.1874					
	Age	1	−0.059054	0.01426774	−4.139	0.0001					
	Smoking (yr)	1	−0.004543	0.00880263	−0.516	0.6063					
							12.491	3	229	<0.001	0.1294
FEF_{25}	Intercept	1	4.120247	0.23026789	17.893	0.0001					
	Exposure	1	−0.001867	0.00935237	−0.200	0.8420					
	Age	1	−0.034817	0.00888912	−3.917	0.0001					
	Smoking (yr)	1	−0.005753	0.00548424	−1.049	0.2953					
							22.244	3	229	<0.001	0.2155

* DF, degrees of freedom (1), variables, (2), subjects; T = *t* statistic for null hypothesis (H0) that parameter in question is equal to 0.

greater than the levels allowed by the Croatian standards for inorganic dust containing up to 70% of free SiO_2 (total dust, 0.5 mg/m^3; respirable fraction, 0.1 mg/m^3). Concentrations of carbon monoxide (CO) varied from 5–65 ppm, with a mean of 29 ppm (allowed, 30 ppm), and for carbon dioxide (CO_2) varied from 1,500–8,500 ppm, with a mean of 3,800 ppm (allowed, 5,000 ppm). Samples were taken during the 8-hour work shift at 12 different locations in each brick-manufacturing plant. Similar dust and gas concentrations were measured in both brick-manufacturing plants. The environmental temperature varied from 23°C to 35°C, which is considerably higher than that allowed by the Croatian standards (up to 28°C). The relative humidity was usually below 35%, which is lower than that allowed by the Croatian standards (35%–65%).

Discussion

Our data in brick workers suggests that employment in the brick-manufacturing industry is associated with the development of chronic respiratory symptoms. Our findings were particularly striking for chronic cough (31.8%), chronic phlegm (26.2%), chronic bronchitis (22.3%), and chest tightness (24.0%). Myers and Cornell[23] studied brick workers and found that the prevalence of respiratory symptoms ranged from 7% for chronic bronchitis to 52% for morning cough and averaged 27% for both chest tightness and wheeze and 9% for dyspnea with effort. They also demonstrated an effect of occupational exposure on FVC; this finding was apparently independent of smoking. Those brick workers who were smokers had higher prevalences of almost all chronic respiratory symptoms than did nonsmokers, suggesting an additive effect of smoking and brick dust in promoting respiratory symptoms. A high prevalence of acute symptoms during the work shift was also recorded in our brick workers, particularly for upper respiratory tract symptoms. Saakadze et al[24] reported an excess of respiratory disease (attacks of bronchitis and tracheobronchitis) in workers engaged in manufacturing ceramics. Burge et al[25] described that among ceramic workers, symptoms of a dry cough, stuffy nose, and breathlessness were accompanied by changes in FEV_1 and FEF_{25-75} and were related to respiratory dust concentrations.

Myers[26] stated that length of service in the brick-manufacturing industry was a good predictor for most respiratory abnormalities in brick workers. In our study, older workers and those workers with longer employment in the industry had significantly higher prevalences for most of the chronic respiratory symptoms than did younger workers and those with shorter employment, independent of smoking habit.

In our brick workers, significantly lower than predicted values for FVC and FEV_1 were found. Proportional decreases of FVC and FEV_1 in our study suggest restrictive changes. These data are similar to those of Ogle et al,[10] who described age and smoking-related loss of ventilatory capacity in china clay workers. In their study, respiratory symptoms and loss of ventilatory capacity (FVC or FEV_1) was accompanied by chest x-ray changes. Interestingly, smokers in our study did not have excess lung function loss, compared with nonsmokers (Table 4). It is possible that this may represent some form of healthy worker effect, with sensitive smokers leaving the industry early because of health effects. Our study design, however, did not permit us to document this question.

Prospective studies by Rundle et al[27] reported rapid declines of FVC and FEV_1 in china clay workers. McConnochie et al[28] also showed an accelerated decline in FVC and FEV_1 with age among sepiolite (absorbent clay) workers exposed to dry dust (compared with those with little exposure). As in our study, these authors did not find evidence of radiographic changes. Neukirch et al[29] suggested that exposure to silica dust in pottery workers was a risk factor for chronic airflow limitation, which was independent of radiographic changes.

Although Rajhans and Budlovsky[5] studied brick plants in Ontario and found high concentrations of ambient free silica, no silicosis was found in this brick industry. In a study of brick workers, Wiecek et al[30] found that the content of free silica in clay was over 30% in the total dust and 5.8%-18.4% in the respirable fraction. No case of pneumoconiosis was registered in this study among those workers making red bricks, but two cases were reported among workers producing thermalite firebricks. Rees et al[7] reported that one third of workers in a South African pottery plant with 15 or more years of employment in high-dust sections of the factory had pneumoconiosis. Among our studied brick workers, no case of pneumoconiosis was identified by regular periodical medical examinations, including chest roentgenograms.

Dust concentrations in our brick-manufacturing plants exceed the maximum allowable values for both total dust and respirable dust fractions. The concentrations of gases (CO and CO_2) were also higher than those allowed by Croatian standards. Myers et al[31] measured dust concentrations in brick plants and found that the mean concentration of respirable dust and total dust were 2.22 mg/m^3 and 15.16 mg/m,^{3} with a mean free silica of 2.1%. Keatinge and Potter[32] reported that the dust in the brick industry consists mainly of combined silica and alumina. Traces of hydrogen sulfide and sulfur dioxide were found. Rees et al[7] showed that the clay used in pottery manufacture had a high quartz content (range, 23%–58%). Lemiasev et al[33] reported that dust control measures in large Dinas brick and chamotte factories have greatly reduced silicosis morbidity but have failed to completely eliminate the risk of silicosis. The authors stated that the eradication of respiratory diseases among workers manufacturing these materials depends on the introduction of a "wet" technology.[33]

In order to prevent respiratory disorders among brick-manufacturing workers, we suggest that reducing dust concentrations is important for primary prevention of acute and chronic respiratory symptoms and lung function impairment. Until environmental conditions are improved, wearing protective masks should be mandatory in those workplaces in which standards are exceeded. In addition, medical surveillance may protect workers from developing chronic respiratory changes by allowing the early detection and the removal of sensitive workers from the industry before chronic disorders develop. Further prospective studies of smokers in this industry may be of interest in determining whether they have a particular sensitivity to this environment.

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