

# A 2-year Follow-up of Spirometric Parameters in Workers of a Tile and Ceramic Industry, Yazd, Southeastern Iran

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## Abstract

**Background:** Respiratory diseases cause a considerable amount of morbidity and mortality in the world. Pulmonary function tests are important measures for the diagnosis and management of respiratory disorders. Workers in tile and ceramic industry are exposed to high amounts of respiratory pollutants.

**Objective:** To identify the changes in spirometric parameters in a 2-year period among tile and ceramic workers in Yazd and compare it with a control group.

**Methods:** The study was conducted in 5 tile and ceramic factories selected by cluster sampling between 2009 and 2011 in Yazd, southeastern Iran. Demographic data and spirometric parameters of participants were recorded.

**Results:** Spirometric parameters were significantly reduced during the 2 years. The largest decrease was observed in FVC ( $\approx 500$  mL) in ball-mill and grinding after 2 years. Decrease in all spirometric parameters was significantly higher in industrial workers than office workers.

**Conclusion:** Respiratory exposure in tile and ceramic industry can significantly affect pulmonary function tests.

**Keywords:** Spirometry; Industry; Ceramics; Dust; Forced expiratory volume; Lung; Volume measurements; Occupational exposure

## Introduction

Respiratory diseases are among the most common occupational disorders and a major cause of absenteeism.<sup>1,2</sup> Exposure to hazardous dusts may cause such pulmonary diseases as chronic bronchitis or asthma.<sup>3</sup> Studies have found a prevalence of 11%–19% for respiratory diseases in men and 4%–5% in women

due to occupational exposures.<sup>4,5</sup>

These diseases are responsible for 14% of work day loss among men and 11% among women.<sup>6</sup> Respiratory diseases comprise a considerable amount of morbidity and mortality in the world.<sup>1</sup> Exposure to workplace respirable dusts is a potential risk factor for chronic pulmonary diseases.<sup>7</sup>

Pulmonary function tests are impor-

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tant in the diagnosis and management of respiratory diseases.<sup>1</sup> This test is widely used in occupational health evaluations, especially for screening.<sup>3,8</sup> Many workplace exposures may gradually decrease spirometric parameters; therefore, follow-up spirometry plays an important role for tracking these minor changes before development of clinical diseases.

Workers in tile and ceramic industry are exposed to a considerable amount of dust and respirable particles. Periodic follow-up of workers for spirometric parameters can thus help in early diagnosis of respiratory disorders which is the main objective of periodic occupational health evaluations.<sup>9</sup>

Neghab, *et al*, showed a significant decrement in some parameters of pulmonary function tests among workers of tile factories.<sup>9</sup> Jaakola, *et al*, found a dose-response relationship between the duration of exposure to respiratory exposures and decrease in forced expiratory volume in one second (FEV<sub>1</sub>) and forced vital capacity (FVC) among workers of tile and ceramic industry.<sup>10</sup> Kurmi, *et al*, showed that tile workers with more than seven years work experience had a significant reduction in their spirometric indices.<sup>11</sup> Dehghan, *et al*, showed a significant difference in respiratory complaints and the

frequency of abnormal spirometry in tile workers comparing to office workers.<sup>12</sup> Halvani, *et al*, found a significant correlation between workplace exposures and prevalence of respiratory symptoms.<sup>13</sup>

Other studies on workers with similar exposures such as those in construction industry have also shown a significant relationship between pulmonary function impairment and respiratory exposures.<sup>14-20</sup> These declines in spirometric parameters may become permanent.<sup>21</sup> There is some evidence that exposure to airborne dust may lead to or aggravate chronic obstructive pulmonary diseases (COPD).<sup>22-24</sup> Rushton, *et al*, showed this effect in some industries including ceramic work.<sup>25</sup>

Tile and ceramic industry consists of several units including warehouse, mixing and grinding, spray drying, forming, drying, glazing, firing, packing, loading, repair, service, and office. Workers in this industry are exposed to a considerable amount of harmful dusts.<sup>12</sup> The most important respiratory exposures in tile and ceramic industry include zirconium silicate, kaolin, silica, magnesium carbonate, calcium carbonate, zinc oxide, aluminium oxide, feldspar, ceramic matrix composites (CMC), tetraphenylphosphonium (TPP), sodium metasilicate, ball clay, and ferrite. Therefore, tile and ceramic workers are exposed to some pneumoconiosis-producing agents such as silica and kaolin.<sup>26</sup> Exposure to silica may also reduce lung function even in the absence of silicosis.<sup>27</sup>

Tile and ceramic industry is one of the main industries in Iran. The largest number of tile and ceramic producing factories is in Yazd, a central province in Iran. We conducted this study to evaluate the changes in spirometric parameters during two years among the workers of different units in a tile and ceramic industry.

For more information on lead poisoning in workers of tile factories in a city of Iran see [www.theijoom.com/ijoom/index.php/ijoom/article/view/6](http://www.theijoom.com/ijoom/index.php/ijoom/article/view/6)

#### TAKE-HOME MESSAGE

- Tile and ceramic industry is one of the main manufacturing industries in Iran.
- Workers in tile and ceramic industry are exposed to a variety of respiratory pollutants.
- FVC and FVC% are the spirometric parameters which had the most significant changes.
- The highest reduction in FVC and FEV<sub>1</sub> occurs in those with higher exposure working in mixing and grinding, ball mill and spray drying units

**Table 1:** Subjects' demographic data. Data are presented as mean±SD.

Parameter	Group 1 (n=302)	Group 2 (n=68)	Group 3 (n=70)	Control (n=56)	Total (n=496)
Age (yr)	33.5±6.7	32.7±7.1	34.0±6.9	33.5±7.3	33.5±6.8
Service length (yr)	7.9±3.8	8.3±3.9	8.5±3.7	7.9±4.5	8.1±3.9
Height (cm)	173.6±6.8	175.0±5.4	175.1±5.5	170.2±8.8	173.6±6.8
Weight (kg)	76.7±14.1	79.1±12.4	78.1±12.9	74.2±11.0	76.9±13.4

## Materials and Methods

Using a cluster sampling, five tile and ceramic factories were selected from Yazd province—one factory from each city. From each factory, 100 workers were selected from different units by simple random sampling. Demographic data and the results of environmental monitoring were extracted from workers' medical files.

Spirometry was performed using a flow-type spirometer (Spirolab III, Mir, Italy). The tests were performed in a sitting position and in the morning. Room temperature was kept between 22 and 27 °C. For height measurement, subjects were standing without shoes against a wall with their heads upright. Weight was measured without shoes using a digital scale (Laica, Italy). All tests were performed according to ATS/ERS guidelines for spirometry: extrapolated volume of less than 0.5% of FVC or 0.150 L and a 1 s plateau in the volume-time curve.<sup>28-31</sup>

Subjects were categorized according to their occupational exposures. The workers were working in 14 different jobs including glazing, glaze-making, forming, ball mill, spray drying, mixing and grinding, packing and loading, mechanic, forklift driving, warehouse, firing, printing, service, and office. These 14 subgroups were

merged to produce four major groups according to the similarity of respiratory exposures. Group 1 (moderate exposure) including glazing, glaze-making, forming, packing and loading, forklift driving, firing, printing and service; group 2 (high exposure) including mixing and grinding, ball mill and spray drying; group 3 (variable exposure) including mechanics; and a control group (low exposure) including warehouse and office. Those with known previous respiratory disease and smoking history were excluded from the study.

The study was approved by the Ethics Committee of the Research Deputy, Shahid Sadoughi University of Medical Sciences, Yazd. Informed consent was obtained from each participant.

Data were analyzed by SPSS® for Windows® ver 19 using *Student's t* test, and  $\chi^2$  test.

## Results

Four workers left their work during follow-up and were excluded from the study. Therefore, 496 workers (491 men and 5 women) from five tile and ceramic factories were evaluated and followed for two years. Table 1 shows the participants' demographic data.

The number of workers in each major

**Table 2:** Comparison of the mean changes in spirometric parameters between studied groups and the control group. Numbers represent p values.

Change in spirometric parameter after ...		p value for comparison with the control group		
		Group 1	Group 2	Group 3
ΔFVC	1 yr	0.003	0.004	0.474
	2 yrs	<0.001	0.001	0.209
ΔFVC%	1 yr	0.043	0.013	0.608
	2 yrs	0.005	0.001	0.553
ΔFEV <sub>1</sub>	1 yr	0.049	0.508	0.403
	2 yrs	0.001	0.001	0.038
ΔFEV <sub>1</sub> %	1 yr	0.202	0.452	0.483
	2 yrs	0.026	0.002	0.177

job category was: 302 (60.9%) in group 1, 68 (13.7%) in group 2, 70 (14.1%) in group 3, and 56 (11.3%) in the control group. The participants in the four groups were not significantly different regarding age (p=0.72), work experience (p=0.67), and height (p=0.11).

Figure 1 shows the changes in FVC and FEV<sub>1</sub> during the studied two years.

The highest decrease was observed in FVC among the workers in mixing and grinding, ball mill and spray drying units—group 2 participants with high exposure level.

A 10% decrease in FVC or FEV<sub>1</sub> were considered as a significant reduction.<sup>32</sup> FVC decreased by 245 mL (p=0.003) after one year and 431 mL (p=0.002) after two years. Group 2 workers had the highest decrease in FVC and FEV<sub>1</sub> compared to the control (Table 2).

## Discussion

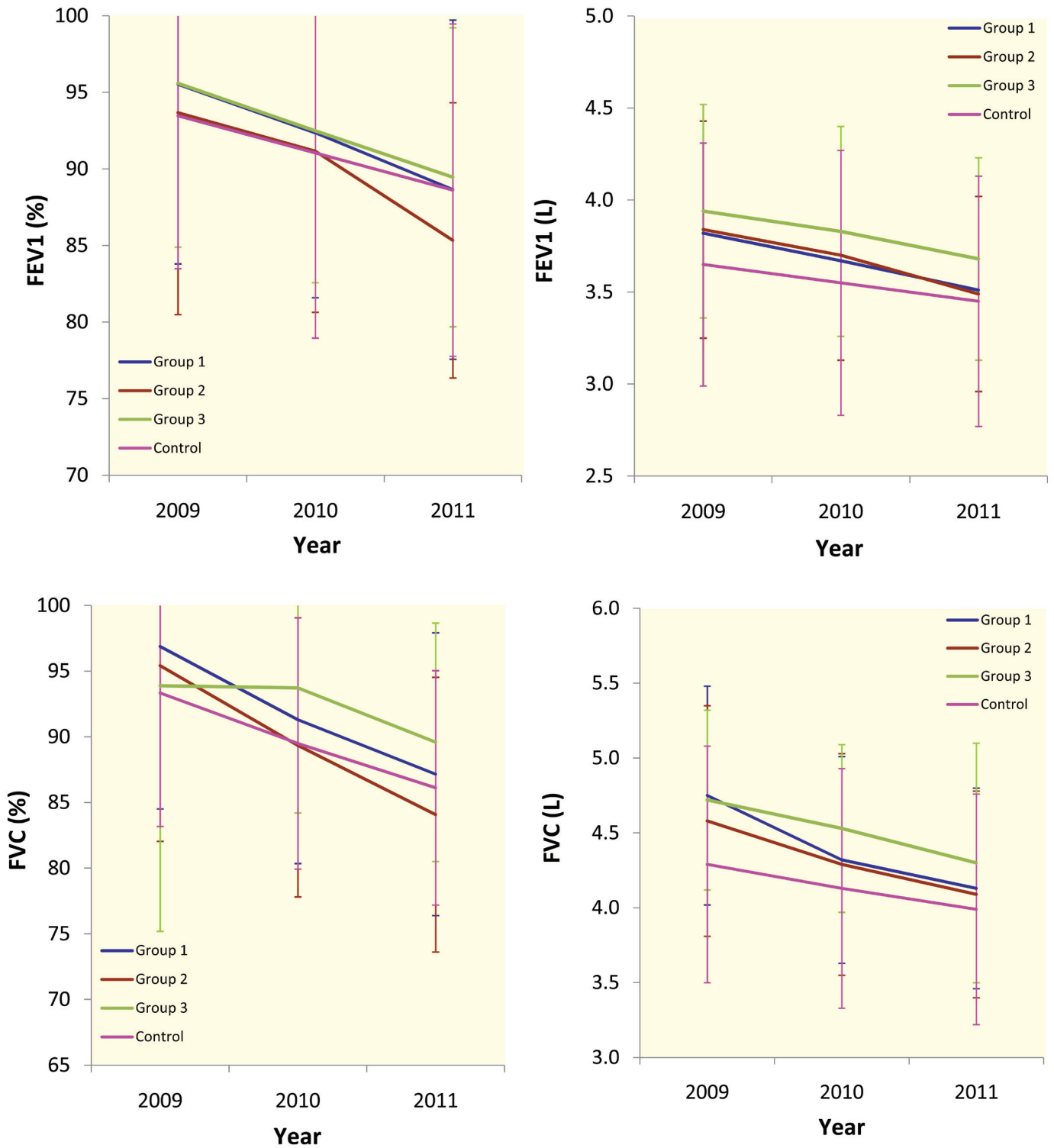
Tile and ceramic industry is one of the main manufacturing industries in Iran

and especially in Yazd province. Workers in this industry are exposed to a variety of respiratory pollutants such as silica, kaolin, zirconium silicate, magnesium carbonate, ball clay, calcium carbonate, etc. Dehghan, *et al*, showed a correlation between exposure to dusty environment in tile industry and spirometric abnormalities.<sup>12</sup> Many studies reported a higher prevalence of respiratory symptoms among tile and ceramic workers.<sup>9,12,33</sup> We found that working in tile and ceramic factories can cause a significant reduction in spirometric parameters, which was consistent with the study of Jaakkola *et al*.<sup>10</sup> Other studies conducted in various industries such as construction, mining, cement, and other dusty environments, reported similar results.<sup>14,15,34-38</sup> Smilee, *et al*, found a similar reduction in spirometric indices in building demolition workers.<sup>14</sup> Zeleke, *et al*, showed a significant reduction in spirometric parameters after two years in workers of a cement industry.<sup>33</sup> Although some respiratory exposures in construction and cement industries are similar to tile industry, there are considerable differences between them in terms of occupational exposures; therefore, we could not compare our results with their findings.

We found that FVC and FVC% were the parameters which had the most significant changes; this was in agreement with the results of the study of Jaakkola, *et al*.<sup>10</sup> Other studies performed in a mining industry with relatively similar exposures, revealed the same results.<sup>35,36</sup> A significant reduction in spirometric parameters in workers after exposure to dusty workplaces was also shown by other researchers.<sup>15,37</sup> Green, *et al*, showed that exposure to mixed mineral dust in early adult life can cause decreased FVC and FEV<sub>1</sub> in addition to excess respiratory symptoms compared to the controls.<sup>38</sup>

In this study, the decrease in

For more information on respiratory and neurological disorders among workers in a bone glue factory in Egypt see [www.thejjoem.com/ijournal/index.php/ijournal/article/view/134](http://www.thejjoem.com/ijournal/index.php/ijournal/article/view/134)



**Figure 1:** The changes in spirometric parameters during the studied period. Error bars represent SD.

spirometric parameters during a two-year period was much higher than that reported previously.<sup>18,22</sup> This large decline would be due to higher exposure levels and inappropriate use of personal protective devices by workers assessed in this study.

We divided the workers into three main groups according to their respiratory exposures. The mean reduction in most spirometric parameters in group 1 (moderate exposure) and group 2 (high exposure) was significantly higher than the control group. The highest reduction was observed after the second year in those working in mixing and grinding, ball mill and spray drying units (group 2 workers with high exposure) which reflects a direct relationship between the intensity of exposure and decline in spirometric parameters.

Exposure to mixed dusts in tile and ceramic industry in our country can significantly reduce the spirometric parameters; the extent of damage seems to be much higher than that reported by previous studies. We have to work on various ways to protect workers and to figure out the underlying mechanisms responsible for such a sharp decline in spirometric parameters.

**Conflicts of Interest:** None declared.

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