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Respiratory Systems of Dental Technicians Negatively Affected during 5 Years of Follow-Up

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Background: Dental laboratory technician is one of the professions in which dust exposure is frequently experienced and therefore the health of workers has to be monitored.

Aims: In this study, changes in the pulmonary functions and of pneumoconiosis frequencies among dental technicians after five years were investigated by comparing the results of two screenings carried out in 2008 and 2013.

Study Design: Cohort study.

Methods: In 2008 and 2013, Provincial Health Directorate carried out two different health screenings covering all of the dental technicians working in dental laboratories in Denizli. In both screenings, a questionnaire was applied, with which socio-demographic and workplace properties of the technicians were obtained. In addition, Pulmonary function tests (PFT) and standard chest X-rays of the technicians were performed. The results of these two screenings were evaluated by a chest specialist, and physical examinations were performed as necessary. In 2013, technicians who had pathologies underwent computerized tomography (HRCT). In this study, the study group was composed of dental laboratory technicians that participated in both screenings (2008 and 2013) and the data obtained from the screenings were compared. The gathered data were analyzed using paired student-t and X^2 tests.

Results: A total of 125 dental laboratory technicians participated in the two screenings. Overall, 92% of the technicians were male and the mean age of the participants was 35. Technicians were working for 9 hours a day, 6 days a week. Total exposure time was calculated to be around 41 thousand hours. Approximately 60% of workers were smokers. When the results of PFT were analyzed, 73% of the first evaluations were found to be normal; however, this ratio decreased to 51% in the second analysis five years later. In the second PFT measurement, compared to the first, there was a 23% decrease in the forced vital capacity (FVC) value, and a 15.7% decrease in forced expiratory volume in one second (FEV_1). While restrictive disorder was found 25% in the first PFT evaluations, this ratio increased to 31% in the second PFT. When the radiological results were considered, 62% of the first X-ray results were found to be normal but this ratio decreased to 18% in 2013. While reticular/reticulonodular opacities were found in 11% of cases in 2008, it increased to 30% in 2013. Seven technicians were diagnosed with pneumoconiosis (5.6%).

Conclusion: Respiratory tracts of the technicians were negatively affected during the five year period. The number of pneumoconiosis cases (5.6%) shows that it is necessary to adopt comprehensive work health and safety precautions for laboratories.

Keywords: Dental technicians, pneumoconiosis, respiratory

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A dental laboratory technician is a worker who repairs and replaces missing tooth and oral tissues of patients and who creates prostheses and dental bridges based upon the measures that the dentist provides. It is also a profession that has a lot of health risks and thus, is legally included in the category of 'very dangerous jobs' (1). Various dusts such as plaster, acrylic and silica are generated during the production process in the laboratory. Therefore, in the profession, it is quite likely that individuals will be exposed to dusts that might lead to lung fibrosis. These dusts, which show an accumulation in the bodies of those working for a long time, might result in dust-based lung diseases called "pneumoconiosis" over the course of time and therefore, workers need to be monitored carefully (1-5). In several studies in the literature, the prevalence of pneumoconiosis among dental technicians was found to be around 9.8-24.2% (6-12).

The purpose of this study was to find out the frequency of pneumoconiosis among dental technicians and determine the effective factors on the occurrence of pneumoconiosis. Furthermore, in order to identify chronic occupational dust exposure, the study also aimed to determine the increases in the number of respiratory symptoms of the technicians, their pulmonary function loss and radiological changes in the lungs of the technicians in the duration of the follow-up period.

MATERIALS AND METHODS

The Provincial Directorate of Health carried out two different health screening tests covering all of the dental laboratory technicians who were working in 2008 and 2013. While 139 technicians participated in the screening carried out in 2008, 166 technicians participated in 2013. During these screenings, technicians were first given questionnaires, then underwent pulmonary function tests (PFT) before standard chest X-rays were taken.

Overall, 125 technicians participated in both of the screenings, therefore constituting the study population. The responses of the participants to the questionnaire, and findings regarding their pulmonary functions and X-ray results were analyzed; the changes over 5 years were compared. Ethical permission and patient consents were obtained.

Questionnaire

In these screenings, first of all, data about some of the socio-demographic properties, respiratory problems and working environments of the technicians were obtained through a questionnaire. For respiratory symptoms, coughs, shortness of breath and phlegm were investigated in the participants. Ventilation in the working environment, and the participants' use of vacuums, masks, goggles and gloves were also investigated. Questionnaires were conducted by face-to-face interviews with the participants. Their total exposure time was calculated using the formula "daily working time x working years in this field x 250 days" was used. Patients' smoking status was investigated based on the Centers for Disease Control and Prevention (CDC) criteria (13). Lifetime tobacco exposure was calculated, which helped to produce a numerical value of lifetime tobacco exposure called pack years. A current smoker was considered any adult who has smoked 100 cigarettes in his or her lifetime and who currently smokes.

Spirometric measurements were obtained by an experienced technician using a spirometer (MIR Medical International Research; Roma, Italy). The results of PFT were analyzed automatically with a spirometer based on the race, age and height of each participant in accordance with the American Thoracic Society standards, considering the forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and the ratio of these two values (FEV_1/FVC) and FEF_{2575}.

Normal: FEV_1 and FVC over 80% and the FEV_1/FVC ratio was $\geq$0.7, this was considered normal.

Restrictive: When FEV_1 remained normal or was slightly decreased, FVC was below 80%, and the FEV_1/FVC ratio was normal or over 0.7, this was considered indicative of restrictive disorder.

Obstructive: If FEV_1 was less than 80% and the FEV_1/FVC ratio is lower than normal, this was considered a sign of obstructive disorder.

Radiological assessment

In both of the screenings, standard chest X-rays of the technicians were taken and were evaluated both by radiology and chest specialists. In the last screening, "High-resolution computerized tomography" (HRCT), the gold standard for the diagnosis of pneumoconiosis, was used for those who were found to have pathology in their chest X-rays; the results were evaluated in detail by a radiology specialist (14).

Survey results, pulmonary functions and chest X-ray findings of technicians who participated in both of the screenings were evaluated and the changes over five years were compared.

Statistical analysis

The data were analyzed using SPSS Statistic for Windows, version 10.0 software (SPSS Inc.; Chicago, IL, USA); in the comparison of data gathered from 125 patients in 2013 and 2008, the paired t test and Chi-squared tests were used.

RESULTS

There were a total of 125 dental technicians that participated in both of the screenings. The ages of the participants ranged from 19 to 55 with a mean age of 34.7±7.6. Some of the features of the technicians are given in Table 1. The major-

TABLE 1. Distribution of technicians according to some socio-demographic characteristics

		n	%
Gender	Male	115	92.0
	Female	10	8.0
Institution	Private	102	81.6
	ODHC	18	14.4
	Town Hospital	5	4.9
Educational status	Primary	56	44.8
	Secondary	38	30.4
	High School	6	4.8
	Vocational School	25	20.0
Departments	Porcelain	33	26.4
	Metal Levelling	29	23.2
	Acrylic Levelling	19	15.2
	Candle Molding	17	13.6
	Plaster Cast	12	9.6
	Acrylic Tepim	7	5.6
	Other	8	6.4
Total exposure time (hours)	<30,000	36	28.8
	30,000-45,000	45	36.0
	>45,000	44	35.2
Smoking	Smokers	75	60.0
	Quitters	16	12.8
	Never	34	27.2

ODHC: Oral Dental Health Centre

ity of technicians were male; of these, 81.6% were working in private labs. The sections in which the technicians mostly worked were the porcelain, metal leveling and acrylic leveling sections.

The technicians were found to have serious exposure to active and passive cigarette smoke. The level of smoking was found to be 60%. Lifetime tobacco exposure was found to be 11.5 packs/year.

According to the results of the questionnaire during the second screening (2013), most technicians had started to work when they were 17. The mean total work time was determined to be 18.1 years. They were working for 6 days a week and their daily working time on average was 9.1±1.3 hours. Therefore, the average total exposure time was found to be 40922±17628 hours.

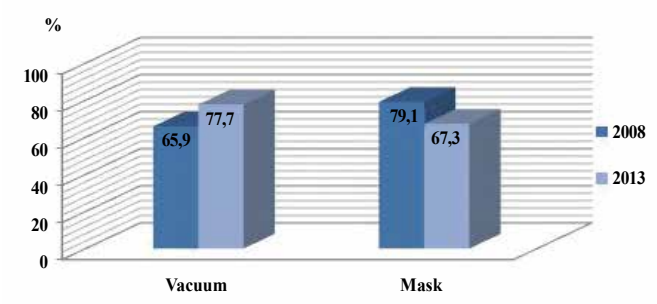

FIG. 1. Changes in the use of vacuum and mask (often/always)

TABLE 2. Changes in the use of protective tools and respiratory symptoms

		2008		2013		p
		n	%	n	%	
Use of mask	Often+Always	87	79.1	74	67.3	>0.05
	Rarely	19	17.3	22	20.0	
	Never	4	3.6	14	12.7	
Use of vacuum	Often+Always	62	65.9	73	77.7	
	Rarely	28	29.8	19	20.2	<0.01
	Never	4	4.3	2	2.1	
Cough	+	8	6.4	14	11.2	<0.05
Breath shortness	+	4	3.2	4	3.2	>0.05
Phlegm	+	2	1.5	3	2.4	>0.05

Changes in protective instruments among technicians were investigated. Despite the risk of dust exposure in the working environment, the technicians' use of personal protective devices was found to be rather low in both of the screenings. While there was a significant increase in the use of vacuums over the five year period ($p<0.01$), there was no significant decrease in the use of masks (Figure 1, Table 2).

Respiratory symptoms exhibited by the technicians and their changes were investigated (Table 2). When the complaints were compared, coughs were the most frequently described symptom in both screenings. The existence of cough complaints increased to 11.2% from 6.4% ($p<0.05$). Another significant symptom, shortness of breath, was found to be present at a level of 3.2% in both screenings. In summary, while there was an increase in cough complaints in 2013 compared to 2008, other symptoms seemed to be similar for both of the screening years.

In order to evaluate the pulmonary system of the participants, PFT measurements of technicians were performed and standard chest X-rays were taken in both screenings.

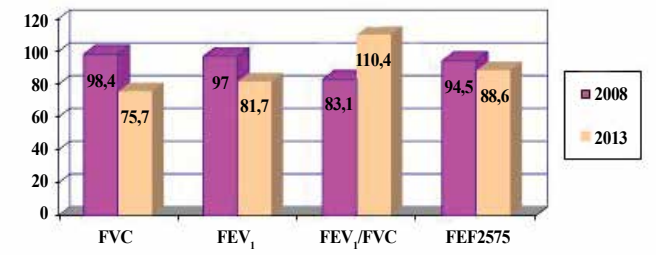

FIG. 2. Comparison of pulmonary function test parameters from 2008 and 2013 (FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; FEF: forced expiratory flow)

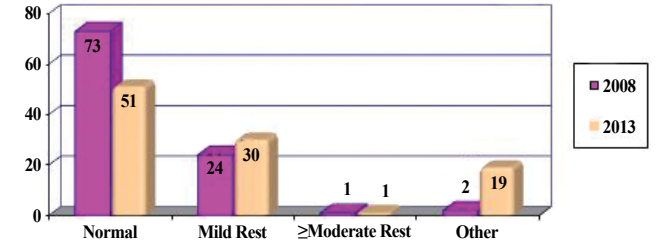

FIG. 3. Comparison of pulmonary function test results from 2008 and 2013

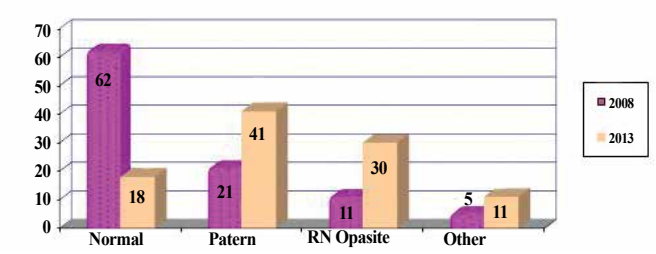

FIG. 4. Comparison of chest graphs from 2008 and 2013

In total, 93 of the technicians received PFT. When the results were evaluated, there was a 23% decrease in FVC, 16% in FEV_1 and 6.2% decrease in FEF_{2575} in the second PFT measurement compared to the first. However, there was a 33% increase in the FEV_1/FVC ratio. These figures are compatible with restrictive-type lung function disorder (Figure 2). Changes in the four compared parameters were found to be statistically significant ($p<0.001$).

Pulmonary function test measurements in both screenings were evaluated and their comparisons are shown in Figure 3. While 73% of the first PFT measurements were found to be normal, this ratio was found to have decreased to 51% in the second measurement five years later. An increase in restrictive-type respiratory disorders in the second measurements was quite remarkable.

In total, 98 technicians received standard chest X-ray in both screenings. When the standard chest radiographs that were taken with the five year interval were compared, while 62% of the first chest radiographs were normal, this level decreased to 18% in the second screening (Figure 4). It is remarkable that there was a 1.9-times increase in the incidence of "Reticulonodular pattern" and a 2.6-fold increase in the incidence of "reticulonodular opacities" in the second radiographs.

Pulmonary function tests and chest X-rays performed in the second screening in 2013 were also evaluated by chest physicians and suspected cases were referred for physical examination. At the end of physical examination, in order to make a differential diagnosis, HRCT was required from suspected

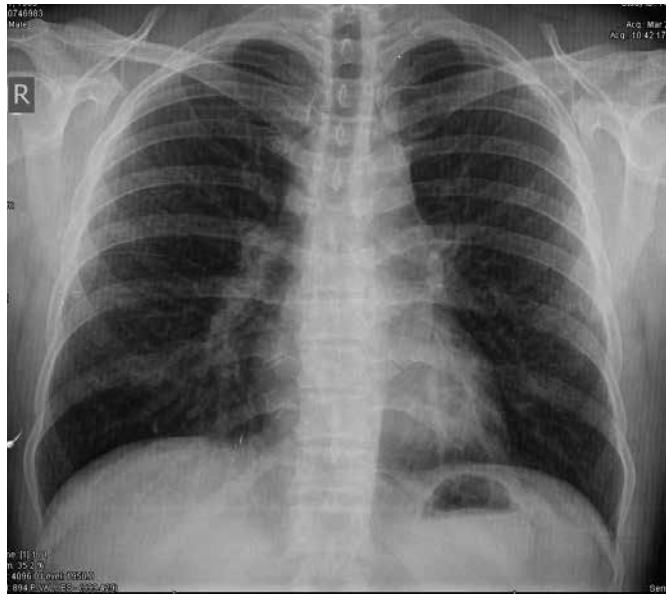

FIG. 5. Chest X-ray of technician diagnosed with pneumoconiosis

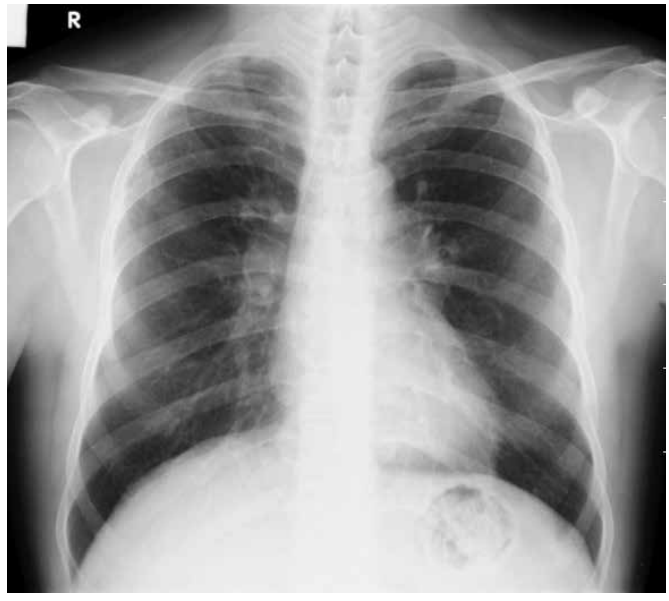

FIG. 6. Chest X-ray of technician diagnosed with pneumoconiosis

TABLE 3. Distribution of pneumoconiosis cases according to some certain properties

		Pneumoconiosis	
		n	%
Gender	Male	7	6.1
	Female	0	0.0
Institution	Private	5	4.9
	ODHC	1	5.5
	Town Hospital	1	20.0
Departments	Acrylic Leveling	1	5.3
	Metal Leveling	2	6.9
	Porcelain	1	3.0
	Acrylic Tepim	0	0.0
	Plaster Cast	1	8.3
	Candle Molding	1	5.9
	Other	1	12.5
Smoking	Smoker	6	8.0
	Ex-smoker	0	0.0
	Never	1	2.0
Working Time (Thousand hours)	<30	1	2.8
	30-45	3	6.7
	>45	3	6.8

ODHC: Oral Dental Health Centre

patients. As a result of further investigations, 7 technicians (5.6%) were diagnosed with pneumoconiosis.

Chest X-ray radiographs of two technicians diagnosed with pneumoconiosis can be seen in Figures 5 and 6. Also, it was agreed that 13 workers should be kept away from dusty environments and monitored accordingly following analysis of their radiographs.

The distribution of the various properties of the 7 workers diagnosed with pneumoconiosis is given in Table 3. All of the cases were male. Pneumoconiosis cases were found much more frequently in those who smoke and work for 30000 hours or more, and in those who work in town hospitals in the sections of plaster casting and metal leveling.

DISCUSSION

Dental technicians have several occupational risks, primarily dust. If the necessary precautions are not taken, dust-related occupational diseases might develop (1-4). When the literature was reviewed, it was remarkable that there are several pneumoconiosis cases that have been reported (6-12). Therefore, it is necessary to take certain precautions (1), including ventilation, vacuum use and increased personal protection methods.

The role of working (exposure) time is important in the transformation process of health risks to disease. The Occupational Safety and Health Administration (OSHA) remarked that dust should be kept at a certain level and introduced restricted working hours (15). Age at first employment, daily and weekly working hours, and in particular the total exposure times in the profession, all have decisive effects on the occurrence of occupational diseases (3). Weekly working hours of technicians was 54 hours. When the legal standard weekly working time (according to labor law legislation) is considered to be 45 hours, technicians' working times are rather long. In the studies carried out in Sivas and İzmir, it was reported that weekly working times of technicians are rather high. This clearly shows that long working times are quite common among technicians (12,16).

Taking general and personal protective precautions are determining factors in the emergence of occupational diseases (3). Local and general ventilation are very important in the prevention of dust exposure and are the primary precautions which should be taken in the workplace. It is possible to prevent occupational diseases by keeping the dust values within acceptable levels in the workplaces (3,8). However, several studies carried out on dental technicians have reported that the number of precautions related to the prevention of dust in the working place was rather low. In a comprehensive study conducted by the Ministry of Labor, it was reported that the deficiencies of general or local ventilation were the most common deprivation in dental laboratories by 95% (8).The use of ventilation was reported to be 33% and 45% in two previous studies (12,17). In our study, vacuum use was found in 66% in 2008 and increased to 78% in 2013, showing a slight increase over the course of time.

It was found that technicians are at high risk of dust exposure in the workplace, but their use of personal protective tools was found to be far below the required level. However, it has been reported that the efficient use of masks decreases the respiratory uptake of dust by 70-95% (18). Regular use of masks was found in 67% of cases in 2013, which was a decrease compared to 2008. The low rate of the use of masks was also reported in other studies (14%, 19% and 32%, respectively) (12,16,17). The rate of not providing and non-use of necessary personal protective equipment was determined to be 92.5% by the Ministry of Labor (8). In summary, when the precautions against dust were investigated, serious deficiencies in the use of general and personal protection precautions were determined in both of the screenings.

The most commonly affected system following dust-related exposure is the respiratory system. When the literature regarding dental technicians is reviewed, it can be seen that there have been several respiratory symptoms at different levels. The proportion of respiratory symptoms was reported to be 10.3% and 16% in two studies (16,19).

The most common symptoms among the technicians who participated in our study were found to be cough and phlegm. In our study, the rate of cough was seen to have almost doubled, from 6% to 11%, during the five year period. Cough frequency was reported to range between 17% and 38% in different studies (17,20-22). In another study carried out by Çımrın et al. (23), cough and phlegm were also given as the primary symptoms. The third most common symptom found in our study was shortness of breath, which is a more serious symptom in terms of chronic exposure to dust; this was found at similar rates in both of the screenings, with a level of 3.2%. Shortness of breath was reported in 37%, 16.7% and 24% of cases in three other studies (17,20,22).

As can be seen in the results of several studies, the frequency and proportions of the symptoms show significant variation. Several factors such as working time and smoking levels might be the cause of these differences.

A significant feature of this study is that it is a follow-up study where the results of two screenings carried out and evaluated with a certain time interval using the same technicians are reported. The total average working time of the technicians who participated in the survey was 13 in the first screening. This figure increased up to 18 years in the second screening. That is, this study involves 5-year screening time. Considering the fact that Pneumoconiosis cases are often seen with the employees working for 10 years or more, and the lowest exposure time for Pneumoconiosis was 3 years, the screening time of the study is suitable in terms of determination of dust exposure and the existence of Pneumoconiosis (24).

Long-term dust related exposure and its common effect generally leads to “restrictive” type disorders in the lungs (6). Therefore, PFT is significant, so PFT measurements were carried out in both of the screenings in our study. When the results of PFT in 2008 and 2013 were compared, a decrease was detected in all parameters. For instance, there was a 23% decrease in FVC and a 16% decrease in FEV_1.

There was an increase in FEV_1/FVC values, which is a significant indicator of restrictive-type respiratory disorder. These findings indicate that restrictive-type respiratory disorders increased among technicians over the five year period. Such findings are typical manifestations of dust-related interstitial lung disease (6). It was found that restrictive pulmonary disorder increased to 31% in 2013 from 25% in 2008. Similar findings were reported in several studies carried out on dental technicians. The results of another study carried out by Ozdemir et al. (20) showed that there was a decrease in the PFT values of the technicians over a seven year period. In two other studies on dental technicians, it was reported that that there were restrictive pulmonary disorders in 22.4% and 33.3% of participants (17,25). In another two studies, it was reported that there was a decrease in FVC and FEV_1 levels and that longer working durations led to worse PFT values (26,27).

In the study, standard chest radiographs of the technicians were taken in both of the screenings in 2008 and 2013. The appearance of rounded opacities in the upper and middle lobes are typical radiological findings, particularly in the assessment of exposure to dust (1,24). It was remarkable that while 62% of chest radiographs were found to be normal in the first screening, only 18% of radiographs were normal in the second screening; this clearly shows that there is an increase in the disorders in the lungs, which can be radiologically determined. A 2.6-fold increase in the occurrence of reticulonodular opacities is also remarkable and clearly indicates a radiological change that dust exposure causes in the lungs during the five year period. Chadout, in his study, stated that abnormal findings were determined in 11.8% of the chest radiographs of the technicians and Alavi et al., in their study, reported the presence of interstitial opacities at a level of 23.8% (7,17). Çımrın et al. (23) detected radiological findings consistent with pneumoconiosis in 23.6% of chest X-rays of technicians. Some studies suggest that there is a positive relationship with the working duration and the rate of occurrence of opacity (17,20). Özdemir et al. (20) reported deterioration of the radiographic findings at the end of their seven year study.

In the screening carried out in 2013, it was detected that radiological findings were consistent with exposure to dust in some technicians as well as restrictive patterns in the PFT results. HRCT was carried out for further examination of the suspected cases. After analysis of the HRCT results, 7 technicians were diagnosed with pneumoconiosis. In other words, the rate of pneumoconiosis was 5.6% among the technicians. Much higher pneumoconiosis rates were reported in different studies carried out in Turkey.

Two studies were carried out on the same technician group with a seven year interval by Özdemir et al. (20), and pneumoconiosis prevalence of 13.8% and 47% was reported. Pneumoconiosis prevalence was reported to be 24.2% by Fidan (21), 17% by Abakay et al. (25) and 15.5 % by Fişekçi et al. (28). In a study carried out by the Ministry of Labor, 4.8% pneumoconiosis prevalence and 1.4% silicosis prevalence was reported in Ankara. Also, pneumoconiosis prevalence was reported to be 3.2% in Adana (8). When the studies conducted abroad were reviewed, pneumoconiosis prevalence in the USA was reported to be 4.5% and 16% in Sweden (26,29). To sum-

marize, although at different rates, pneumoconiosis cases are commonly encountered diseases among technicians which clearly shows the risk of dust in dental laboratories. In fact, dental laboratories were defined as risky working areas by "The Turkish Thoracic Society Silicosis Prevention Initiative Group" in terms of silicosis, and it suggested that sandblasting be prohibited (30).

In the current study, the emergence of pneumoconiosis cases in those working for more 30 thousand hours and longer is significant in terms of showing the relationship with exposure time and occupational diseases. Overall, 85% of technicians diagnosed with pneumoconiosis are found to have worked for 30 thousand hours or more. These findings indicate that the potential risk of having the disease is higher in those working in this field for a long time. In the study carried out by the Ministry of Health, 85% of the technicians diagnosed with pneumoconiosis were those working for 11 years or longer in the profession (8).

In addition, the emergence of cases of pneumoconiosis more commonly among those workers from metal leveling or plaster casting sections, or workers in town hospitals, is also significant in terms of showing the high risk areas and workplaces. The fact that this disease is seen more frequently among technicians who smoke indicates the additional damage caused to the respiratory tract by smoking.

It is seen that dental technicians, particularly those who have been working for approximately 16 years in work places exposed to dust and their PFT and radiologic evaluations show that respiratory tracts are negatively affected. The results of the study also show that negative impacts on the respiratory tracts have gradually increased over the five year period.

The level of pneumoconiosis cases of 5.6% shows that it is necessary to adopt comprehensive work health and safety precautions.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Pamukkale University School of Medicine (07.05.2014/60116787-020/9623).

Informed Consent: Written informed consent was obtained from participants who participated in this study.

Peer-review: Externally peer-reviewed.

Author contributions: Concept - N.B., B.Y., A.İ.B.; Design - N.B., B.Y., A.İ.B., Ö.Y.; Supervision - N.B., B.Y., A.İ.B., M.T.; Resource - B.Y., Ö.Y., M.T.; Materials - B.Y., Ö.Y., M.T.; Data Collection and/or Processing - B.Y., Ö.Y., M.T.; Analysis and/or Interpretation - N.B., B.Y., A.İ.B., Ö.Y.; Literature Search - N.B., A.İ.B.; Writing - N.B., B.Y., A.İ.B.; Critical Reviews - N.B., B.Y., A.İ.B.

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