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Occupational and Envronmental Lung Diseases

Spirometric Parameters of the Villagers Living Around Power Plant in Muğla, Turkey

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Abstract

Objective: This research was carried out to investigate the respiratory effects of the stack emissions of the Yatagan coal-fired thermal power plant in the Mugla Province of Turkey. **Methods:** The village that is located within 5 km around the power plant was investigated as the power plant village. Three similar villages those were located more than 30 km away from the thermal power plant were investigated as control villages. The study design was based on the comparison of the spirometric parameters of the individuals living in the two different village groups. The study was carried out on individuals who are age 15 and older and living in these villages. **Results:** The spirometric parameters of the residents of the village around power plant were found to be significantly worsened as compared to the residents of the control villages ($p<0.05$). The never-smokers of the control villages were found to have the best spirometric results and also they had statistically significantly better spirometric findings than never-smokers of the village around the plant ($p<0.05$); whereas no statistically significant differences of the spirometric measurements of current smokers were observed between the two groups of villages ($p>0.05$). **Conclusion:** The spirometric findings suggest that living within the vicinity of a coal fired thermal power plant could result in obstructive lung disease.

Keywords: environmental health, respiratory effect, coal-fired thermal power plant, spirometry

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INTRODUCTION

Air pollution has several and complex adverse effects on health particularly on the cardio-respiratory system; furthermore it is discussed under the causative factors of several malignances in the human body and premature deaths [1,2]. Long term exposure to air pollution may contribute to the pathogenesis of airway disease, and that urban levels of air pollution have some histopathological adverse effects on the respiratory tract in humans [3-6].

In terms of volume and variety of contaminants emitted, few other single pollution sources come close to matching the negative impact from electric power plants. Among power plants, the coal-fired facilities are reported to produce the most serious pollution [7]. Thermal power plants' emissions contain huge amounts of gases and uncountable particles that can easily be inhaled by the humans. Among those particles, nitrates, acids of sulfur, metal salts and carbon particles are found [8].

In Turkey, although there are many studies carried out in the vicinity of coal fired thermal power plants, these studies are mainly about the power plants effects on the fauna, agriculture, vegetation and forests [9, 10] rather than on human health [11]. However the numbers of studies about the health effects of coal-fired thermal power plants on human respiratory mechanics are limited [12-17].

Bearing in mind the importance of the subject, this research was carried out in the Mugla Province of Turkey in order to detect the respiratory effects of the power plant, using a pulmonary function test, and by comparing the spirometric parameters of the individuals living in a village around Yatagan coal-fired power plant with the residents of the control villages.

MATERIALS AND METHODS

Area of the study

The Yatagan thermal power plant which was established in the Mugla Province of Turkey started to function with full capacity in 1984. Yatagan Region is located in Agean side of Turkey and around 60 km. away from the coast.

Lignite coal from the coal mine near the power plant is used for generation of electricity. The plant has three units, each one of them having 210 MWt power. The stack height is 120 meters. The plant burns 15 thousand tons of lignite coal every day [18]. The stack of the plant gives out 5000-7500 tons of ash to the environment every day

The Bozuyuk village which was located within 5 km around the power plant was investigated as village around the power plant. Three control villages (Çıtlık, Ataköy, Gökova) were similar to the power plant village as far as population, climate, culture and life-style of people and they were located more than 30 km away from the thermal power plant.

Subjects

The people of the above-mentioned villages mainly earn their living by agriculture and by breeding cattle. None of the inhabitants of the villages worked at the termal power plant.

The Bozuyuk village had a population of 511. The population over 15 years of age living in this village was 392. The population from the Bozuyuk village who were examined in this study was 309 (Table 1).

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Table 1. The population of the Control Villages (Çıtlık, Ataköy, Gökova)

Name of the village	Population	Population over 15 years of age	Population examined in the study
Çıtlık	307	243	190
Ataköy	122	86	60
Gökova	98	64	44

Measurements

In order to measure the respiratory effect of the power plant, pulmonary function tests were performed using a portable spirometer. Height and weight of the study population were measured prior to spirometric measurements. Height, age and sex of the individual were recorded in the spirometer before the spirometric measurement. For all these measurements, checklists were prepared beforehand and used during the measurements to standardize them. The individuals were asked to blow in the spirometer when standing upright and clasping the nose, not allowing the air to escape from the nose. European Respiratory Society's (ERS's) prediction formula for spirometric indices was used [19].

Three consecutive spirometric measurements were carried out. The highest values were recorded. Forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), FEV1 expressed as a percentage of FVC (FEV1/FVC) and mean forced expiratory flow during the middle half of the FVC (FEF25-75 %) were the spirometric function tests that carried out.

Questionnaires

A structured questionnaire was administered as face to face interview to collect demographic data and smoking habits.

Statistical analysis

For statistical analysis of the collected data student t-test was used. Statistical significance level was considered as p value < 0.05.

RESULTS

Comparison of spirometric findings of all individuals

In Table 2, it is observed that there is statistically significant differences between the two groups of villages in the spirometric parameters except for the FEV1/FVC values ($p<0.05$). Our findings showed that pulmonary function tests of the residents of the village around plant were significantly worse compared to the residents of the control villages with the exception of the FEV1/FVC values. ($p<0.05$).

Comparison of spirometric findings of the never smokers

In Table 3, shows only the individuals who have never smoked in two village group; and their spirometric measurements. The never smokers of the power plant village had lower spirometry measurements than the non-smokers of the control village with exception of the FEV1/FVC values.($p<0.05$). Never smokers had higher means of spirometric measurements both in the village around plant and in the control villages than current smokers whose values can be observed in Table 4.

Comparison of spirometric findings of the smokers

In Table 4 shows the individuals who were current smokers and their spirometric measurements were compared between the two groups of villages. We observed that in current smoker group there were no difference in the spirometric parameters between the two village population.($p>0.05$).

Comparison of spirometric findings of the passive smokers

Table 5 shows only the individuals who have never smoked and did not exposed to second hand smoke every day. We examined this group in order to rule out the adverse effects of passive smoking on pulmonary function tests. Their spirometric measurements were compared between the two groups of villages. In this population, the residents of the control villages were found to have significantly better spirometric measurements (except for the FEV1/FVC values) compared to never smokers of the village around power plant ($p< 0.05$).

DISCUSSION

In the findings of this study when all of the individuals were compared according to various parameters of spirometry, individuals living in the control villages were found to be healthier. In a study carried out around a power plant in Mexico, it is reported that even if such plants are comply-

Table 2. Comparison of Spirometric Measurements According to Place of Residence: All Individuals

SPIROMETRIC PARAMETER	Around plant (n=309)			Control (n=294)			Statistical significance	
	Mean	SD	SE	Mean	SD	SE	t-value	p
FEV1	96.99	23.45	1.33	104.66	20.67	1.20	4.25	0.000
FVC	98.15	22.56	1.26	105.22	21.63	1.26	3.92	0.000
FEV1/FVC	103.33	12.95	0.74	104.03	11.38	0.66	0.70	>0.05
FEF25-75%	82.43	30.46	1.74	91.65	29.01	1.69	3.80	0.000

Table 3. Comparison of Spirometric Measurements According to Place of Residence Among Never Smokers

SPIROMETRIC PARAMETER	Around plant (n=175)			Control (n=171)			Statistical significance	
	Mean	SD	SE	Mean	SD	SE	t-value	p
FEV1	100.60	23.51	1.78	106.08	20.38	1.56	2.32	0.021
FVC	100.09	23.78	1.79	106.33	21.76	1.67	2.54	0.01
FEV1/FVC	105.19	11.53	0.87	105.39	9.20	0.70	0.18	>0.05
FEF25-75%	85.44	28.75	2.18	92.87	24.85	1.90	2.56	0.011

ing with national standards, their emissions can still have significant impacts on the health of the surrounding population [20]. In that study it is reported that these emissions were estimated to result in 30 premature deaths per year in the nearby region. In a study carried out in Thailand, hospital admissions for cardio-respiratory complaints were estimated to be related to the exposure to a power plant [15]. However, it is very hard to find studies in literature that investigates the pulmonary functions of individuals who are exposed to the air pollution of power plants. There are some studies showing the exposure to environmental air pollution in general can cause a dose-dependent effect on pulmonary functions [21, 22]. In other words with chronic exposure to pollution, pulmonary function tests particularly FEV1 values can be expected to be lowered. Pope stated that every 10 micrograms/m^3 increment in the concentration of PM10 in air would result with a decrement of less than 2% in the pulmonary functions [23]. In a cohort study carried out in Deutschland, living in the polluted urban areas was found to decrease FEV1 and FVC in 12 years time as compared to living in the rural areas [24]. The UCLA population study in Los Angeles also explains the average declines in FEV1 to reflect the accumulated respiratory effects of chronic exposure to air pollution [25]. In the Goren's study in Israel, the annual increase in FEV1 and FVC was altered the most in the four subgroups from the community expected to be most polluted, implying that not only FEV1 but also FVC is affected by the increase of pollutants in the air [13]. In Kütahya, Turkey, the residents of the villages located around the coal-fired thermal power plant was found to be statistically significantly affected on spirometric measurements of FEV1 and FEF25-75 % values [11]. In our study, the spirometric parameters of FEV1, FVC, and FEF 25-75% were found to differ significantly between the two groups of villages ($p< 0.05$) suggesting of a particularly obstructive ventilatory patterns.

In a paper, Utell MJ et al. states that the likelihood of environmental lung disease depends on the exposure received, as exposure determines the dose of an agent at target sites in the lung and on the susceptibility to another agent. 'Synergism' refers to the independence of the effects of two agents whose combination exceeds the expectation based on the effects of the individual agents [22]. The combination of active cigarette smoking with exposure to the air pollutants of the thermal power plant could adversly influence the pulmonary functions. Keeping this in mind, we compared the smokers between the two groups of villages and found no statistical differences ($p>0.05$). We conclude that the pulmonary function tests of the current smokers are worsened due to smoking in both villages.

In this study when the individuals who have never smoked were examined in order to show the effect of living around the plant as an independent effect from the effect of smoking; never smokers' spirometric parameters were found to be statistically significantly lower in the village around the plant ($p<0.05$). In a similar study carried out in Turkey, FEV1, FVC and FEF25-75 % of the never smokers living in the villages around coal-fired power plant were found to be statistically significantly reduced as compared to the never smokers living in the control villages [11].

Smoking in controlled environment was found to be associated with adverse respiratory effects [26]. The importance of control of indoor air pollution such as passive smok-

Table 4. Comparison of Spirometric Measurements According to Place of Residence Among Current Smokers

SPIROMETRIC PARAMETER	Around plant (n=101)			Control (n=92)			Statistical significance	
	Mean	SD	SE	Mean	SD	SE	t-value	p
FEV1	94.35	22.28	2.22	100.42	21.53	2.20	1.92	>0.05
FVC	96.88	21.43	2.13	102.67	21.76	2.28	1.86	>0.05
FEV1/FVC	101.18	10.03	0.78	102.31	9.97	0.70	0.78	>0.05
FEF25-75%	79.17	31.17	3.10	86.09	35.49	3.70	1.44	>0.05

Table 5. Comparisons of Spirometric Measurements According to Place of Residence Among Never Smokers without Exposure of Passive Smoking

SPIROMETRIC	Around plant (n=87)			Control (n=86)			Statistical significance	
PARAMETER	Mean	SD	SE	Mean	SD	SE	t-value	p
FEV1	100.31	25.72	2.76	110.03	16.77	1.81	2.94	0.004
FVC	100.39	24.89	2.67	111.17	19.11	2.06	3.19	0.002
FEV1/FVC	105.33	12.42	1.33	103.52	10.58	1.14	1.03	>0.05
FEF25-75%	81.01	30.21	3.24	93.38	29.12	3.14	2.74	0.007

ing in developing countries was reported as well as other current literature [27, 28]. To investigate the effect of pollution due to smoking on pulmonary functions, the never smokers who claim not to be exposed to indoor pollution of current smokers were also examined in our study and it was found that the statistically significant difference prevailed between the two groups of villages ($p<0.05$). We believe that to take environmental measures to protect never smokers around the power plant can be a more effective measurement particularly if they were not exposed to passive smoking.

Here we conclude that the spirometric findings are worsened by living within the vicinity of a coal-fired thermal power plant suggesting particularly an obstructive ventilatory defects. The benefits of reducing ambient air pollution from the power plants are expected to protect the pulmonary functions of never smokers especially if they were not exposed to passive smoking before. Ambient air monitoring and more specific tests to confirm the diagnosis of acute and chronic lung diseases should be carried out in the area in further studies. Follow-up studies which closely monitors dose of exposure to the effects of the plant and smoking can also be recommended.

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