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THE EFFECT OF BIOMASS FUEL COMBUSTION ON PULMONARY FUNCTION TESTS IN THE ADULT POPULATION OF SIVAS PROVINCE

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Abstract : The effects of natural traditional energy sources which is called biomass, mainly cowdung, on pulmonary function was investigated. In rural regions of Sivas City, pulmonary function tests of 112 cow-dung users and 153 modern energy source users were compared. When comparing the mean values of spirometric measurements of two groups' males and females seperately, all the spirometric parameters of the cow-dung users' group were found to be decreased ($P<0.05$) and this decrement was in obstructive type. As a result, cow-dung which is a special type of biomass, was seen to effect pulmonary function tests negatively both in males and females.

Key words : biomass cow-dung pulmonary function tests

INTRODUCTION

Cow-dung, wood and agricultural waste which are called biomass are used by about half of the world's population as a major energy source cooking and heating (1, 2).

Continuous indoor buring of biomass and exposure to large amounts of biomass smoke since the childhood with inefficient conditions for removing smoke and air pollutants may cause pulmonary diseases such as repetitive pulmonary infections, chronic obstructive lung disease (3, 4, 5).

In rural regions of Sivas city, cow-dung is generally used as the major energy source. The effect of biomass (especially cow-dung) on pulmonary functions among this region's population by a field study had never investigated before. Because of this, we aimed to investigate the effect of cow-dung fire on pulmonary function test parameters in the villages located in rural regions of Sivas city.

METHODS

The investigation was done in 265 nonsmoker subjects which were selected from Sivas city center and from the villages in January–1997. While 112 of the selectees living in the villages selected as biomass affected group, 153 of them living in the

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city center selected as control group. The biomass affected group was consisted of the people living in Koyuncu and Kavlak villages and using only cow-dung as the energy source from the birth. Before spirometric tests a general questionnaire about fuels used as an energy source and socioeconomic and health status was done. In all the houses of these villages only cow-dung were used as the energy source and housing conditions and socioeconomic parameters were inefficient. All the people were exposed to biomass burning from birth. The members of the control group were selected from the people using only modern energy sources and living in the Sivas city center by the simple random sampling method. All the members of the two groups were nonsmokers.

Pulmonary function test parameters were collected by using Minato AS 600 spirometer. The Values were measured as BTPS. After every five measurement the spirometer was calibrated with 2-L calibrator syringe accurate to ± 1%. All measurements were made in the standing position with a nose clip applied. Examinations were conducted by the same trained technical staff. In every measurement subjects performed three maximal efforts after detailed instruction and the best one was recoreded. The ventilatory function test measurements included forced expiratory volume in one second (FEV_1) forced vital capicity (FVC), FEV_1/FVC ratio and flow between the first 25 and 75 of forced expiratory flow (FEF_{25-75}).

In the statistical analysis Student-t test and analysis of correlation were used (6).

RESULTS

In biomass affected group while 75 of 112 subjects (67%) were female, 37 (33%) of them were male. Control group consisted of 92 female (40.8%) and 61 male (59.2%) subjects.

TABLE I : The comparison demographic data of the two groups.

	Female (X±Sd)			*Male (X±Sd)*		
	Biomass (+) (n=75)	*Biomass (–) (n=92)*	*Test*	*Biomass (+) (n=37)*	*Biomass (–) (n=61)*	*Test*
Age (year)	35.6±14.8	34.1±7.5	P>0.05	37.6±11.2	35.5±8.7	P>0.05
Weight (kg)	63.1±11.0	61.2±10.1	P>0.05	73.2±10.2	74.8±10.1	P>0.05
Height (cm)	159.2±6.0	161.6±5.9	P>0.05	172.5±6.8	174.1±7.7	P>0.05

TABLE II : Mean values and standard deviations for pulmonary function measurements in biomass affected and the control groups.

	Female (X±Sd)			*Male (X±Sd)*		
	Biomass (+)	*Biomass (–)*	*Test*	*Biomass (+)*	*Biomass (–)*	*Test*
FEF_{25-75}	3.33±1.15	4.04±0.82	P<0.01	4.02±1.98	5.47±1.56	P<0.01
FEV_1	2.39±0.76	2.74±0.51	P<0.01	3.18±1.10	3.98±0.78	P<0.01
FVC	2.50±0.81	3.02±0.48	P<0.01	3.50±1.02	4.27±0.82	P<0.01
FEV_1/FVC	90.93±5.87	95.89±4.86	P<0.05	89.37±11.15	93.98±6.09	P<0.05

As seen in Table I, there was no statistical difference between two groups in respect of age, height and weight.

Pulmonary data obtained from the two groups are given in Table II. When the mean values for pulmonary function measurements of the two groups' females were compared, all the parameters of the biomass affected group were found to be decreased statistically comparing with the control group ($P<0.05$). Similarly, in the comparison of the two groups' males, spirometric values of biomass affected group were statistically lower than the control group ($P<0.05$).

In the biomass affected group when the relation between exposure time and pulmonary tests was investigated, it was seen that there is a negative correlation between the exposure time and pulmonary data (FEF_{25-75} r= −0.56, FEV_1 r= −0.54, FVC r= −0.45, FEV_1/FVC r= −0.33) ($P<0.01$).

The ratio of the often respiratory tract infection anamnesis of the biomass affected group and the control group was 35.9% and 19.6% respectively. The difference was statistically significant ($P<0.05$).

DISCUSSION

Especially in the rural regions of developing countries biomass burning causes important health problems because of its widely using as an energy source. The harmful effects of these organic fuels including cow-dung are due to waste products of combustion such as hydrocarbons (eg; aldehyde, phenol, toluen). The inflammatory reactions caused by recurrent exposure to irritant and mucus-coagulating emissions make the trachea, bronchi and bronchioles susceptible to infection, which may manifest itself infetive bronchitis, bronchiolitis or pneumonia (1). As a result of this, the people living in the regions of biomass use have higher incidence of respiratory diseases (7). Pulmonary function tests have an importance in investigating the effcts of biomass on respiratory system and in diagnose of the respiratory diseases. FEV_1, FVC, FEV_1/FVC, FEF_{25-75} are the major spirometric parameters that are used for determining the airflow limitations (8).

To the results of our study, mean values of pulmonary function test measurements were found to be decreased statistically both in males in females of biomass affected group. This finding is thought to be related with decreased air flow both in big and small airways. Because of the high incidence of respiratory tract infections and low values of some pulmonary function test parameters that are helpful for showing the obstructive lung diseases like FEV_1, FVC, FEV_1/FVC, FEF_{25-75}, it can be thought that the incidence of chronic obstructive lung disease may have been increased among the biomass affected people in our study. But for the exact diagnose of chronic obstructive lung disease, radiographic examination was needed. Because of this, the suspicious cases were sent to the City Hospital for further examination. In a recent study, Demirtas (9) found a strong statistical correlation between the prevalence of chronic obstructive lung disease and biomass smoke exposure in Turkey. In this study mean values of FEV_1, FVC, FEV_1/FVC and PEF

were found to be decreased statistically among biomass affected people. In Pandey and Ghimire's (10) study to be lived in rooms made smoky by wood and cow-dung fires were identified as risk factors for repeated respiratory infections. Another study made by Pandey (11) have shown a similar relationship between decay of lung function measured by spirometry and indoor biomass exposure. In ongoing studies made by Helsing et al (12) and Jones et al (13), pulmonary function have shown to be decayed among women using biomass fuel as an energy souce while cooking. Similarly, Cookson et al (14) have indicated increased prevalence of chronic obstructive lung disease among biomass affected women. In rural regions where the biomass fuels are used some pulmonary toxic agents such as aldehyde, CO and benzopyren are shown to be exceeded the respirable limits of indoor air (15). So, the decrease of mean values of pulmonary function test, measurements in our study can be explained with the indoor air pollution mainly due to traditional biomass fuel combustion.

As a result, among the population living in the rural regions of Sivas city, pulmonary fuction tests are shown to be affected negatively with biomass (especially cow-dung) use. Unfortunately, most of the developing countries have the same problem. For this reason a concerted effort of international cooperation is required to provide solutions.

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