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Original Research Article

Effect of passive smoking on lung function tests in women

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ABSTRACT

Pulmonary function tests are non-invasive diagnostic test that provide measurable feedback about the function of lungs. An assessment of lung volumes, capacities and flow rates provide specific information for clinical diagnosis and research purposes. Smoking is an addiction which affects the normal life, body and organ system as whole. Passive Smoking is defined as exposure of non smoker to tobacco smoke in the environment. Second hand tobacco smoke is the precursor of the primary active smoke from the smoker. Second hand tobacco smoke is believed to be more harmful than the primary smoke from the active smoker. The potency and health effects of second hand smoke involved the smell of secondhand smoke being an allergen affecting the respiratory system. The effects of passive smoking on respiratory system and lung function test warrants documentation.

Aims and Objective: To evaluate the effect of passive smoke on lung function test among women exposed for ten years.

Materials and Methods: The study was conducted on fifty females in the age group of 30-60 years who were exposed to passive smoke for ten years. An identical number of age matched females who were not exposed to cigarette smoke at home served as controls. The lung function parameters recorded were FVC, FEV1, FEV1/FVC%, PEFR, MVV and FEF25-75%

Results: The study demonstrated decline in mean values of FVC, FEV1/FVC%, MVV and FEF25-75% in female subjects but the difference in the mean values when compared with controls was found to be statistically insignificant. The mean values of FEV1 and PEFR was less in female subjects and the difference in the mean values was statistically significant. The study demonstrated decline in the expiration of FVC in first second and decline in maximum flow rate during forceful expiration that conforms to obstructive pattern of lung changes in females exposed to chronic passive smoke.

Conclusion: Any significant decline in lung functions in females being most vulnerable in household, with time merits attention as they indicate likely morbidity in the event of continuing exposure to the offending agent.

1. Introduction

Lung function tests are of increasing interest in the quantitative and qualitative evaluation of pulmonary function test in patients with cardio respiratory disorders.[1] The simple ventilatory function test have proved useful in establishing the diagnosis, prognosis and in guiding therapy.[2] The American Thoracic Society(1991), the European Community for Coal and Steel (ECCS) and the European Society for Clinical Respiratory Physiology have published guidelines focusing primarily on spirometry as the most widely used lung function test.[3]

The different parameters in the lung function test provide information relating to large and small airways,

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pulmonary parenchyma. They are more of prognostic value i.e. response to treatment while Lung function parameters also guide in establishing a diagnosis whether obstructive or restrictive pattern of disease. The interpretation of the lung function test requires the knowledge of normal values and must be combined with the patient's clinical history and clinical symptoms.

Cigarette smoking is the leading cause of preventable death in smokers. It causes disease and disability harming every organ of the body. Smoking is one of the common recreational drugs. The dried tobacco leaves are rolled into a rectangular rolling paper to create cylindrical cigarette and combustion of dried tobacco leaves vaporize and deliver active substance –Nicotine into the lungs. Nicotine is absorbed into the blood stream to reach the body tissues causing pleasure and enlightment. According to Center for Disease Control and Prevention (CDC), Smoker is defined as, "an adult who has smoked 100 cigarettes in his lifetime and who currently smokes them". Besides smokers, the non smokers who are in close association with smokers whether in household or office are at higher risk of tobacco smoke. Such non smokers are exposed to passive smoking effects in the ambit of active smokers.

Passive Smoking is defined as exposure of non smoker to tobacco smoke in the environment.[4] Synonymously passive smoking is breathing in other people's tobacco smoke. The second hand tobacco smoke comes from cigarettes, pipes, cigars etc. An active smoker breathes in the mainstream smoke or exhales out while passive smokers are exposed to cigarette smoke in two ways: by direct exposure to the smoke of passively burning cigarette (side stream) and exposure to the smoke exhaled by the smoker.[5] Since the temperature of passively burning cone is lower as the cigarette smoulders than during active puffing, combustion is incomplete in side stream than in main stream smoke. As a result side stream smoke has higher concentration of some toxic and carcinogenic substances than the main stream smoke. When exposed to second hand smoke, non smokers inhale 60-80% of airborne nicotine similar to that absorbed by smokers. Females have higher prevalence of second hand smoke exposure than males and are mostly exposed at home.

Passive Smoking is equivocal to active smoking and the severity depends on the duration of exposure of passive smoker to the tobacco smoke of active smoker. The high risk groups of the active smokers are the people in the horizon of active smokers. They are predominantly females in the household, offices, workplaces, travelling, colleges etc. In addition, children also have high prevalence of secondhand smoke exposure than adults.

The lung reactivity to passive smoke warrants documentation through lung function test. The present study is conducted to evaluate the effects of passive smoking on lung function test among females.

2. Aims and Objectives

To assess the effect of Passive Smoking on Pulmonary function test in females.

3. Materials and Methods

The study was designed to examine the influence of passive smoking on Pulmonary Function test in females. The study was conducted in 50 adult females in the age group of 30-60 years who were exposed to tobacco smoke at home predominantly by the active smokers who were smoking for 10 years or more. In addition the females were exposed to tobacco smoke at work places, travelling, offices etc. The female subjects were selected from OPD facility, families, neighbours, colleagues. The information on the exposure of the females to cigarette smoke was obtained by a questionnaire containing questions on medical history, smoking habits, duration of smoking of smoker and socioeconomic status of the family. The only female subjects were selected who were exposed to tobacco smoke for more than 10 years and the smoking pattern conformed to smoking minimum of 4 cigarettes per day. An identical number of age matched females who were not exposed to cigarette smoke at home served as control. The anthropometric parameters included age in years on the last birthday, weight in Kg recorded on platform beam balance. Height was measured by a vertical measuring rod fixed on the wall and the horizontal bar of the measuring rod was lowered to touch the head which gave height in centimeters. The Body Surface Area was calculated from Dubois nomogram in sq. meters. The general physical and relevant respiratory examination was done. Computerized medspiror was used to record lung function test. It is a low cost high performance apparatus and advancement in pulmonary function testing. It is used with electromechanical pneumotach transducer supplied with the instrument that converts respiratory flow energy into electrical energy which is processed in the electronic circuitry to provide the record. The built in thermal printer provides the printout containing calculated, predicted and percent predicted values of all lung parameters. Before taking the record the subjects were fully assured, thoroughly familiarized with the apparatus and demonstration was given to them to perform the test. The nose clip was attached to the subjects and clean mouth pieces were pushed in the transducer assembly for each subject. Two maneuvers (FVC & MVV) were required to accumulate the volume data and the flow rate.

FVC Test – The subjects were asked to exhale through the mouth piece with full force after forceful inspiration. The parameters FVC, FEV1, FEV3, PEFR were displayed on the LCD.

MVV Test—the machine was switched to MVV Test mode and time period was selected. The subject was

asked to inhale and exhale through the mouth piece of the transducer for the selected time period. After the maneuver print out of the result was taken.

Forced Vital Capacity (FVC)- It is the maximum amount of air exhaled forcibly and rapidly after forceful inspiration.

Forced Expiratory Volume in 1 second (FEV1) - It is the volume of air which is expelled from the lungs in the first second of FVC.

FEV1/FVC% - It is the ratio of forced expiratory volume in 1 second to forced vital capacity expressed as percentage.

Peak Expiratory Flow Rate (PEFR)- It is the maximum expiratory flow rate.

Forced Expiratory Flow Rate 25-75% (FEFR25-75%) It is the mean expiratory flow rate at 50% of FVC.

Maximum Voluntary Ventilation (MVV) – It is the largest volume of air that can be moved in and out of the lungs per minute by maximum voluntary effort.

The mean and standard deviation of each of the variables was determined. The mean value between subjects and controls was statistically analyzed by Student's unpaired t-test. The p value ≤ 0.05 was considered statistically significant.

4. Results

Table 1: Mean values of anthropometric parameters among subjects and control

Anthropometric parameters	Subjects (n= 50)	Control (n=50)	Statistical Inference
Age	42.37±5.09	42.88±5.30	P=0.5
Weight	61.61±8.86	64.64±12.22	P=0.24
Height	154.89±6.47	154.12±6.15	P=0.49
Body Surface Area	1.10±0.14	1.18±0.16	P=0.13

Table 2: Mean values of lung function parameters among subjects and control

Lung Function parameters	Subjects (n= 50)	Control (n=50)	Statistical Inference
FVC	3.02±0.68	3.10±0.30	P=0.34
FEV1	2.20±0.81	2.86±0.21	P=0.05*
FEV1/FVC%	88.97±20.74	92.24±4.43	P=0.21
PEFR	5.84±1.81	6.63±1.88	P=0.03*
MVV	99±32.80	100±26.98	P=0.1
FEF 25-75%	4.00±1.45	4.01±0.88	P=0.76

*- Statistically Significant

Table 1 demonstrates statistically insignificant relationship between age, weight, height and body surface area between subjects and controls.

Table 2 demonstrates the mean values of lung function parameters between subjects and controls.

The mean value of FVC in subjects was lower but was statistically insignificant. The mean value of FEV1 in subjects was lower than controls and was statistically significant when compared with controls (p=0.05). The mean value of FEV1/FVC% was lower in subjects but varied insignificantly with controls (p=0.21). The mean value of PEFR was less in subjects than controls and varied significantly with controls (p=0.03). The mean value of MVV and FEF 25-75% was comparable between subjects and controls and varied insignificantly (P=0.1).

5. Discussion

The lung consists of large conglomerate of minute expansile air spaces that ventilate to the atmosphere through a complex of arborized airways.[6] The maximum capacity of lungs to ventilate depends upon two factors: first factor being total volume of gas which can be displaced by a single maximal respiratory effort, the second factor is the speed at which the volume can be exhaled. The speed depends upon two resistance factors: the resistance offered by the respiratory passages to the flow of air and the resistance offered by the lung and thorax to a change in their shape incidental to breathing. Normal ventilatory function depends on both adequate ventilatory function and on absence of abnormal resistance factors.

Pulmonary function tests are non invasive diagnostic tests that provide measurable feedback about function of lungs. The present study evaluates the effect of passive smoking on lung function test in females exposed to smoke for 10 years. The parameters recorded were FVC, FEV1, FEV1/FVC%, PEFR, MVV, FEF25-75%. The lung function parameters recorded were compared between subjects and controls. In the present study, the mean value of FEV1 is 2.20±0.81in subjects and 2.86±0.21 in controls and the difference between them was statistically significant(p=0.05). The mean value of PEFR was also statistically significant (p=0.03). Rest of the lung function parameters viz. FVC, FEV1/FVC%, MVV and FEF25-75% were statistically insignificant.

The study conducted by Bird and Staines[7] demonstrated that exposure to second hand smoke in adolescence leads to increased respiratory symptoms and reduction of pulmonary test values. Our results are consistent with finding of Masjedi et al[8] showing negative association between passive smoking and lung function among men but not women. The study conducted by Ayle et al[9] demonstrated that passive smoking significantly increases the peripheral resistance and adversely affects the lung function in pre-school children born late preterm. The study conducted by Sherrill et al[10] on longitudinal effect of smoke exposure including parental smoking on lung function in a cohort of New Zealand between the age group of 9-15 years demonstrated persistent but mild and non progressive impairment of FEV1/FVC % ratio in males. In children with

reported wheeze, parental smoking has progressive, more serious and clinically significant effects on FEV1/FVC% ratio among adolescents of both sexes causing a mean reduction in FEV1/FVC% ratio by age 15 of 3.9% in males and 2.3% in females.

Forced Vital Capacity is the most important pulmonary function test sensitive to diseases that affect the lung elasticity and its mechanical properties.[11] Forced Expiratory Volume in 1 second provides an indication of expiratory power and overall resistance to air movement in the lungs. Normally 80% of the vital capacity can be expelled in 1 second. FEV1 is the reliable indicator to distinguish between obstructive and restrictive disease. FEV1/FVC% ratio is more important index than FVC alone allowing separation of patients with ventilatory abnormalities into obstructive or restrictive disease. In obstructive disease the ratio of FEV1/FVC% is reduced (FVC normal and FEV1 decreased) and in restrictive disease FEV1/FVC% ratio is increased (FVC is reduced more than FEV1).[12] MVV measures the status of respiratory muscles and compliance of lungs. PEFR is the maximum expiratory flow rate. FEF25-75% reflects the behavior of small and large airways.

Second hand smoke also called environmental tobacco smoke or passive smoke has been reported to be more toxic and carcinogenic.[13] According to the recent human studies, even 1 hour second hand smoke exposure can induce a significant decrease in FEV1 and FEV1/FVC% ratio along with cytokine release such as interleukin 1, β4, 5 and 6, tumour necrosis factor, α and γ interferon in the lungs suggesting significant lung inflammation.[14] These findings do not implicate that second hand smoke provoked decrement in lung function will lead to the development of COPD. However adverse effects of second hand smoke exposure in lung function develops regardless of exposure duration. The present study demonstrates statistically significant decline in FEV1 in female subjects exposed to passive smoke for 10 years. The FEV1/FVC% is decreased in female subjects but is insignificant. The PEFR in passive smoker female subjects declined significantly. Smoking in an enclosed area increases the risk of exposure to passive smokers of respirable particles predominantly nicotine and others like Carbon monoxide, nitrogen oxide etc. the effect of active smoking on non smokers in household, offices, workplaces, colleges depend on indoor air quality which further depends upon the number of smokers, intensity of smoking, size of indoor space, ventilation of indoor with outdoor space and use of air purifiers. Tobacco smoke inside an enclosed room tends to hang in the midair rather than disperse. Hot smoke rises but tobacco smoke cools rapidly which stops its upward climb and smoke descends. A person who smoke heavily indoors create low lying smoke cloud that other householders have no option but to breathe in. Chemicals in second hand smoke damage eyes, nose, throat and lungs. The passively exposed smoke causes hypertrophy and hyperplasia of mucous glands. The mucus secretion increases the mucousal permeability against allergens. As a result chronic inflammation of smaller airways leads to infiltration of cells, mucus clogging and swollen airways that leads to bronchial obstruction. The chronic exposure to passive smoke increases the peripheral airway resistance and expiratory airway obstruction leading to diminished FEV1, PEFR, FEV1/FVC%. The high exposure due to frequent smoking in small indoor spaces with lower rate of ventilation predisposes female household to the passive smoke. The present study demonstrates significant decrease in FEV1 and PEFR while FEV1/FVC% ratio though decreased in female subjects but is insignificant.

The second hand smoke exposure in female subjects points towards obstructive pattern of symptoms with passive smoke exacerbating the lung function changes like active smoker. High rate of smoking is found in men who spend more time at home because of unemployment and increases the exposure among females being in close association with them. Health care providers have a central role in educating the adult smokers to provide smoke free environment at home. The inviolability and sanctity of family restricts the ability of government action to diminish passive smoke exposure at home. However the government is authorized for stringent action and laws pertaining to smoking at public places. The governmental action and enforcement of strict laws with punishment can restrict the smoking and second hand smoke exposure at public places.

6. Conclusion

Chronic passive smoking is ambiguous to active smoking and its deleterious effects on lung point towards the obstructive pattern in the airways with smoke precipitating airway inflammation and blockage. Females being predominantly exposed to second hand smoke at home are likely to remain asymptomatic till significant pulmonary damage results viz. regular monitoring of lung functions is desirable.

We conclude that passive smoking is a major contributing factor to the development and persistence of air flow limitation.

7. Source of Funding

None.

8. Conflict of Interest

The authors declare no conflict of interest.

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