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EXERCISE INDUCED BRONCHIAL LABILITY IN NORMAL MEN AND WOMEN - A COMPARISON

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Abstract: Normal male (n=29) and female (n=39) medical students with a mean age of 19.2 years who were nonsmokers, with no personal history of allergy were studied. The bronchial lability was assessed from peak expiratory flows and forced expiratory spirograms taken before, during and upto 45 minutes after a standard exercise using the Harvard steps. Women had a significantly lower ($P<.001$) resting FVC, FEV1, FEF 25-75% and PEF as compared to men. Although the exercise lability index was not significantly different in men and women, the latter showed a greater percent increase ($P<.02$) and a lesser percent decrease ($P<.02$) of PEF during and after the exercise respectively. They also showed a significantly ($P<.005$) faster recovery to normal. These results suggest that airway dynamics may be better in women than in men. This could account for the lower incidence and morbidity from respiratory allergic disease seen in women as compared to men.

Key words : bronchial lability exercise lability index pulmonary function

INTRODUCTION

Along with industrialisation, the prevalence of allergy and asthma is on the rise globally (1, 2). Interestingly, it has been found that the incidence, morbidity and mortality due to allergy and asthma is less in females than in males (3, 4, 5). Evidence from studies done in our laboratory and other published work indicate that airway function and responsiveness may be different in men and women. Cohort studies done in our laboratory show that men have a greater age related decline in flow rates as compared to women (6). The incidence of chronic bronchitis has been shown to be less in female smokers as compared to their male counterparts (7). Boys have been shown to have a greater tendency to wheeze with viral respiratory infections as compared to girls (8). But the reason for this difference in bronchial responsiveness is not known. One of the useful tests used in clinical practice for the study of bronchial responsiveness is the provocation test. While methacholine, histamine and exercise are all used (9), exercise testing has the advantage of not only being physiological but also being capable of reflecting both the dilator and constrictor ability of the bronchi. Hence the present study was undertaken to compare the exercise induced bronchial lability in normal men and women and to identify the differences if any.

METHODS

Preclinical medical students of the Christian Medical College formed the subjects. Smoking history and personal history of allergy with special reference to respiratory allergy was taken and those who were smokers and those who were allergic or asthmatic according to Broder's criteria (10) were eliminated from the study. An informed consent was obtained and the subjects (men-29; women-39) were assessed during the same time of year and at the same time of day to avoid possible seasonal and diurnal variations. It was ensured that all subjects were normal at the time of testing and at least 6 weeks prior to it. Forced expiratory spirograms were obtained using the Collins respirometer and peak

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expiratory flows (PEF) using the Wright peak flowmeter. The forced vital capacity (FVC), forced expiratory volume in one second (FEVI%), FEVI expressed as a percentage of FVC (FEVI%), forced expiratory flows at 25% and 75% of FVC (FEF 25-75%) and volume compensated flow (FEF/FVC) were obtained from the spirograms and expressed at BTPS. The height and weight were also recorded.

For assessing the bronchial lability, the subjects stepped up and down a height of 25 cms, 30 times per minute for 6 minutes (an intensity sufficient to raise the heart rate to an average of 140 beats per minute) (11), PEF was measured before the exercise, 3 minutes after start, soon after and every 5 minutes upto a maximum of 45 minutes after end. Five readings were taken each time and the average of the highest three calculated. Forced expiratory spirograms were obtained before the exercise and 1 and 11 minutes after end. The subjects were required to make at least 3 satisfactory forced expiratory vital capacity manoeuvres. The spirogram with the highest sum of FVC and FEVI was analysed (12). Bronchial lability was then determined using the exercise lability index (ELI) (13). This was calculated as the difference between the highest and lowest values of a parameter expressed as a percent of the initial value for that parameter. ELI was calculated using PEF, FEVI and FEF 25-75%. From the ELI, % rise (dilator component) was calculated as highest - initial value/ initial value × 100 and % fall (constrictor component) as lowest - initial value/ initial value × 100. Statistical analysis was done using the student test and Chi square test.

RESULTS

The mean age, height, weight and pulmonary function of the subjects are given in Table I. As expected height and weight were significantly greater in men (P<.001). There was no significant difference between the ages of men and women. Resting FVC, FEVI, FEF 25-75% and PEF were higher in men (P<.001). On exercising, the women had a significantly greater %

TABLE I : Physical characteristics, preexercise pulmonary function and ELI-PEF.

	Men (n = 29)		*Women (n = 39)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Age, yrs.	19.0	1.10	19.5	1.06
Height, cms.	172.9	5.10	158.0*	7.16
Weight, kgs.	62.0	10.50	49.5**	6.80
FVC, 1.	4.26	0.48	2.74**	0.47
FEVI, 1.	3.75	0.43	2.47**	0.40
FEVI %	88.5	5.77	90,5	6.16
FEF 25-75%, 1/sec	4.66	1.26	3.30**	0.82
PEF, 1/min	545.9	60.33	399.4**	47.55
FEF/FVC	1.11	0.32	1.22	0.32
ELI-PEF% rise	1.89	2.55	3.54*	2.88
ELI-PEF% fall	5.41	2.76	3.44*	3.37

*P<.02
**P<.001

increase in PEF during exercise and lesser % decrease throughout recovery (Fig.1). By 30 minutes 63% of women had recovered to baseline as compared to only 28% of men (X^2 test = 7.91; P<.005). Even at the end of 45 minutes 45% of men had not recovered as compared to only 20% of women. While the ELI-PEF was not significantly different between men and women, men showed a greater constrictor (P<.02) and lesser dilator component (P<.02) of ELI-PEF (Fig.2). Greater dilator component was also seen in ELI-FEVI and ELI-FEF 25-75%, although these were not statistically significant.

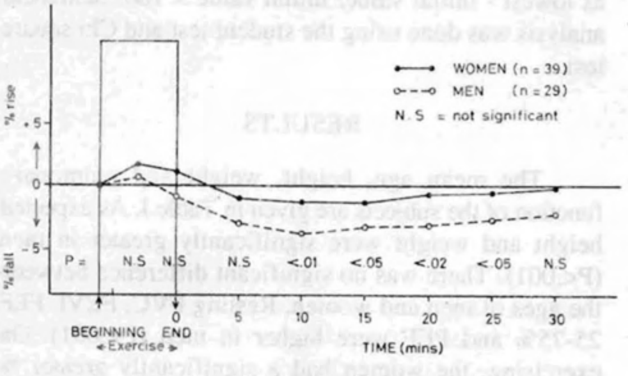

Fig. 1: % change in PEF during and after the exercise challenge in normal men and women. (The zero line represents the level of preexercise PEF. The level of significance of the difference between men and women at each point are indicated.)

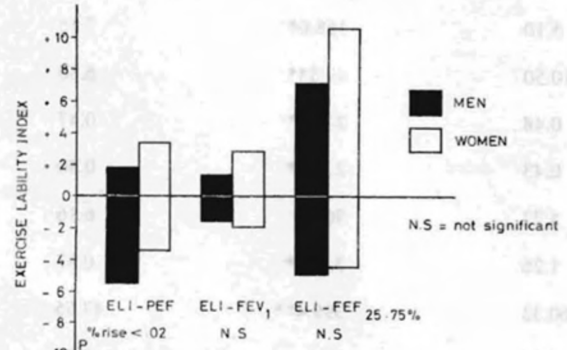

Fig. 2: Bronchial lability and its components in normal men and women. (The zeroline represents the preexercise flow rates and values above and below this line indicate the % rise and % fall in flow rates in response to exercise challenge. The level of significance of the ELI differences between men and women are indicated).

DISCUSSION

This study shows that the lung volumes and flow rates in men are significantly higher than in women. FVC, FEVI and PEF have been shown to be higher in men even after adjusting for height and weight (6). These differences between men and women may be attributed to the better development of chest muscles in men. Interestingly, flow rates that are compensated for lung volume, such as FEV% and FEF/FVC are greater in women. Published reports in the literature support this finding (14,15). This suggests better airway function in women. Clinical evidence also supports this view. It has been reported that viral respiratory infections have a greater tendency to produce wheezing in boys than in girls (8).

Epidemiological studies also have demonstrated greater small airway dysfunction in men than in women (7, 16). The influence of female sex hormones on the airways may account for these differences. Progesterone has been shown to have a smooth muscle relaxant effect (17) and therefore may have a bronchodilator action. Moreover, it is also known that female sex hormone levels can affect a number of biological factors that can modify airway calibre such as prostaglandin metabolism (18), lung adrenoceptor density (19) and leukocyte function (20). Hence it is possible that in females, a better functional status of the airways is maintained by an interplay of all these mechanisms.

With a short bout of exercise, the response of the normal bronchi is biphasic (11). There is an initial dilatation followed by constriction. Both the men and women in this study demonstrated this typical response (Fig.1). The exact cause for this biphasic response is not definitely known. It is postualted that the initial bronchodilatation may be related to an increase in sympathetic activity (21). It has also been attributed to the release of bronchodilator neuropeptides like vasoactive intestinal peptide and nitric oxide from nonadrenergic noncholinergic nerves (NANC) (22, 23). The postexercise bronchoconstriction has been attributed to various reasons. The dry, cold air inspired during exercise can stimulate thermally active receptors with resultant bronchoconstriction (24). Airway smooth muscle contraction may also be brought about by increased parasympathetic activity, by antidromic reflexes and through NANC nerves which release excitatory neuropeptides like nuerokinins and substance P (22). Bronchoconstriction may also be caused by mediators like prostaglandins and leukotrienes released from locally resident cells (such as mast cells) or cells brought to the airways by the circulation (such as basophils, eosinophils and neutrophils) (24). All these mechanisms may influence bronchomotor tone directly and/or indirectly by producing changes in vascular tone and permeability (8, 22, 23, 24). Thus an interplay of several complex mechanisms that regulate airway calibre and its response to stimuli may be operative in inducing this biphasic response.

Our study also shows that this bronchial response to exercise differs qualitatively in men and women. Women have a greater increase and lesser decrease in flow rates as compared to men (Fig. 1&2), indicating a greater degree of bronchodilatation and less of bronchoconstriction. This difference may be due to the modulation exerted by the female sex hrmones on the various interactive mechanisms that cause the bronchomotor changes. If so, one would expect variations in the response to exercise in women, due to cyclic variations in their sex hormone levels. This view is strengthened by our finding that the bronchomotor response to exercise is more variable in women than in men and that in 11 of our subjects (10 females as compared to only 1 male), there was only a bronchodilatation but no postexercise bronchoconstriction for upto 30 minutes after exercise. An earlier study done in our laboratory showed that expiratory flow rates changed significantly during the menstrual cycle (25). Other studies too indicate that there are changes in airway responsiveness during the menstrual cycle (26, 27). Thus, this greater variability could be due to the changing level of female sex hromones with the phases of the menstrual cycle.

The greater capacity of the bronchi in females to dilate, seems advantageous as it has been shown that high lability of bronchi is associated with the best chance of improvement in asthmatic subjects (28). It has also been shown that there is less pulmonary function decline in those smokers (29) and respiratory allergics (30) who have greater bronchial lability. The higher lability seen in women could thus account for the low incidence and morbidity due to allergic respiratory diseases seen in them. Our findings indicate that these sex differences in bronchial response and lability may have to be considered in the prescription and maintenance of therapeutic regimens for obstructive airway diseases.

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