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Gender based comparative evaluation of pulmonary function tests

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Abstract
Background: The dynamic ventilatory tests actually depend upon the speed and efficiency with which filling and emptying of lungs take place and not upon the actual size or range of movements. Dynamic tests proved to be more informative than the static one.
Objective: To compare the results of pulmonary function test among males and females.
Methods: Present study was carried out on one hundred eighty five young adults of both sexes belonging to 17 to 22 years of age group. All sampled young adults were examined clinically carefully for all the systems especially respiratory. Mean values along with S.D. for all variables were analyzed. Statistical analysis was done using students “t” test and p value of less than 0.05 was considered as statistically significant.
Results: All lung functions variables except FEV .5/FEV % and FEV1/FEV% were significantly higher in males in comparison to their female counterparts.
Conclusion: M.V.V. is a good measure of the overall function of the lung especially as it is also related to the ability to increase the ventilation during exercise. The pulmonary function test values were significantly more among males as compared to females. There was an increase in all lung functions values in luteal phase.

Keywords: Yoga, Outdoor and/or Indoor Games, Comparative Evaluation.

Introduction
Earlier investigation of lung functions was mostly confined to the measurement of vital capacity which was considered a very good test of pulmonary functions, expiratory reserve volume, inspiratory reserve volume, tidal volume, residual volume, functional residual capacity were also commonly considered as lung function tests. These tests all together are said to be static. Maximum Voluntary Ventilation is a dynamic test for testing pulmonary functions. Now-a-days many tests have evolved to be included in dynamic lung function tests. Forced vital capacity and flow rates at different points of force vital capacity and volume in 0.5, 1, 2 or 3 seconds of forced expiration are some of them. This transition from static to dynamic was very slow. The dynamic ventilatory tests actually depend upon the speed and efficiency with which filling and emptying of lungs take place and not upon the actual size or range of movements. Dynamic tests proved to be more informative than the static one.(1)

Lung functions are dependent on many other factors like birth weight, pollution in area of residence, smoking habits (both active and/or passive smoking) of households, level of physical activities etc. Therefore variations in lung functions are also unavoidable. Taking into considerations the above points and as per recommendations of a study group set up by World Health Organization (W.H.O.) in 1957, that for getting a detailed picture of any health problems or disease of any origin, more and more such studies needs to be undertaken.(2,3) Hence the present study has been with the objective to study the efficacy of Maximum Voluntary Ventilation is a dynamic test for testing pulmonary functions.

Material and Methods
The present cross sectional study was carried out at Department of Physiology, MGM Medical College, Indore. Institutional Ethics Committee permission (Ethical number: MGMMC/Ethics Committee/2004/23. Dated: 12-09-2004) was taken prior to the study. Present study was carried out on one hundred eighty five young adults of both sexes belonging to 17 to 22 years of age group. A total of 220 subjects participated out of which 185 were eligible as per the eligibility criteria. Overweight or underweight, very tall or short, undergoing hormonal treatment, females with history of irregular menstrual cycles was excluded. Informed consent was obtained from all eligible subjects. All sampled young adults were examined clinically carefully for all the systems especially respiratory.

Procedure for test administration: Test was conducted from 10 a.m. to 2 p.m. in quiet and comfortable atmosphere in two steps.

(a) Preparation: Before subjecting the participants for test, it was ensured that-
1. He or she was not wearing tight or restrictive items such as tight belts, neck-tie, etc.
2. Sterilized, clean mouthpiece was used in measuring system for every sampled individual.

(b) Test administration:
1. Simple and clear i.e. well explained instructions were passed on to the subjects followed by demonstration.
2. FVC (forced vital capacity) and MVV (maximum voluntary ventilation) tests were performed on each subject in sitting position. Instrument used was Medspiror manufactured by Medicaid systems, Chandigarh.
3. During both maneuvers nose was kept closed.
4. Chin was slightly elevated and neck was slightly extended.
5. After deep inspiration subject was asked to exhale into the mouthpiece as forcibly as possible in FVC test. This test was done three times and the highest value was noted down.
6. Subject was asked to breath for 10 seconds as rapidly and deeply as possible in MVV test.
7. The above tests in females were conducted - once in follicular phase from 8th to 10th day of menses and gain from 20th to 22nd day i.e. in luteal phase. Calculation of the phases was done from dates of last menstrual period.

Variables studied were: Forced vital capacity (FVC) in liters, Forced expiratory volume in ½ second (FEV .5) in liters, Forced expiratory volume in 1 second (FEV 1) in liters, Peak expiratory flow rate (PEFR) in liters/sec, Mean forced expiratory flow during the middle half of FVC (FEF 25-75) in litres/sec, Forced expiratory flow after 25% of FEV has been expired (FEF 25%) in litres/sec, Forced expiratory flow after 50% of FVC (FEF 50%) in litres/sec, Forced expiratory flow after 75% of FEV (FEF 75%) in litres/sec, Forced expiratory volume in 0.5 seconds to forced vital capacity ratio expressed in percentage (FEV.5/FVC), Forced expiratory volume in 1 second to forced vital capacity ratios was expressed as percentage (FEV1/FVC), Maximum voluntary ventilation (M.V.V.) in litres/min.

Statistical Analysis: All the data thus collected was entered and analyzed with the help of SPSS (version 17) software. Students "t" test was used for analysis and p value of less than 0.05 was considered as statistically significant.

Results

Table 1: Pulmonary function tests of males and females (n=185)

Variables	Males (n=104)	Females (n=81)	t value	p value
FVC (liters)	3.40±0.48	2.29±0.33	26.70	0.0000001 (S)
FEV.5 (liters)	2.56±0.34	1.73±2.08	17.00	0.0000001 (S)
FEV1 (liters)	3.19±0.40	2.21±0.35	18.06	0.0000001 (S)
PEFR (liters/sec)	8.30±1.36	4.92±1.33	17.70	0.0000001 (S)
FEF25-75 (liters/sec)	4.29±1.05	3.06±0.72	8.70	0.001 (S)
FEF 25% (liters/sec)	7.19±1.37	4.57±1.23	13.50	0.000001 (S)
FEF 50% (liters/sec)	4.79±1.13	3.46±0.87	8.40	0.000001 (S)
FEF75% (liters/sec)	2.52±0.90	1.93±0.56	4.77	0.00001 (S)
FEV.5/FEVC%	75.37±9.38	75.92±9.83	–0.38	0.6989 (NS)
FEV1/FEVC%	93.91±5.71	95.96±5.54	–2.42	0.01505 (S)
M.V.V. (liters/min)	148.63±20.18	92.25±18.93	19.94	0.0000001 (S)

NS = Not significant, S = Significant

From the above table it is seen that all the pulmonary function test values were significantly more among males as compared to females except for FEV.5/FEVC% which was not significant.

Table 2: Pulmonary function tests during follicular and luteal phases of menstrual cycle (n=81)

Variables	follicular phase(n=81)	luteal phases (n=81)	t value	p value
FVC (liters)	2.29±0.35	2.39±0.34	-1.84	0.06697 (NS)
FEV.5 (liters)	1.75±0.27	1.85±0.26	-2.4	0.01749 (S)
FEV1 (liters)	2.20±0.32	2.31±0.31	-2.22	0.02768 (NS)
PEFR (liters/sec)	5.00±1.25	5.59±1.05	-3.25	0.001394 (S)
FEF25-75 (liters/sec)	3.08±0.69	3.20±0.69	-1.1	0.2701 (NS)
FEF25% (liters/sec)	4.60±1.19	5.02±1.02	-2.4	0.01701 (S)
FEF50% (liters/sec)	3.50±0.81	3.63±0.86	-0.99	0.3235 (NS)
FEF75% (liters/sec)	1.92±0.54	1.87±0.51	0.6	0.5455 (NS)
FEV.5/FEVC%	76.51±9.79	77.20±8.17	-0.48	0.6269 (NS)
FEV1/FEVC%	95.95±5.65	96.26±3.93	-0.4	0.6857 (NS)

M.V.V. (liters/min)	91.09±18.70	98.33±15.54	2.36	0.008164 (S)

NS = Not significant, S = Significant

There was an increase in all lung functions values in luteal phase except in FEF75% in comparison to follicular phase. On statistical analysis increase in FEV.5, PEFR, FEF25% and M.V.V. was found statistically significant (p value <0.05).

Discussion

It was found that FVC for males was significantly higher as compared to females i.e. 3.40±0.48 liters vs. 2.29±0.33 liters ($p < 0.001$). The may be attributed to the greater respiratory muscle strength of males. Males have more number of alveoli per unit area as compared to their female counterparts and their alveoli are larger and have greater compliance.[4,5]

The mean value of FVC in the present study for males were more or less similar to values recorded by Singh SK et al[6] and Talsania RC et al.[7] Bhargava RP et al[8] and Mazumdar BN et al[9] noted higher values, while Mahajan K et al,[10] Jain SK et al,[11] Mathur KS et al,[12] Gupta S et al[13] noted higher values for FVC in their study in comparison to noted by net only.

FEV.5 for males were 2.56±0.34 litres and for females 1.37±0.28 litres. This difference was found statistically significant (t value 17 and p value < 0.001). While FEV.5/FVC percent were found equal for both males and females. Mean value noted were 75.37±9.38 and 75.92±9.83 respectively for males and females. As comparison of FEV1 and FEV1/FVC percent are of better significance. There is scarcity of literature about FEV.5 and FEV.5/FVC percent.

Mean values for FEV1 for males and females in the present study were 3.19±0.40 and 2.21±0.35 litres respectively. On statistical analysis, the difference was found significant (t value 18.06 and p value <0.001). The mean value for male was slightly higher in comparison to findings by Singh SK et al[6] The reason may be that their subjects were older with mean age of 2.4 years in comparison to the subjects of the present study. Mathur N et al[14] found in their study that there was an increase in the FEV1 up to 25 years of age and then gradually it decreased. Kuppu Rao et al[15] found higher values (3.54 litres) in comparison to the findings of the present study. This may be because of subjects in their were sports persons and it is a established fact that sports persons have better lung function in comparison to an average person.

As far as FEV1/FVC is concerned proportion for males was 93.91±5.71 and for females 95.96±5.54. This higher proportion in females was found statistically significant (t value 2.42 and p value <0.05). Mathur KS et al[12] and Bhargava RP et al[8] in their studies noted higher value for females which were more or less in accordance with the findings of the present study. This difference in the values of male and female may be due to narrowing of the airways which occurs during expiration, being relatively more pronounce in males than in female, hence airways in males are less supportive. Cotes JE[16] in his publication mentioned that complete closure of the airways also occurs at a larger lung volume in men with the result that their residual volume is also more than that of women.

MVV for males and females respectively were 148.63±20.18 litre/min and 92.25±18.93 litre/min. The t value for this difference was 19.94 and on highly significant difference of < 0.001 p value. The findings of the present study was more or less similar to the findings of Kuppu Rao et al,[15] Jain SK et al,[11] Bhargava RP et al,[8] Mahajan KK et al.[10] While values noted by Singh SK et al,[6] Khandare SS et al,[17] Gupta S et al,[13] Mathur KS et al[12] and Kasliwal RM et al[19] were lower in comparison to the present study. The findings of Talsamia RC et al[7] and Quazi IR et al[18] were higher in comparison to the findings of the present study. The probable reason may be the difference in anthropometric measurement, their different level of physical activity and may be because of different tools which were used for measuring the variables.

It is essential to detect and treat respiratory obstruction at an early and reversible stage for the prevention of permanent damage. We observed that PEFR was 498 litre/min (8.30±1.36 litre/sec) for normal male in comparison to 295.2 litre/min (4.92±1.33 litre/sec) for normal females. These findings were more or less similar to the findings of Mahajan KK et al,[10] Mailk SK et al.[19] While Dikshit MB et al[4,5] and Das KK et al,[20] Gupta S et al[13] and Singh SK et al[6] noted higher PEFR values in comparison to the present study while findings of Kuppu Rao et al[15] was lower than the findings of the present study.

All the flow rates were higher in males than in females with p value < 0.001. Larger airways and stronger respiratory muscles males are responsible for higher flow rates.

FEF 25-75 in the present study were higher than the findings of Mathur KS et al,[12] Jain SK et al,[11] Gupta S et al[13] and Walter et al[21] while the findings of Bhargava RP et al[8] and Mahajan K et al[10] showed higher values in comparison to present study.

81 female subjects who were having regular menstrual cycles, at least for last two months were taken on sample for lung functions. Their lung functions were recorded twice i.e. once in follicular phase and again luteal phase. It was revealed that there was an increase in all lung functions values in luteal phase except in FEF75% in comparison to follicular phase. On statistical analysis increase in FEV.5, PEFR, FEF25% and M.V.V. was found statistically significant (p value <0.05). Functional lungs are able to adapt the metabolic need of the body and accordingly the lung function varies during different conditions. Since hormonal level also varies as

per the metabolism, any variation in the female gonadal hormone during different phases of menstrual cycle exerts corresponding changes in the lung functions.

These findings of the present study were more or less consistent with the findings of Rajesh CS et al[22] and Pai SR et al.[23] The most possible cause for an increase in pulmonary function parameters during luteal phase of menstrual cycle in the hyperventilation associated with increased progesterone secretion Pai SR et al.[23] Periodic hyperventilation during exercise improves respiratory muscle strength and lung capacity. Progesterone induces hyperventilation through both the central medually and peripheral receptors and the sensitivity of the respiratory receptors during the luteal phase. Progesterone also causes relaxation of smooth muscles especially of reproductive and gastrointestinal system.[22] These mechanism are collectively responsible for better lung functions in luteal or secretary phase of menstrual cycle. Resmi SS et al[24] also expressed the similar views.

Conclusion

M.V.V. is a good measure of the overall function of the lung especially as it is also related to the ability to increase the ventilation during exercise. The pulmonary function test values were significantly more among males as compared to females. There was an increase in all lung functions values in luteal phase.

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