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COULD THE DIFFERENCE IN RESPIRATORY MUSCLE POWER EXPLAIN GENDER VARIATION IN LUNG FUNCTION?

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Abstract-* Few studies have been done to explain gender difference in lung function and none was conclusive. This study questions whether there is a gender difference in respiratory muscle power and its correlation with the lung function values. The study included two groups of University students 25 males and 25 females matched for age, height and weight. They were of the same ethnic class, socio-economic status and perfect health. Height and weight were measured using standard scales. Lung Function Tests (FVC, FEV_1 & PEF) were performed using a digital spirometer and maximum inspiratory and expiratory pressures (MIP &MEP) as indicators for respiratory muscle power were measured using a digital Respiratory Pressure Meter. Data were analyzed using SPSS software and independent t- test was used to compare the mean difference in results. The mean FVC (L), FEV_1 (L) and PEF (L/min) were significantly higher in the males group ($p<0.001$). Similarly, mean MEP and MIP (cm/H_2O) were significantly higher in the males group with a significant positive correlation between respiratory muscle power indicators (MEP or MIP) and lung function parameters (FEV_1, FVC and PEF in both sexes ($p < 0.001$, $r = 0.74$). The study concluded that gender variation in lung function is likely explained by gender difference in the power of the respiratory muscles

Keywords- Gender and lung function; Respiratory muscle power; Pulmonary function test

I. INTRODUCTION

Females differ from males in many physiological functions including lung function. These differences become more apparent after puberty. Gender variation in lung function is more evident in lung volumes and capacities involving forced muscle contraction e.g Forced Vital Capacity (FVC), and not obviously observed in resting Tidal Volume (TV) and Residual Volume (RV) [1]. A study by Sitrokovic and Cvoriscec (1995) [2] in male and female school children had noticed significantly higher FVC and FEV_1 values in boys. Similar results were obtained in an Indian population study [3].FEV_1, FVC and PEFR had been found to be higher in boys compared to girls indicating gender variation in lung function. Reference tables for FEV_1, FVC and PEFR take sex, age and height as variables to find the normal predicted values.

I.I CAUSES OF GENDER VARIATION IN LUNG FUNCTION

Few studies have been done to demonstrate the reason behind gender difference in lung function. Frame size as an explanation of race and sex differences in lung function was studied by David et al using the CARDIA (Coronary Artery Risk Development in Young Adults) cohort study in 20 to 32 –year – old black and white men and women. FVC and FEV_1 were standardized for standing height, sitting height, leg height, elbow breadth, and biacromial diameter in such a way that the standardized lung function showed minimal statistical dependence on these measures of frame size. Race and sex differences in lung function have been reported even after adjustment for height. After standardization for height, FVC and FEV_1 were found to be 14 to 19% higher in whites than in blacks and in men than in women. Standardization of FVC and FEV_1 for sitting height, leg height, elbow breadth, and biacromial diameter combined reduced these differences to 13–16%. Thus, race and sex differences in lung function exist even after detailed adjustment for frame size [4].

A study done by Brown et al (1986) in which the pharyngeal cross sectional area had been measured in 24 healthy human volunteers (14 males and 10 females) using acoustic reflection technique. Pharyngeal cross-sectional areas in males and females were compared at three lung volumes: Total Lung Capacity (TLC), 50% of the Vital Capacity (VC) and Residual Volume (RV).The difference in pharyngeal cross- sectional area between males and females was statistically significant at TLC and 50% VC but not at RV. However, when this pharyngeal cross-sectional area was normalized for body surface area, this difference was not significant [5].

Suwatanapongched et al (2003) have studied the variation in diaphragm position on chest radiographs in relation to sex, age, and weight in adults with normal lung function. The diaphragm tended to lower with higher age, lower weight and smaller transverse and antero-posterior thoracic dimensions (as in females).They related the substantial variability in normal diaphragm position to weight, age and thoracic dimensions. The gender variation in diaphragm position has been studied so as to be considered when evaluating chest radiographs for interpretation of abnormalities. The study did not include statistical data to correlate sex difference in lung function to diaphragm position and no anthropometric matching has been done [6].

On a background study on the power of the respiratory muscle during pregnancy by Conteras et al (1991), the power of the respiratory muscle as an explanatory assumption for gender variation was studied by Amir and Musa in 22 Sudanese males and females using a modified sphygmomanometer for measuring expiratory oral pressure in

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both sexes [7]. The promising results of this study have encouraged us to do a proper set-up new study to prove this assumption using a reliable, safe and clinically applicable technique. In addition, both maximum expiratory and inspiratory pressures are included to assess the strength of both inspiratory and expiratory muscles as the previous study did not include the maximum inspiratory pressure.

I.II OBJECTIVES OF THE STUDY

To investigate if the gender variation in lung functions is due to variation in respiratory muscle power by: 1. estimation of respiratory muscle power by measuring the maximum expiratory and inspiratory pressures (MEP &MIP) in two matched groups of both sexes; 2. correlation of the obtained MEP and MIP results with the measured lung function values FVC, FEV1 and PEF.

II. MATERIALS AND METHODS

The study has been performed in two groups of university students 25 males and 25 females matched for age, height, and weight at The National Ribat University in Khartoum, Sudan. The two groups were of the same ethnic class, socio-economic status and perfect health. A British weight and height scale was used to measure weight and height simultaneously at the physiology laboratory. Lung Function Test (FVC, FEV1, and PEFR) was performed to all subjects using a Digital Spirometer Manufactured by Micromedical Limited (UK). The procedure was first explained to the subject ; ensuring that he/she was standing erect with feet firmly on the floor, the subject was asked to take a deep breath (maximum inspiration to the total lung capacity) and expire forcibly and as long as possible into the Spirometer to record FVC and FEV_I. This procedure was repeated three times and the best readings were recorded. The strength of the respiratory muscles was assessed in all subjects under the study using a Respiratory Pressure Meter (MicroRPM). The MicroRPM is a hand held instrument designed for rapid assessment of inspiratory and expiratory muscle strength by measurement of the mouth pressures: Maximum Expiratory Pressure (MEP) and Maximum Inspiratory Pressure (MIP). For MIP test: after fitting the mouth piece the subject was asked to exhale to residual volume then perform a forced inhalation against the MicroRPM with as much effort as possible for as long as possible. For MEP test: the subject was asked to inhale to total lung capacity then perform a forced exhalation against the MicroRPM as maximum and long as possible. Each test was repeated 3 times and the best value was taken. The obtained data were analyzed using SPSS program version 16, Paired T- test was used to compare results and linear regression for correlations. P-value < 0.05 was considered to be significant.

III RESULTS

Fifty subjects were included (25 males and 25 females) matched for age, height, and weight. The mean age (year), height (cm) and weight (Kg) of males group under the study were 20.32 ± 0.80, 167.88 ± 2.99 and 61.36 ± 5.87 respectively while in females group were 20.00 ± 0.6 4, 165.96 ±4.36 and 61.88 ± 7.15 respectively (table -1). The mean FVC (L), FEV1 (L) and PEFR (L/min) was significantly higher in the males group than the females group (p<0.001),) (table-2, fig.1). Similarly respiratory muscle power indicators (Mean MEP and MIP (cm/H2O) were significantly higher in the males group (table-2, fig.2, 3). A positive correlation between FEV1, FVC and PEFR and MEP in both sexes was found (r = 0.58, 0.60 and 0.68 respectively) and with MIP (r = 0.63, 0.66 and 0.74 respectively, P = 0.000) (fig.4).

TABLE -1 MEAN AGE, HEIGHT AND WEIGHT OF THE STUDY GROUPS

Parameter	Sex	N	Mean± SD
Age (Years)	Male	25	20.3 ± 0.80
	Female	25	20.00 ± 0.64
Height (cm)	Male	25	167.88 ± 2.99
	Female	25	165.96 ±4.36
Weight (Kg)	Male	25	61.36 ±5.87
	Female	25	61.88 ±7.15

TABLE-2 MEAN SEX DIFFERENCE IN MIP, MEP, FEV1, PEFR &FVC

Parameter	Sex	N	Mean± SD
MIP (cm/H2O)	Male	25	111.92 ±15.05
	Female	25	73.08 ±12.35
MEP (cm/H2O)	Male	25	143.48 ± 23.83
	Female	25	87.72 ± 20.02
FEV_1 (L)	Male	25	3.68 ± 0.45
	Female	25	2.8 ± 0.36
PEFR (L/min)	Male	25	561.6 ±70.1
	Female	25	389.6 ± 46.68
FVC (L)	Male	25	4.09 ± 0.51
	Female	25	2.93 ± 0.45

(p < 0.001 for all variables)

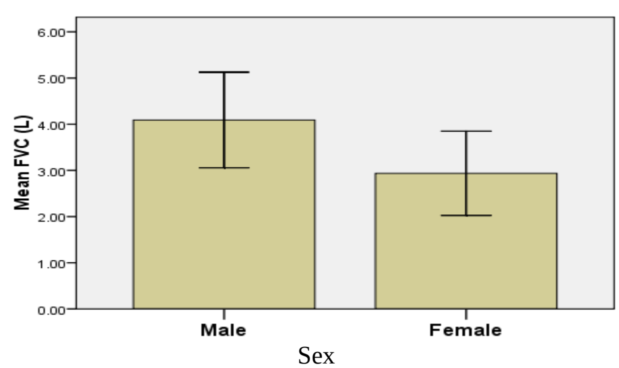

Fig. 1 Mean sex difference in FVC (P < 0.001)

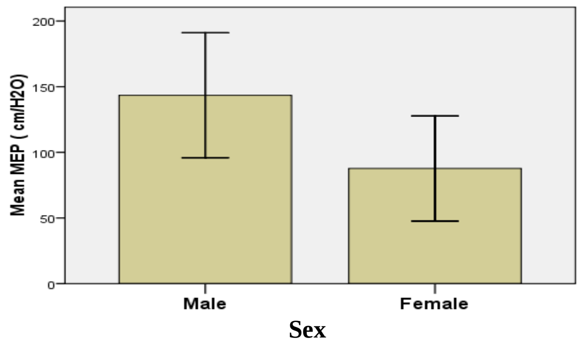

Fig. 2 Mean sex difference in MEP (P < 0.001)

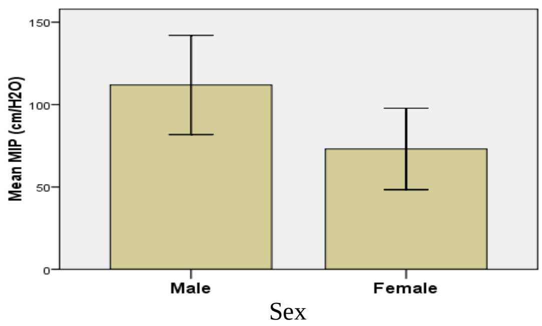

Fig. 3 Mean sex difference in MIP (P < 0.001)

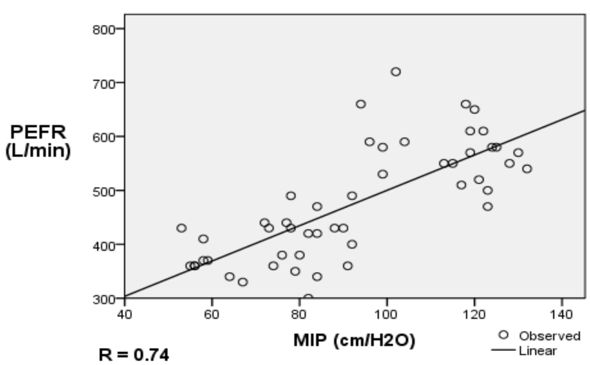

Fig. 4 Linear regression curve estimation for correlation between PEFR and MIP for both sexes (Correlation coefficient r = 0.74, p < 0.001)

IV. DISCUSSION

In the present study, the mean values of FVC, FEV_1 and PEFR in males group were significantly higher (p<0.001) compared to females group. The same results have been reached by Sitrokovic and Cvoriscec (1995) who found that males have significantly higher FVC and FEV1 than females. [3] In the present study, no observable difference has been detected in FEV1/FVC ratio as found by many investigators (Crapo et al, 1990;Paoletti et al, 1986 and Miler et al, 1986) and even some of them have found decreased ratios in males. Rajkappor et al (1997) have detected this sex variation in school children with statistically higher FVC, FEV_1, and PEFR in boys [8-10]. These results could be explained as follows: at rest where expiration is passive, no forced muscle contraction is needed, so the tidal volumes of the females are expected to be closer to those of the males, but because the vital capacity as well as the forced expiratory volume in the first second need forced inspiration as well as forced expiration, any one with stronger respiratory muscles could of course perform better. This is not only applied for sex difference as the males have more abundant muscles than females, but also could explain the variation in lung function between the athletes and the non-athletes.

The absence of a detectable change in FEV_1/FVC ratio between males and females can be explained easily by the fact that, as the FVC decreases, the FEV_1also decreases proportionally in the females.

Many other studies have proved the gender variation in lung function, but few have tried to explain it. Crouse and Laine (1999) have tried to explain the gender variation in lung function by measuring the air flow rate and nasal and oral pressures using rhinomanometry in 214 females and 118 males with an age range of 16 – 82 years. The airflow rates and pressures were significantly higher in males. This study looks very similar to the present study with exactly similar results but the wide range of age may be considered as a limitation factor [11].

Few other studies had tried to explain the difference between males and females of the same age, standing and sitting heights and anthropometric measurements such as chest circumference and none was conclusive.

In the present study, we have demonstrated the most likely cause of this difference using a portable, safe, reliable and clinically applicable technique. The similarity of the two groups in ethnic, socio-economic and anthropometric measures in our study justifies the validity of the results though the sample size was 50 subjects (25 from each group). FVC, FEV_1 and PEF as indicators for lung function were found significantly higher in the males group (p < 0.001). Similarly, MEP and MIP as indicators for power of the respiratory muscle were significantly higher in males with significant positive correlation between MEP or MIP and FEV_1, FVC and PEF in both sexes (r = 0.58 – 0.74, p < 0.001) (table 5-3 and fig.5.4 - 5.11).

Our results were supported by a more recent cross-sectional study by Rocha et al (2011); who have evaluated 28 international-level swimmers with ages ranging from 15 to 17 years,19 (61%) were males. At base line MIP but not MEP was found to be significantly lower in females compared to males (p = 001). Mismatching of the two gender groups might be the cause of insignificant difference in MEP [12] .On the other hand, Measurement of maximal oxygen consumption (VO_{2max}) for both males and females will further support our findings.

V. CONCLUSION

Gender variation in lung function is likely explained by gender difference in the power of the respiratory muscles. MEP and MIP measuring could be applied to study sport variation in lung function suggesting a new factor to be considered in calculating the predicted lung function values as well as explaining low lung function in conditions affecting muscle power.

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