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Body Fat and Fat Free Mass as Reference Variable for Maximum Voluntary Ventilation

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Abstract:*Maximal Voluntary Ventilation (MVV) is a relatively a short tes,t used to evaluate a patient's ability to maintain an elevated minute ventilation. This measures the greatest amount of air someone can breathe in and out during one minute. MVVprovides an estimate of the ventilatory reserves available to meet the physiologic demands of exercise. This test is very patient effort dependent. The study was performed to establish Fat Free Mass (FFM) and Body fat Percent (BF%)as the most important reference variables rather than much used Body Mass Index(BMI). This study was conducted on 150 (85, males;65, females) apparently healthy medical students18-24 years age group. Body fat percentage was assessed using 'Bioelectric Impedance' technique. Correlation of MVV with body composition parameters showed that FFM has highest correlation coefficient with MVV followed by FFMI. BF% showed negative correlation with MVV. BMI and Waist by Hip ratio showed quite lesser correlation than FFM and FFMI.*

I. Introduction:

Maximal ventilatory Volume (MVV) is highly dependent on subject cooperation and effort. For long, we have been using Body Mass Index as reference variable for obesity and lung function. But BMI has important limitation of not distinguishing between Body Fat & Body Fat Free Mass (FFM)[1]. Increased BMI does not clarify that person is overfat or over-muscular.Fat free mass includes muscle, bone, water & blood. Fat percentage is independent of stature and FFM resembles body mass in being correlated with stature. The association is reduced or eliminated by expressing FFM as Fat Free Mass Index[1] (FFMI=FFM/Stature^2).

Various studies have shown the association of elevated BMI with impaired Pulmonary Function Parameters[2,3]. This study is undertaken to assess if correlation of MVV exists with body fat percentage, FFM, FFMI and whether it is possible to establish them as MVV reference variable.

II. Methods

The study was conducted on 150 medical students (85 males, 65 females) aged between 18-24years. All the volunteers were apparently healthy. The experimental protocol was explained to all student volunteers and written informed consent was obtained. The Institutional Ethical Committee has approved the study, conducted between October, 2010 to September, 2012. The study was conducted after a minimum of 2 hours of light breakfast and before lunch.

All anthropometric measurements such as, age sex height and weight were recorded. Body weight was recorded in kilograms on empty bladder and before lunch wearing light weight clothing and bare foot with "Prestige Digital Weighing Scale". Standing height was recorded using "stadiometer" to the nearest 0.1cm. BMI was calculated.

BMI (Quetlet's Index)=Weight (in kg)/{Height(in meters)}^{2}

The body fat percentage was measured by "Bioelectric Impedance" analysis technique using 'OMRON Body Fat Monitor (HBF-306)'. From BF%, FFM (100-Fat% × body weight) and FFMI (FFM/Ht^2) were calculated.

Pulmonary Function were recorded on a window based "Flowhandy ZaN 100 USB & ZaN. GPI. 3xx",Germany. Pulmonary function was recorded according to American Thoracic Society Guidelines[4].

III. Results

The results were analysed using software 'GraphPad Prism Version6.0'.

Anthropometric Parameters (Mean ± Sd): Table → 1.

	MALES(n = 85)	FEMALES(n=65)	p-VALUE
HEIGHT(In cm)	165.55 ± 5.8608	154.1158 ± 6.109	<0.0001
WEIGHT(In kg)	64.706 ± 11.7838	56.8153 ± 11.387	<0.0001
WAIST CIR(In inches)	31.846 ± 2.9081	30.118 ± 4.147	0.0027
HIP CIR.(In inches)	36.984 ± 2.629	35.781 ± 3.853	0.0222
WAIST/HIP RATIO	0.8606 ± 0.04819	0.841 ± 0.061	0.0196
BMI (kg /m^2)	23.5108 ± 3.7207	23.9015 ± 4.4875	0.5556(ns)

BF%	22.946 ± 5.1178	31.14 ± 6.125	<0.0001
FFM (kg)	49.4012 ± 6.7735	38.481 ± 4.816	<0.0001
FFMI (kg /m^2)	17.984 ± 1.9372	16.1866 ± 1.657	<0.0001

($p < 0.05$ is significant)

On ‘Unpaired t-test’ the anthropometric parameters were significantly different for males and females except BMI.BMI is within normal range for both males and females. But the fat percentage is 22.9% in males which is more than the normal range (8-19%) and in females the average value is 31.14% which is within normal range (21-33%)[5].

Maximal Ventilatory Volume In Males & Females (Table→2) :

	MALES	**FEMALES**	**p - VALUE**
MVV (lit/min)	108.218 ± 25.238	98.9523 ± 18.875	0.0138

($p < 0.05$ is significant)

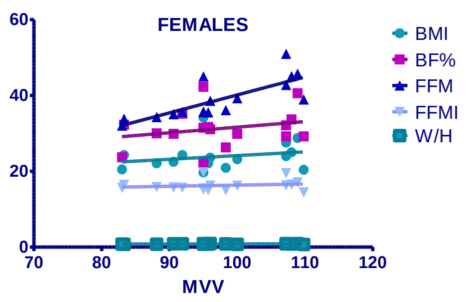
The MVV values are not similar for males and females. ‘Unpaired t-test’ showed significant difference between male and female flow rates. So, the male and female lung function was compared separately to avoid gender related variation.

Correlation Coefficients Of Mvv (Males & Females) Table → 4 :

MVV	**BMI**	**WH Ratio**	**BF%**	**FFM**	**FFMI**
MALES	-0.02285	-0.1535	-0.06797	0.2216	0.05715
FEMALES	-0.2294	-0.3222	- 0.04672	0.3023	0.2897

Table→ 4 shows that FFM & FFMI have positive correlation with MVV in both Males and Females. BF% has negative correlation in both males & females. BMI and W/H Ratio have negative correlation with MVV.

Fig→ 1



Fig→2

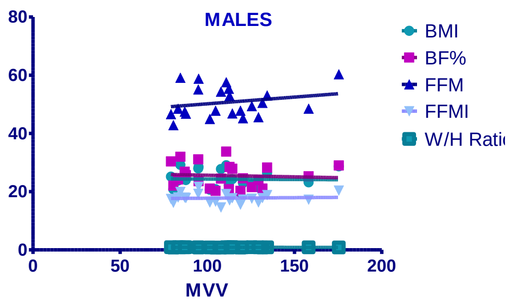


Fig 1&2, on insertion of linear regression equation, show that MVV has highest slope with FFM and negative slope with BF% has negative slope.

IV. Discussion

Correlation coefficients in Table→ 4, proves that increase in Fat Free Mass will increase the subject effort and MVV whereas increase in BF% will decrease the MVV. Though BMI & W/H ratio have negative correlation with MVV, they do not specify which component improves or declines MVV.Inspiratory muscle strength, expiratory muscle strength, compliance of lungs and chest wall, airway resistance also contributes to MVV[6].

Our correlation of MVV with BF% and segmental lean body is same as **Lorenzo and co workers, 2001**[7]and **Joshi AR et al, 2008**[8]who had also observed BF% to have negative correlation with MVV. **Ceylan and co-workers, 2008** [9] negative correlation existed between WHR and MVV which is also similar in our study.

V. Conclusion

MVV shows:

- Positive correlation with FFM & FFMI.
- Negative correlation with BF%, BMI and Waist by Hip ratio.

Making allowances for body composition can improve the accuracy and biological relevance of reference equation for lung function[10]. The use of anthropometric and skinfold measurements has been criticised as being unreliable and inaccurate; they are unable to adequately assess adiposity and are liable to operator bias[11].Limited usefulness of BMI should be taken into consideration and FFM & FFMI should be used as reference variable. Measurement of FFM by 'Bioelectrical Impedance' method is inexpensive, reliable, simple, safe and non-invasive technique for use in lung function laboratories[12]

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