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Original article:

A study to assess the co-relation between chest circumference and maximum voluntary ventilation in healthy adults

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Abstract

The maximum voluntary ventilation (MVV) or maximum breathing capacity (MBC) is the maximum volume of air that can be breathed per minute by voluntary effort.The test of maximum voluntary ventilation (MVV) helps in establishing a clinical diagnosis, assess the prognosis, also assist in quantifying the severity of airway disease. This study was conducted to find a correlation between chest circumference as well as chest expansion with certain spirometry parameters like MVV and Dyspnoeic index which in turn strongly correlate with levels of a person's physical fitness. After explaining the methodology to the subjects,the physiological variables required for the study like chest circumference at maximum inspiration and maximum expiration, chest expansion, MVV and dyspnoeic index were calculated and correlation between these parameters was assessed using the Pearson's correlationcoefficient.Wefound that the chest circumference shows a strong linear correlation with MVV as well as Dyspnoeic index. However the results showed a medium correlation between chest expansion and the MVV as well as Dyspnoeic index values. Our findings suggest that the chest dimensions are a strong determinant of MVV and Dyspnoeicindex values, thus they can be used as pseudomarkers to assess a person's physical fitness.

INTRODUCTION

The maximum voluntary ventilation (MVV) or maximum breathing capacity (MBC) is the maximum volume of air that can be breathed per minute by voluntary effort. [1] MVV test helps in establishing a clinical diagnosis, assess the prognosis, also assist in quantifying the severity of airway disease.[2] In the past several studies have tried to correlate MVV with these anthropological dimensions and most of them have shown positive correlations. [3] The predicted values for MVV which act as a reference for doctors to assess the extent of air way obstruction, lung performance and physical fitness have been derived by taking into account the factors like height,weight, stature and age.[4] However the chest circumference, chest expansion or percentage of expansion has not been considered in deriving these reference values whereas greater chest circumference and chest expansion accounts to greater volume of thoracic cavity which results increased filling of lungs with air.[5] Moreover it isa well-documented factthat the people with larger chest circumference/relative chest size e.g. Gorkhas and other highlanders perform much better during strenuous exercise.[6] And as compared to the people from other communities and same age groups, they are much shorter and leaner.However, the exact relation between theseparameters and MVV is not well established.[7]

Dyspnea is defined by the American Thoracic Society as the "subjective experience of breathing

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discomfort that consists of qualitatively distinct sensations that vary in intensity. [8] Dyspnea is quantified by calculating dyspnoeic index from values of MVV and resting minute ventilation (RMV). The values of Dyspnoeic index less than 60% indicate higher chances for a person to develop dyspnea. [9] Thus higher the value of Dyspnoeic index higher will be the level of a person's physical fitness.[10] In this study, we will try to see if there is any correlation between chest circumference and MVV as well as dyspnoeic index. This will enable us to predict the utility of using chest circumference as predictor of peak physical performance achieved by a person. It will also help improve the efficiency and reliability of reference MVV charts.

AIMS & OBJECTIVES

The aim and objectives of this study are to study the correlation between chest circumferences with MVV, to study the correlation between chest circumference and dyspnoeic index, to find the correlation between chest expansion with MVV and to study the correlation between chest expansion with dyspnoeic index.

MATERIAL & METHODS

Study population: Healthy males between the age groups 18-25 years comprising of MBBS students.

Study Sample: 30 healthy males were selected from the above population randomly by using random number tables.

Inclusion criteria: Adult male students in age group 18-25 who have no known health problem and physically fit and having balanced diet.

Exclusion Criteria: Individuals suffering from or with any history of respiratory diseases, smokers or drinkers, excessively obese or individuals having very low level of exercise tolerance, subjects having chest pain, breathlessness, joint pain, and individuals with any history of exercise training.

Physiological variables recorded: Height (cm), Chest circumference(cm) at the end of maximum expiration and at the end of maximum inspiration, chest expansion (cm), weight (kg), MVV (L/min)– Maximum ventilatoryvolume, RMV (L/min) – Resting minute ventilation and Dyspnoeic index(DI)-DI= [(MVV-RMV)/MVV]X100.

Equipment used: PFT-RMS MedSpiror spirometer - for recording MVV & restingminute ventilation, Stadiometer(LECAWOGELAND HALKE-HAMBURG)-forrecordingheight and weight, and flexible measuring tape– for recording chest circumference & expansion.

Methodology in brief: After explaining the study protocol in brief an informed consent was taken from all subjects. Personal particulars and basic anthropometric measurements was done and recorded on a data entry sheet. All the subjects were instructed to have a good sleep on night prior to the day of test, have breakfast at 0700 hrs on the day of test, report for spirometery testing at 0900 hrs and not to consume either tea or coffee at least 4 hrs before the tests.

OBSERVATION AND RESULTS

In this study we recorded the chest circumference at the end of peak expiration and at the end of peak inspiration as well as spirometry parameters like MVV and RMVin 30 (thirty) healthy young individual of comparable height and BMI. From thevalues of chest circumference the peak chest expansion was calculated, in addition to this we also calculated the values of Dyspnoeic index from MVV & RMV values in all the subjects. The mean and standard deviation of these parameters are as per Table 1 and the details of all the parameters recorded are as per Table 2.The correlation between the chest dimension parameters and MVV and Dyspnoeic index was evaluated using

Pearson's correlation coefficient. The values of Pearson correlation coefficient are as per Table 3.

TABLE 1:

It gives the mean and standard deviation of the values of the various parameters.

Parameters	Mean	Std. Deviation	N
*Ce(cm)	84.73	6.425	30
**Ci(cm)	90.29	6.274	30
Ci-Ce(cm)	5.61	.895	30
R R (/min)	13.95	1.986	30
RMV(l/min)	6.75	1.214	30
MVV(l/min)	153.90	12.320	30
DyspnoeicIndex [(MVV-RMV)/MVV]X100	95.56	.979	30

TABLE 2:

Values of recorded variables in all the subjects

Ce = Chest circumference at the end of maximum expiration (in cm)

Ci = Chest circumference at the end of maximum inspiration (in cm)

Ci – Ce = Chest expansion (in cm)

RR = Respiratory rate (in per min)

RMV = Resting minute ventilation (in L/min)

MVV = Maximum voluntary ventilation (in L/min)

Dyspnoeic index calculated from MVV & RMV by the following relation - [(MVV-RMV)/MVV] X100

Sl no	Ce (cm)	Ci (cm)	Ci-Ce (cm)	R R (/min)	RMV (l/min)	MVV (l/min)	Dyspnoeic Index
1	91	95	5	12	6	158	96.2
2	81	87	6	12	5	150	96.67
3	80	86	6	16	7	154	95.45
4	77	84	7	16	8	159	94.97
5	79	84	5	16	8	159	94.97
6	94	100	6	12	6	162	96.3
7	80	85.5	5.5	16	8	140	94.29
8	81	86	5	16	8	142	94.37
9	82	87	5	16	7	154	95.45
10	87	94	7	12	6	169	96.45
11	97	102	5	12	6	170	96.47
12	94	100	6	16	7	164	95.73
13	96	101	5	12	5	178	97.19
14	87	92	5	16	7	152	95.39
15	91	98	7	12	5	170	97.05

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16	94	99	5	12	6	163	96.31
17	96	102	6	12	5	165	96.97
18	78	83	5	16	9	139	93.53
19	85	90	5	16	8	160	95
20	83	88	5	12	6	154	96.1
21	79	84	5	12	5	145	96.56
22	81	88	7	12	5	170	97.06
23	80	85	5	15	8	142	94.37
24	81	87	6	16	8	164	95.12
25	91	96	5	12	7	160	95.63
26	80	86	6	12	6	152	96.05
27	80	85	5	16	7	148	95.27
28	81	86	5	16	9	155	94.19
29	79	84	5	12	6	142	95.77
30	80	85	5	16	8	150	94.67

TABLE 3. Shows correlation between various parameters

Parameter 1	Parameter 2	Pearson Correlation
Ce(cm)	MVV(l/min)	.695**
	Dyspnoeic Index	.544**
Ci(cm)	MVV(l/min)	.739**
	Dyspnoeic Index	.577**
Ci-Ce(cm)	MVV(l/min)	.421*
	Dyspnoeic Index	.399*

DISCUSSION

In this study we tried to analyze the correlation between the anthropological parameters like chest size and expansion with spirometry parameters like MVV and also Dyspnoeic index which in turn was computed from MVV and RMV values. The MVV values give us an estimate of the level of physical fitness of an individual and the Dyspnoeic index shows the likelihood of a person to develop dyspnoea.[11] The normal value of Dyspnoeic index in > 90%, and any value <60% denotes increased chances for a person to experience dyspnoea, which again can be used as a marker of physical fitness. [12] Thus by means of this study we tried to look at the scientific basis of using chest expansion of > 5 cm as criterion of physical fitness. In addition to this we also tried to test our hypothesis that better performance in strenuous tasks by a person with higher chest circumference can be attributed to higher MVV.

In our study we found that chest circumference at peak expiration and that at peak

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inspirationshowedstrong linear correlation with the MVV and Dyspnoeic index values. These results are in accordance with studies done by Whittekar et al and Malik et al(6, 7) where they found a strong correlation between chest circumference and MVVvalues. This shows that people with larger chest size have higher values of MVV and dyspnoeic index which can probably explain their better physical performance in variousstrenuous tasks. This could bedue to fact that with increase in the chest circumference, the thoracic volume as well as the lung volume increases, which could contribute to higheroxygenation as well as higher oxygen uptake by a person and thus better physical fitness. Our study also brought out a medium strength linear correlation between chest expansion and Dyspnoeic index as well as MVV values. This finding supports the use of chest expansion of more than 5 cm as criterion for physical fitness. This again can be attributed to fact that better expansion of chest means better expansion of lungs thus higher oxygenation and also a higher oxygen uptake.

CONCLUSION

In the light of findings of this study, the use of chest expansion as a criterion for physical fitness is justified. However based on our finding of strong linear correlation of chest circumference with MVV values it is recommended that in order to improve the reliability of MVV reference values, the chest dimensions should also be considered along with other parameters like height, weight and ethnicity in calculating these reference values. However further large scale studies with more number of subjects are needed to exactly quantify the role played by chest dimensions in determining the MVV values.

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