

VITAL CAPACITY AND MAXIMUM BREATHING CAPACITY IN GUJARATIS

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In recent years there has been a steady increase in the use of Pulmonary Function Tests for the assessment of the efficiency of cardiopulmonary mechanism in patients with pulmonary disability. It is only during last twenty years that these tests have drawn active attention in our country.

Vital Capacity is a static volume and represents the maximum amount of air that can be expelled in one breath. Maximum Breathing Capacity on the other hand is a dynamic volume and represents the maximum amount of air ventilated by the lung in a unit time and is thus a better index of ventilatory function.

Normal values for vital capacity (V.C.) in normal adult males have been reported by Bhargav (2), Bhatia (4), Krishnan and Vareed (10), Krishnan and Vareed (11), Mukherjee and Gupta (13), Reddy (14), Reddy and Sastry (15), Singh and Parbhakaran (16), Singh (19), Telang and Bhagwat (20) and Thompson (21). While those for Maximum Breathing Capacity (M.B.C.) have been reported by Baldwin, Cournand and Richards (1) Bhargav and Somnath (3); Cournand and Richards (5), Dripps R. D. and Comroe (7), Gray Barnum, Matheson and Spies (8), Khandare (9), Matheson and Gray (12), Singh and Parbhakaran (16), Singh (17), Singh (19) and Thompson (21). There does not however appear to be a common ground of agreement regarding the normal values for V.C. and M.B.C. for normal adults from different regions of this country.

These normal values in the different regions have an important place in Thoracic Surgery. With this in view a study of normal values of V.C. & M.B.C. and their relationship with physical characteristics in 73 normal individuals between the age groups 17-39 years belonging to Gujarat was undertaken. The results are presented and discussed in this paper.

MATERIAL AND METHODS

Studies were conducted on 73 subjects, 59 males in age group of 17 to 29 years Group (1a), and 14 males in the age group of 30-39 years Group (1b).

The subjects were staff and students of the M.P. Shah Medical College & Irwin Group of Hospitals at Jamnagar. These subjects were selected because of their easy

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availability and to some extent their familiarity with laboratory surroundings. In Group 1a, most of them were Medical Students. Height in centimeters and Weight in Kilograms were recorded and Body Surface Area (B.S.A.) was determined by reference to a nomogram constructed from the formula of Du Bois. Thorough Clinical Examination of subjects was carried out, only healthy subjects were taken.

Posture : Vital Capacity and Maximum Breathing Capacity were recorded in sitting posture.

A Benedict Roth Spirometer was used to obtain graphic records of Vital Capacity (V.C.) and Maximum Breathing Capacity (M.B.C.)

For Vital Capacity, the subject was instructed to inhale maximally and then exhale completely into the spirometer. For Maximum Breathing Capacity, the subject was instructed to breathe as deeply and rapidly as possible for about 15 seconds. From the steepest portion of the ventilogram, the Maximum Breathing Capacity was calculated in litres per minute. Only expiratory spiograms are used in calculating M.B.C.

ANALYSIS AND RESULTS

73 male subjects ranging from 17-39 years old were divided into two groups on basis of age ; one group of 59 subjects between the ages 17-29 years, and the other of 14 subjects between the ages 30-39 years. Averages, Standard deviation, Standard error and Co-efficient of variation in both age groups are given in Table No. 1.

TABLE I
Group (1a) Age 17-29 years

	Age in years	Height (c. m. s.)	Weight (Kgms.)	B. S. A. (Sq. M.)	V. C. (c. c. s.)	M. B. C. (Lit/Min)
Mean	21.7	167.3	57.4	1.64	3380	158.6
Standard Deviation	±2.55	±6.3	±11.4	±0.01	±459	±22.9
Standard Error	0.33	0.8	1.4	0.002	59	2.9
Coefficient of Variation	11.8	3.8	19.8	1.15	13	14.4

Group (1b) Age 30-39 years

	Age in years	Height (c. m. s.)	Weight (Kgms.)	B. S. A. (Sq. M.)	V. C. (c. c. s.)	M. B. C. (Lit/Min)
Mean	32	166.2	55.2	1.61	3029	124.4
Standard Deviation	±2.72	±8.40	±79.5	±0.11	±392	±17.3
Standard Error	0.72	2.25	2.13	0.03	104	4.6
Coefficient of Variation	8.50	5.05	14.40	7.22	12.9	13.9

Correlation co-efficients between Vital Capacity and Maximum Breathing Capacity and physical characteristics obtained in the present study and also by other observers are summarised in Table No. 2a and 2b.

TABLE 2a
Correlation Coefficients of V.C. & M.B.C. with Physical Characteristics

Author	No. of Cases	Age Group	Correlation of Vital Capacity with			
			Age	Height	Weight	B. S. A.
Singh (18)	118	17-29	—	+0.51	—	+0.53
Present Study	59	17-29	-0.39	+0.26	+0.29	+0.36
	14	30-39	-0.64	+0.27	+0.19	+0.22

TABLE 2b

Author	No. of Cases	Age Group	Correlation M.B.C. with			
			Age	Height	Weight	B. S. A.
Baldwin et al. (1)	17	17-34	-0.63	+0.40	+0.26	+0.36
Gray et al. (8)	283	18-35	+0.09	—	—	+0.30
Singh (18)	118	17-29	—	+0.37	—	+0.35
Khandare (9)	60	18-33	+0.11	+0.16	+0.26	+0.18
	59	17-29	-0.09	-0.03	+0.04	+0.01
Present Study	14	30-39	-0.30	-0.12	+0.40	-0.36

Data is statistically examined and presented.

When Correlation co-efficients of Maximum Breathing Capacity with physical characteristics were computed and tested for significance, it was observed that no coefficient was significant enough to make a positive statement regarding the relationship of Maximum Breathing Capacity with physical characteristics; but Vital Capacity was related with the physical characteristics, as correlation coefficients computed between Vital Capacity and physical characteristics were found to be significant in males in the Age group of 17 to 29 years.

On the basis of this, the following regression equations have been fitted by the method of least square.

$$\text{Vital Capacity in c.c.s.} = 4919 - (\text{Age in Years} \times 71)$$

$$\text{Vital Capacity in c.c.s.} = (21 \times \text{Height in cms}) - 88.$$

$$\text{Vital Capacity in c.c.s.} = (1207 \times \text{B.S.A. in Sq. m.}) + 1401.$$

The above formulae may be useful for calculating the expected Vital Capacity value in the Male Subjects in the age group of 17-29 years in Gujaratis.

DISCUSSION

Vital Capacity in the Age Group of 17-29 Years

In Male Subject : Our Mean Value for Vital Capacity of 3380 c.c. for Gujrati men in the age Group of 17-29 years is more or less the same as reported by Thompson Wells (21), Bhargav (2) and Singh (19) who also employed recording spirometers like us. However, our Mean Value is little higher than the figures reported by some of the previous Investigators. (4, 10, 6, 20, 15).

In Table No. 3 are presented the Mean Vital Capacity values as reported by various workers in Male Subjects in India.

The discrepancy observed in findings may be due to the differences in the degree of physical development and capacity of the subjects and to the fact that most of the previous investigators employed non-recording spirometers.

Hence the normal values and prediction equations presented here from the statistical analysis may serve as a basis for evaluating ventilatory function and assessing the degree of ventilatory impairment in patients with cardiopulmonary disorders in male subjects in the age group of 17-29 years.

Difference in Vital Capacity in Age Group 17-29 Years and 30-39 Years in Male Subjects

Though relation between age and vital capacity has not been demonstrated in Indian male subjects so far, Singh and Prabhakaran (16) observed a reduction of 350 c.c. in the Mean value of the Vital Capacity in the higher age group.

Our observation of a reduction of 351 c.c. in the Mean value of Vital Capacity in the higher age group is in agreement with the observation of Singh and Prabhakaran (16). This appears also to be in agreement with the observations of some western investigators referred to in this study. The subject in the higher age groups (Doctors and clerical staff) by virtue of their occupational environment were engaged in a lesser degree of physical activity than the medical students in the younger age group and this may account for part of the reduction. It is also possible that the reduction in vital capacity occurs at an earlier age in Indian male subjects.

Maximum Breathing Capacity in the Male Subjects in the Age Group 17-29 Years

Our mean value for Maximum Breathing Capacity 158.6 litres per minute of Indian male subjects in the age group of 17-29 years is nearer the values obtained by Dripps and Comroe (7), Gray *et al.* (8), Matheson and Gray (12), Thompson Well (21), and Singh and Prabhakaran (16) but our mean value is little higher than that obtained by Baldwin *et al.* (1), Bhargav and Somnath (3) and Khandare (9).

TABLE 3

*Comparative Statement of Vital Capacity Values As Reported
by Various Workers in Male Subject*

Author	Apparatus	No. of Subjects	Age Group	Mean Capacity (c. c. s.)	Region
Bhatia (4)	Spirometer	100	20—45	3091	Bombay
Mukerji & Gupta (13)	Not Stated	12	20—28	3560	Bengal
Krishna & Vareed (10)	Lowne's Spiro- meter	103	18—29	2929	Madras
Krishna & Vareed (11)	Sanborn Spiro- meter	198	17—26	3050	Madras
Reddy (14)	—	105	—	3156	Vizag
De & De (16)	Verdin's Spiro- meter	100	17—23	2833	Bengal
Telang & Bhagwat (20)	Palmer Spiro- meter	172	18—29	2949	Bombay
Reddy & Sastry (15)	Sanborn Spirometer	(1)243 (11)67	17—25 26—43	3002 2923	Vizag —
Bhargav (2)	Hutchinson's Spirometer	47	17—23	3260	M. Bharat
Thompson Wells (21)	Collin's Respiro- meter	50	Mean 22	3691	Vellore
Singh & Prabhakaran (16)	—	(1)118 (11) 28 (111) 25	17—29 30—39 40—62	3900 3550 3150	Madras — —
Singh (19)	—	79	18—29	3541	Madurai
Singh (19)	—	21	30—55	3454	—
Present Study	Benedict Roth Spirometer	59	17—29	3380	Gujarat
	—	14	30—39	3029	—

Data obtained in various western and Indian Male subjects are summarized in Table No. 4.

TABLE 4

Comparative Statement of Mean M.B.C. Values as reported by Various Authors in Male Subject.

Author	Apparatus	No. of Subjects	Age Group	Mean M.B.C. Lit/Min.	S.D.	C.V.	Region
Baldwin et al. (1)	Modified Benedict Roth	17	16—34	126.0	±28.6	23.0	—
Gray et al. (8)	Benedict Roth	283	18—35	167.0	±21.0	13.0	—
Matheson and Gray (12)	—	100	23.3 Mean	168.3	±19.2	11.4	—
Cournand et. al. (as Quoted by Gray et al.) (5)	—	20	—	154.0	±30.9	20.0	—
Drips & Comnoe (As Quoted by Gray et al.)	—	19	—	166.0	±20.3	12.0	—
Hermannsen (As Quoted by Gray et al.)	—	23	—	99.0	±24.8	20.0	—
Thompson Wells (21)	Collin's Respirometer	50	22.0	153.6	—	—	Vellore
Bhargav & Somnath (3)	Douglas Bag	100	17—23	132.8	—	—	Rajasthan
Singh & Prabhakaran (16)	Collin's Respirometer	118 28	17—29 30—39	166.0 144.2	±20.3 —	12.2 —	Madras —
Singh (17)	—	25	40—62	117.5	—	—	—
Kandare et al. (9)	Tissot Spirometer	60	18—33	118.3	±21.7	18.3	Maharashtra
Singh (19)	Collin's Spirometer	79 21	18—29 30—55	131.0 116.0	— —	— —	Madurai —
Present Study	Benedict Roth Spirometer	59 14	17—29 30—39	158.6 124.4	±22.9 ±24.0	14.4 19.31	Gujrat —

*Difference in Maximum Breathing Capacity in Age Group of 17-29 Years
and 30-39 Years in Male Subjects*

In subjects of 30-39 years it was observed that Maximum Breathing Capacity was 34 liters less than the corresponding value of the age group of 17-29 years.

Our Mean value is little less than the corresponding value reported earlier by Singh and Prabhakaran (16). Other data in this Age group for comparison is not available in Indian literature as different workers have taken different age groups for their study. Even in the west the older age group is poorly represented in most of the series.

These observations appear to indicate that the Maximam Ventilatory Capacity in Indians is not lower than western subjects.

SUMMARY

(1) Normal values of Vital Capacity and Maximum Breathing Capacity of 73 normal male individuals of Gujarat State between the ages 17-39 years were statistically analysed and correlated with physical measurements.

(2) Three prediction equations presented here give a fairly accurate normal value of Vital Capacity in male subjects in the age group of 17-29 years.

Prediction equations for young adults (17-29 years)

Vital Capacity in c.c.s. = $4919 - (\text{Age in Years} \times 71)$.

Vital Capacity in c.c.s. = $(21 \times \text{Height in cms.}) - 88$

Vital Capacity in c.c.s. = $(1207 \times \text{B.S.A. in Sq. m.}) + 1401$.

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