

VENTILATORY TESTS AND LUNG VOLUME STUDIES IN MADHYA PRADESH - PHYSIOLOGICAL NORMS

R. P. BHARGAVA, S. M. MISRA AND N. K. GUPTA

Department of Physiology, Gandhi Medical College, Bhopal

Summary: In 260 subjects of either sex ranging in age from 16 to 65 years, various ventilatory tests and lung volume studies were performed to establish physiological norms, particularly for the region of Madhya Pradesh. Mean values in males were higher than in females. Various values declined with age. The physiological norms obtained have been compared with those obtained by other workers from different parts of the country.

Key Words: ventilatory tests lung volumes physiological norms

INTRODUCTION

Normal values for vital capacity (VC) in healthy Indian adult males have been reported earlier (3,5,10,11,14,16,17,18,19,23,25,26). Values for VC in Indian female subjects have also been reported (1,2,7,10,12,18,23). Similarly normal values for maximum breathing capacity (MBC) in the Indian male (4,6,9,15,19,21,22,26) and the Indian female (1,2,7,24) have been reported. Physiological norms for other ventilatory tests and lung volumes have been reported by Kasliwal *et al.* (7) from Rajasthan and Mathur *et al.* (13) from Uttar Pradesh. However, sufficient data about various ventilatory tests and lung volumes in different sexes and age groups from different regions of India is not yet available. The present study was aimed at collecting these data in the healthy Indian subjects.

MATERIALS AND METHODS

260 subjects of either sex belonging to different age groups between 16 to 65 years were selected from amongst doctors, medical students and employees of the Medical College, and their relations. Respiratory, cardiovascular or renal disorders were ruled out by thorough history taking, physical examination and fluoroscopy. The subjects giving history of significant illness were not included in the series.

Tidal volume (TV), vital capacity (VC), inspiratory reserve volume (IRV), expiratory reserve volume (ERV) and inspiratory capacity (IC) were determined with Collin's spirometer. Timed vital capacity (TVC), MBC and maximum mid expiratory flow rate (MMEFR) were determined by using Inco's double recording spirometer in conjunction with electric Kymograph with a speed of 116 mm/sec. The record was obtained on a paper having vertical and horizontal rulings. The distance between two vertical line representing 1/4th second and between two horizontal lines representing 100 ml. For determination of MMEFR the subject was asked to inspire maximally and then to blow out as hard and fast as he could. The first 200 ml of expired air was disregarded and the flow rate was measured between 200 and 1200 ml of expired air in litres/min.

The percentage breathing reserve (BR) was calculated from the values obtained for the MBC and pulmonary ventilation (PV)

$$\text{Percentage BR} = \frac{\text{M.B.C.} - \text{P.V.}}{\text{M.B.C.}} \times 100$$

All observations were made in the standing posture. All gas volumes were corrected to B.T.P.S. Height and weight were recorded in each case and surface area (SA) was calculated by reference to the nomogram of Boothby and Sandiford (based on Dubois formula). Chest measurements after full inspiration and expiration were taken as a routine.

RESULTS

Values for the various ventilatory tests and lung volumes as obtained in healthy males and females of different age groups are depicted in Table I and Table II.

It is observed that all values in case of males are higher than in females except for the percentage value of FEV, where no significant difference has been noted. The various values also decline with age, highest values being recorded between 16-35 years. However, the values for MMEFR do not show any significant variation in different age groups. Values for M.B.C. show a marked reduction in each higher age group as compared to the previous one.

TABLE I: Showing mean values \pm S.D. of surface area (SA), tidal volume (TV), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), inspiratory capacity (IC) and vital capacity (VC) in males and females of different age groups.

Age group (years)	SA (sq. m.)	TV (ml)	TRV (ml)	ERV (ml)	IC (ml)	VC (ml)
16-25						
Males (60)	1.62 \pm 0.3	547.62 \pm 72.81	1521.86 \pm 284.34	996.61 \pm 140.92	2066 \pm 258.04	3042.37 \pm 373.7
Females (40)	1.43 \pm 0.74	488.85 \pm 57.07	1154 \pm 138.03	790.57 \pm 101.27	1635.71 \pm 170.75	2712.85 \pm 375.8
26-35						
Males (20)	1.52 \pm 0.13	610 \pm 84.06	1440 \pm 239.5	987.5 \pm 87.3	2053. \pm 93.98	3037.5 \pm 275.3
Females (20)	1.50 \pm 0.02	551 \pm 47.48	1164 \pm 86.48	830 \pm 91	1715 \pm 111.44	2545 \pm 71.58
36-45						
Males (20)	1.49 \pm 0.14	560 \pm 73.32	1210 \pm 342.8	888 \pm 122.76	1770 \pm 327.1	2776 \pm 148.3
Females (20)	1.45 \pm 0.05	515 \pm 60.2	1015 \pm 119.37	610 \pm 119.37	1530 \pm 119.09	2200 \pm 128.67
46-55						
Males (20)	1.54 \pm 0.08	520 \pm 57.12	1190 \pm 117.56	750 \pm 100	1710 \pm 108.3	2460 \pm 129.04
Females (20)	1.39 \pm 0.03	460 \pm 22.36	940 \pm 119.37	690 \pm 65.19	1380 \pm 75.82	2070 \pm 90.69
56-65						
Males (20)	1.53 \pm 0.07	456 \pm 27	1014 \pm 93.7	770 \pm 44.72	1470 \pm 97.48	2260 \pm 82.31
Females (20)	1.43 \pm 0.05	443 \pm 37.01	856 \pm 175.2	586 \pm 21.9	1309 \pm 157.01	1875 \pm 165.84

TABLE II: Showing mean values \pm S.D. of maximum breathing capacity (MBC), pulmonary ventilation (PV), breathing reserve (BR), mean mid-expiratory flow rate (MMEFR) and forced expiratory volumes for 1st and 2nd seconds (FEV_1 and FEV_2) in the males and females of different age groups.

Age group (years)	MBC (l/min)	PV(l/min.)	BR (%)	MMEFR(l/min)	FEV_1 (%)	FEV_2 (%)
16-25						
Males (60)	142.25 \pm 15.15	10.47 \pm 1.44	92.63 \pm 1.15	290 \pm 37.57	87.73 \pm 4.87	97.09 \pm 2.6
Females (40)	110.42 \pm 11.40	9.41 \pm 1.11	91.3 \pm 1.48	285.69 \pm 62.18	88.14 \pm 5.38	97.70 \pm 3.15
26-35						
Males (20)	118 \pm 3.91	14.35 \pm 3.15	89.94 \pm 1.12	362 \pm 141.31	87.03 \pm 8.07	98.66 \pm 2.27
Females (20)	94.6 \pm 3.84	10.39 \pm 1.57	88.73 \pm 1.54	332.5 \pm 129.21	91.61 \pm 3.61	97.64 \pm 1.89
36-45						
Males (20)	104.2 \pm 3.76	10.05 \pm 1.31	90.32 \pm 1.45	283 \pm 33.16	88.89 \pm 4.37	97.19 \pm 2.77
Females (20)	76.4 \pm 5.85	9.21 \pm 1.09	87.94 \pm 1.24	272 \pm 89.27	86.71 \pm 9.01	97.45 \pm 2.20
46-55						
Males (20)	82.2 \pm 9.31	9.33 \pm 1.04	88.49 \pm 1.69	327.55 \pm 85	90.53 \pm 6.25	98.79 \pm 1.00
Females (20)	63.6 \pm 6.06	8.46 \pm 0.33	87.27 \pm 0.75	238 \pm 4.24	84.95 \pm 5.38	97.02 \pm 2.9
56-65						
Males (20)	63.87 \pm 7.04	8.85 \pm 0.82	86.05 \pm 0.51	310 \pm 57.44	86.45 \pm 5.59	96.91 \pm 2.44

DISCUSSION

Values for various ventilatory tests and lung volumes in males and females of different age groups in subjects from Rajasthan (7) and Uttar Pradesh (13) have been reported. In conformity with the findings of these workers, higher values have been obtained in males as compared to females. These values were higher in the younger age group and declined with age.

Mean values for TV in the present study were higher than those reported by Kasliwal *et al.* (7). The highest value obtained in this study being 610 ml as against 530 ml reported by Kasliwal *et al.* Values for IRV, i.e. the maximal volume of air which can be inspired from the end-inspiratory position ranged from 1014 to 1521 ml in males and 856 to 1164 ml in females. These values are much lower as compared to the western standards ranging between 2000-3200 ml (8).

Mean values for ERV in different age groups were much lower than those reported by Mathur *et al.* (13). The highest value reported by Mathur *et al.* was 1915 ml. as against 996 ml recorded in the present investigation. Our values however fall approximately within the range of 750-1000 ml quoted for the westerners (8). The highest value of 2066 ml for IC in the present investigation was lower than the highest value of 2675 ml reported by Mathur *et al.*

Mean values for VC were lower than those reported by earlier authors (7,13,18) However, the values obtained in the present study were more or less the same as reported by some other authors (3,5,10,11,16,17,23).

Mean values for MBC in the present study were slightly higher than those of Kasliwal *et al.* in both sexes. However, the values reported by Mathur *et al.* for males were slightly higher (except the youngest age group) and those for females slightly lower than the values obtained in the present series. The values obtained by others (18,22) were higher than those in the present investigation.

Mean values for Pulmonary Ventilation (PV) ranged from 8.14 to 10.39 L/min. in females and from 8.85 to 14.35 L/min in males. Values for PV in Indian subjects of different age groups could not be traced. Mean values for percentage Breathing Reserve (BR) ranged from 84.2 to 91.3% in females and from 86.05 to 92.63% in males. Mean values for MMEFR (200-1200 ml) had no significant relationship to age. The mean values were higher than those reported by Kasliwal *et al.* and more or less similar to those obtained by Mathur *et al.* The mean FEV values in the present study were higher than those reported earlier (7,13). These values were not related to age or sex.

Variation in values could be due to the technique employed and the sample of subjects studied. The present work has helped in establishing norms in either sex for some of the ventilatory tests and lung volumes in different age groups particularly for the region of Madhya Pradesh.

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