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Original Research Paper

Pulmonary Medicine

PULMONARY VOLUMES AND VITAL CAPACITY AMONG ADULT POPULATION OF GUJARAT

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ABSTRACT **Background:** The respiratory ailments are becoming more common in developing countries. One reason may be pollution caused by industrialization. It is necessary to know the normal functioning of lungs of all regions. We attempted to find out the normal in the Province of Gujarat of India.

KEYWORDS : Pulmonary volumes, pulmonary capacities, male, female, Gujarat population

INTRODUCTION

Lungs play a major role in the process of respiration. During inhalation and exhalation oxygen is given to the blood in exchange of carbon dioxide. Respiratory organs are also performing non respiratory functions like sneezing, coughing, vocalization etc.

Different tests like lung volume, capacities, rates of flow and gas exchange are studied to estimate the functioning of total respiratory organs. Functioning of lungs is mainly studied by conducting Pulmonary Function Tests. These information shall be helpful in diagnosis and in the management of respiratory disorders such as asthama, chronic obstructive pulmonary disease and restrictive lung diseases (Burney, Hooper 2014).

In this study the term "Lung volume" refers to any one of the four primary, non overlapping subdivisions of total lung capacity. Each capacity refers to two or more primary lung volumes. Lung volumes and capacities are reported in liters (Marya 2016). The aim of this study was to standardize Lung volumes and Capacities of people of GujaratProvince.

MATERIALS AND METHODS

The study was conducted at Government Medical College, Surat in the Province of Gujarat. The participants of the study were male (n-185) and female (n-80) students of 1st year MBBS class. They belonged to the age group of 19 to 21years. Their height in cm and weight in kg were measured and surface area in sqm was calculated. Initially participants had undergone a general medical examination.

A popular instrument, spirometer, was preferred for this study. Participants were adults of both sex representing the Province of Gujarat. Spirometry is a simple and useful technique for assessing the ventilator functions of the lung (MacIntyre 2012;Varshaney, Bedi 2019). By using spirometer we have measured Tidal Volume(TV), Inspiratory Reserve Volume(IRV) and Expiratory Reserve Volume(ERV) in standing positions and Vital Capacity(VC) in three different position, standing, sitting and lying.

RESULTS

All participants were medically fit. No participant ever fell ill due to any major respiratory disease. They never had any illness of cardiac in nature. They were all non smokers. The calculated surface area and values for Lung volumes and vital capacity for male (Table 1) and female (Table 2) are presented here. Our study results are compared with that of other authors (Table 3). In both sex, as body surface area increase the lung volumes and capacities increased.

Table 1. Results of Lung volumes and vitals capacity among male subjects in relation to surface area

Surface area in square meter	n	Tidal volume (ml)	Inspiratory reserve volume(ml)	Expiratory reserve volume(ml)	Vital capacity (L)		
					Standing	Sitting	Lying
		Mean	Mean	Mean	Mean	Mean	Mean
1.16-1.25	21	400	1200	1000	2600	2550	2450
1.26-1.35	39	400	1250	1000	2600	2500	2500
1.36-1.45	45	420	1250	1050	2600	2600	2500
1.46-1.55	35	430	1250	1050	2650	2600	2550
1.56-1.65	33	450	1300	1100	2750	2720	2700
1.66-1.75	12	500	1300	1150	2850	2820	2770

Table 2. Results of Lung volume and Vital capacity among female subjects in relation to surface area

Surface area in square meter	N	Tidal volume (ml)	Inspiratory reserve volume(ml)	Expiratory reserve volume(ml)	Vital capacity (L)		
					Standing	Sitting	Lying
		Mean	Mean	Mean	Mean	Mean	Mean
1.26-1.35	20	380	970	1000	2300	2250	2200
1.36-1.45	24	400	1100	1000	2500	2400	2400
1.46-1.55	25	400	1150	1050	2600	2550	2500
1.56-1.65	11	430	1200	1100	2750	2600	2500

Table 3. Average lung volume and capacity of healthy male and female adults reported by different authors

Authors	Tidal volume (ml)	Inspiratory reserve volume (ml)	Expiratory reserve volume (ml)	Residual volume (ml)	Vital capacity (ml)
Barrett et al. (2016)	500-750	2000	1000	1300	3500

Sembulingam, Sembulingam (2016)	500		3300		1000		1200		4800	
Silverthorn (2016)	500		3000		1100		1200			
Hall et al. (2017)	500		3000		1100				4600	
Choudary (2016)	500		2000-3000		1000				4500	
Chatterji (2016)	500		2000-3000		1000				4500	
Linda (2014)	500		3000		1200		1200		4700	
Jain (2013)	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	500		2000-3200		1000-2000				4800	3200
Varshaney, Bedi (2019)	500		2500-3200		1000-2000		1200		4800	3200
Pal, Nanda (2017)	500		3300	1900	1200	700	1200	1100	4000	3000
Pal, Parvathy (2014)	500	500	3000	2000	1000	700	1200	1100	4500	3100
Present study	450	400	1250	1100	1050	1000			2700	2500

DISCUSSION

Pulmonary volumes and Capacities are considered widely while assessing respiratory status of a person. In most parts of the world it became a part of routine health examination for respiratory functioning like in occupational, sports medicine and in public health screening.The structure of the thoracic cavity, which houses and protects lungs, is vital for optimal lung functions. Changes to the spine, muscles and ribs over time with aging impact normal lung functions.The abdominal muscles include the rectus abdominis, external oblique abdominis, internal oblique abdominis and transverse abdominis play a role in trunk motion, posture, labor, vomiting, dejection and respiration (Kera et al. 2005)

In the present study we attempted to establish the average values of TV,IRV,ERV and VC values of the people of Gujarat. Their ethnic group is different from other parts of this vast country(Broun et al.2013. Burney, Hooper 2014).We observed in the present study pulmonary values is greater in male than in female in relationship to their body surface area. Pulmonary volume values increase parallel with that of increase in height and surface area of individuals (Schwartz et al. 1988).

Physiological factors like age, gender, height and ethnicity show variations in pulmonary functions (Bhatti et al. 2014)Several physiological factorsresponsible for maintaining VC were studied by many workers like,1.Age 2.Gender3. Physical dimension4.Strength of respiratory muscles 5.Posture and 6.Pregnancy.

1. Pulmonary volumes and capacities are increasing as age advances as seen among children (Skandhan et al. 1976). Age associated changes in the respiratory system are known; the size of the thoracic cavity decreases and alteration in the muscles responsible for respiration limit lung volumes. In the present study subjects were normal healthy adults of both sex. Overall muscle function in the body decreases by 2% annually as an adult increases his age. Aging is associated with reduced inspiratory and expiratory respiratory muscle strength. As the age advances the respiratory system reduces its functioning. VC decreases in old age due to loss of elasticity of lungs. Elastic fibers get replaced by fibrous tissue as age advances, which may end in chronic obstructive pulmonary disease(COPD) (Elkhateeb et al. 2015; Lowery et al.2013; Minimo 2013). The reduction in functioning could also be due to skeletal changes (Lombardi et al.2005) or due to changes in muscles (Arora, Rochester 1982;Brown, Hasser 1996)
2. Pulmonary volumes and capacities are different in different ethnic group (Bhatti et al. 2014). This factor is important and where by on reported values different from other places (Table 3). Similar results are also present in literature (Schwartz et al.1988). On the basis of surface area and body height, women have 80 per cent of the vital capacity of males. In Chinese population 'norms' of women as given by Foster and Hsieh (1923) are about 75 per cent of the male values. Astrand (1952) found 19 per cent lower values for VC in women compared to men. In India, comparison of male average value was calculated by Reddy (1944) and female by Mason (1932) showing that Indian women have a vital capacity of 72 per cent less than men. Chen and Kuo(1989) concluded that men had greater respiratory muscle and pulmonary functions than women, who were physically active than in those who were sedentary.
3. We observed lung volumes and vital capacity values are more in males (Table 1,2& 3) reason is have large chest size, more muscle power and more body surface area. According to the increase in height, lung volumes and capacities have increased in both male and female subjects (Tables 1 &2) Similar observations were reported by several authors (Adesol et al.2013). Bhatti and others(2014) found in their cross sectional study, variation in vital capacity of individuals in relation to their heights within the same ethnic and age groups. It might be due to the increased surface area of the lungs in relation with increasing height. The increase in pulmonary values as height increases shall be explained as increase in chest girth and thoracic area which lead to increase in surface area of lung(Bhatti et al.2014).
4. Muscle strength is an important factor for total functioning of respiratory system. As the activity of muscles increases VC increases in swimmers and divers (Vaithiyanadane et al. 2012). At times, extreme of exercise may induce lung injury (Bove 2016).
5. We observed changes in VC values in different postures (Tables 1&2). Which was highest in standing position and lowest in lying down.This was compared with that of others (Table 3). . Kera et al. (2005) stated the effect of gravity on abdominal viscera changes in each position and which is responsible for the change in lung volume and capacity. According to Lundgren et al. (1953) vital capacity was significantly smaller (6% on an average) in recumbent body position than in standing position. In standing posture pulmonary blood flow is less and diaphragm descends down permiting increase in inspiration. Our study is supported by Raju et al. (2004) and Virani et al. (2001). Hurtado et al. (1933) were the first to show influence of posture on lung volume determinations. They observed in young and old alike, that in recumbent posture as compared with the sitting position there was-(a) moderate reduction of total capacity, (b) slight reduction in vital capacity, (c) marked decrease in functional residual capacity, residual capacity and (d) slight increase in inspiratory reserve capacity.

   Postural effect on respiratory functions are studied in normal and in patients with chronic obstructive pulmonary disease (COPD) by different authors. In COPD the feeling of breathlessness was experienced (Kera, Maruyama 2005). In contrast, tonic activity of the abdominal muscles was observed in 6 of 10 subjects in a

45-degree head-up position and in 8 of 10 subjects in an 80-degree head up position. This was explainedas increase in tonic activity resulted from an increase in intra-abdominal pressure attributed to gravity and that this activity served to prevent a shift in the length-tension relation by shortening the diaphragm (De Troyer 1983).

6. VC decreasesin pregnancy due to the progressive increase in abdominal volume which elevates diaphragm and reduced the expansion of lungs (Skandan et al. 1977;Shailaja,Shrikanth 2013)

CONCLUSION

In conclusion our study established the pulmonary volume and capacities for the Province of Gujarat showed all values are higher in male than female. These values reported here are lesser than reported by different authors from other parts of the country. It may be due to the difference in ethnicity of the people of this area.

The contributions of all three authors are equal as from designing the work to
completing this article.

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