Speech-1

by

BODY POSITION EFFECT ON RESPIRATORY MEASURES IN NORMAL ADULTS

Respiration is an essential and important process in all living organisms. It helps in the exchange of gases and provides oxygen which is very important for the survival. Exhalation and inhalation are the two stages associated with respiration**.** The primary function of respiration is to sustain life, and the source of speech production (Herlihy, 2000). Respiratory measures like lung volumes and lung capacities are useful in understanding in working of respiratory system. Both lung volumes and lung capacities are responsible to breathing for life sustaining and breathing for speech production function. Any abnormality in respiration involves in coordination of breathing patterns for speech production.

The respiratory parameters pressure, volumes, capacities, flow, and chest wall shape are important for speech production. Spirometry is a physiological test for the assessment and management of chronic obstructive pulmonary disease (COPD), Asthma, acute myocardial infarction, lung cancer, and stroke, and many other pulmonary diseases. Spirometry plays an important role in assessing and managing respiratory function in production of speech. It is useful for the respiratory function and determining volumes such as vital capacity and tidal volume. In normal healthy persons, the volume of air in lungs primarily depends upon the body size. However the body positions also influence the pulmonary measures. It has been found that most of the volumes decrease when person is lying down rather than in standing position.

The respiratory measures are influenced by a number of factors particularly height, age, usual habitat, and geographical conditions. (Da Costa, 1971; Sider & Peter 1973; Cotes & Ward, 1996). A comparative study was done by Zemlin (1981) among the American, European, Jordanian, and the Pakistani subjects. It was found that the former three groups were superior to the remaining groups. The vital capacity varies with the age, sex, height, weight, body surface area, body build and other factors.

Lallo, Becklace, and Goldsmith (1991) examined the effect of the standing versus sitting position on spirometric indices in 94 healthy non-obese adult subjects (41 men and 53 women). On average all the spirometric indices examined except the peak expiratory flow rate (PEFR), were higher in standing position compared to sitting. Reduction in flow expiratory volume in the first seconds (FEV1) with the change in position was statistically related to pond real index but not the age, height or the initial lung function level. Vilke et al. (2000) also stated small differences in spirometric values between sitting, supine and prone position in the normal adult population in forced vital capacity (FVC), FEV1, and maximum voluntary ventilation (MVV) in sitting, supine, and prone positions.

Krishna Murthy (1986) and Chatterjee (1988) reported no significant difference between the vital capacities and mean flow rates for both males and females. Several studies have provided information on the normal standards for air volume measurements in two or three different positions. There are no established comparative norms for air volume measurements in five positions that is sitting, standing, supine, prone & right lateral recumbent i.e. right side lying (RLR). For a speech language pathologist, such norms are especially important for estimating the respiratory capacity and efficiency in patients with various voice disorders and speech disorders. This is particularly important for bed-ridden patients who require a bed-side examination of speech & language evaluation. Also, such information can serve as baseline while planning intervention for paralyzed (stroke) patients. It also enhances our understanding of respiratory measures in professional singers who use different position such as sitting and standing.

Thus, literature indicates that the vital capacity (VC) and FVC, PEFR and MVV among other aerodynamic factors, play an important role in speech production and also the duration for which an individual can sustain phonation.

The aim of the present study was to obtain normative baseline for FVC (forced vital capacity), FEV1 (forced vital capacity in 1 second), PEF (peak expiratory flow), MVV (maximum voluntary ventilation), and VC (vital capacity) in five different positions sitting, standing, supine, prone, and RLR, comparison of the respiratory parameters between the five positions, comparison of the respiratory measures obtained across the gender.

Method

Participants: A total number of 60 normal healthy individuals (30 male and 30 female) in the age range of 18-30 years were considered for the present study. All the subjects were taken based on the inclusionary criteria.

Participant selection criteria: The participants were selected based on no history of major health issues, no history of orthopedic issues, no smoking history, and vigorous exercises were not to be done 30 minutes before the test. participants were not supposed to consume alcohol for 4 hrs prior to the test. They should not have heavy meal before the test in order to avoid inconvenience during the test. A body mass index (BMI, defines as weight in kilograms divided by height in meters, squared, mentioned in table 1) >30 kg/ m2 were also excluded.

BMI = Weight (Kg)/ Height2 (m2)

Table 1.

BMI classification adapted from WHO (1995) & WHO (2004)

Body Weight	BMI
Under weight	<18.50
Normal	18.50-24.99
Over weight	>25.00
Obese	>30.00

Pre-testing conditions to performing the spirometric test, subject's were instructed to wear loose clothing for the purpose of the test accurate height, weight of subject's body mass index were calculated for ruling out obesity. For calculating body mass index the individuals' body weight is divided by the square of their height using the following formula (WHO 1995, 2004).

Procedure

Each participant was tested individually at a time and was instructed about the test procedure, along with demonstration model given by the researcher. Before starting the test, mouth pieces were cleaned and sterilized properly. Each participant was instructed based on the Spirometry parameters. A Spirometer system RMS Helios 401 was used to measure the FVC, FEV1, PEFR, MVV, and VC of each subject. All subjects had full range of motion of the Supine, Prone positions, Right lateral recumbent (RLR) position i.e. The participant lay on right side on an examination table, with head facing parallel to the body, legs are extended and feet together .

In each position subjects were made comfortable and a brief rest of 2 minutes was given 4 to minimize the fatigue effect on the 4 respiratory musculatures. The subject has been asked to take deepest breath orally as much as possible (without the spirometer) and blow hard into the transducer tube of the spirometer for obtaining FVC, FEV1, and PEF. To obtain VC the subjects were asked to take normal inhalation and exhalation orally for two times, then to take slowly deep breath as possible and to blow slowly as possible and then to take normal inhalation and 25 exhalation orally. To obtain MVV the subjects were instructed to take deep inhalation orally and to blow out into the transducer tube of the spirometer as fast as possible for 6 sec. All these parameters were obtained for different positions.

Statistical Analysis

The data obtained was tabulated and statistically analyzed using 5 analysis of variance (ANOVA) with repeated measures and independent sample t test (SPSS Ver.17) to know the significant difference in different positions and parameters.

Results and Discussion

Table. 2

Mean and standard deviation in parenthesis of FVC, FEV1, PEFR, MVV, and VC in Five positions

Parameter / Position	FVC	FEV1	PEFR	MVV	VC
Sitting	2.73 (.77)	2.61 (.66)	6.53 (1.76)	116.97 (30.43)	2.82 (.66)
Supine	2.56 (.69)	2.49 (.63)	6.26 (1.60)	110.38 (27.94)	2.74 (.64)
Prone	2.48 (.69)	2.35 (.67)	6.33 (1.74)	107.73 (28.55)	2.65 (.68)
RLR	2.56 (.74)	2.46 (.66)	6.19 (1.59)	111.23 (29.83)	2.66 (.74)
Standing	2.91 (.78)	2.77 (.68)	7.07 (1.79)	123.27 (32.04)	2.88 (.78)

Mean and standard deviation values of FVC, FEV1, PEFR, MVV and VC in five positions are shown in table 2. It can be inferred that for all the five parameters, the mean values were higher in standing position that other positions. On the other hand, the mean values were lesser in prone position in all the parameters except PEFR.

Table 3.

Mean values of 5 parameters in males and females at different positions

	Gender	N	FVC	FEV1	PEFR	MVV	VC
Sitting	F	30	2.09	2.07	5.33	96.77	2.28
	M	30	3.37	3.16	7.74	137.17	3.36
Supine	F	30	2.02	2.00	5.12	90.73	2.26
	M	30	3.11	2.97	7.41	130.03	3.22
Prone	F	30	1.92	1.87	5.17	88.47	2.22
	M	30	3.04	2.84	7.49	127.00	3.09
RLR	F	30	1.95	1.93	5.08	89.17	2.20
	M	30	3.16	3.00	7.29	133.30	3.13
Standing	F	30	2.18	2.14	5.74	96.90	2.42
	M	30	3.46	3.26	8.46	139.63	3.38

N- Number of Participants

Table 3 represents the mean values of five parameters in both males and females at different positions. The mean values for all the positions was higher in males compared to females, but standing position elicited higher mean than other positions in males and females.

Standing position has lead to the higher lung volumes (Badr et al., 2002; Fang et al., 2006; Lalloo et al., 1991). This might be due to greater elastic recoil of the lungs and the expiratory muscles are at a more optimal part of the length-tension relationship curve and thus capable of generating higher intra thoracic pressures (Leith, 1968; McCool & Leith, 1987). Increased lung volumes in the standing position appear to be related to increased thoracic cavity volume, first gravity pulls the abdominal contents caudally within the abdominal cavity, increasing the vertical diameter of the thorax (Castile et al., 1982). Whereas Gary et al., (2000) found significant difference between prone, sitting and supine positions. In the prone position, basically lung volume reduces even more compared to other positions because the anterior ribs are compressed by the weight of the body and as a result cannot expand completely, limiting both volume and the ability to force air out of the lungs. Thus, it suggests that respiratory measures vary according to the position of the participants.

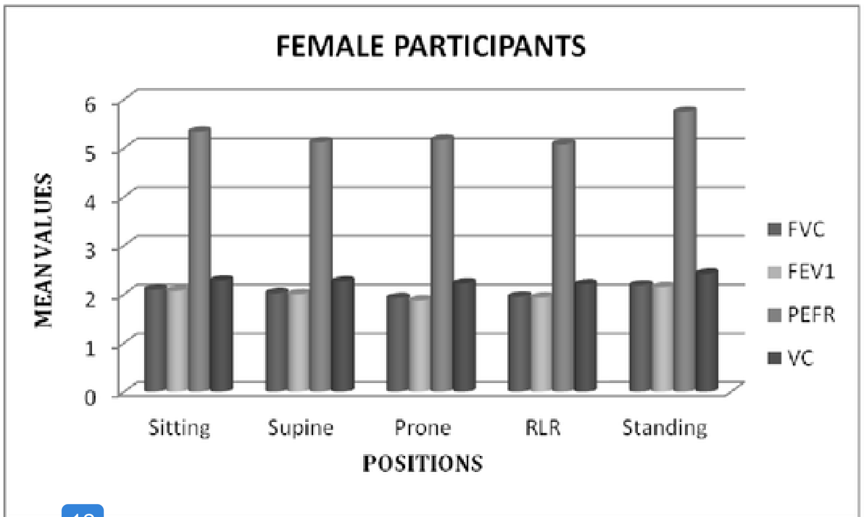

Figure 1. *Mean values of FVC, FEV1, PEFR and VC parameters at five positions in female participants.*

Figures 1 and 2 illustrates the mean values of FVC, FEV1, PEFR and VC parameters in five positions in female and male participants respectively. Clearly it is evident that in standing position mean values were higher compared to other positions. Figure 3 represents the mean values of MVV parameter in both females and males.

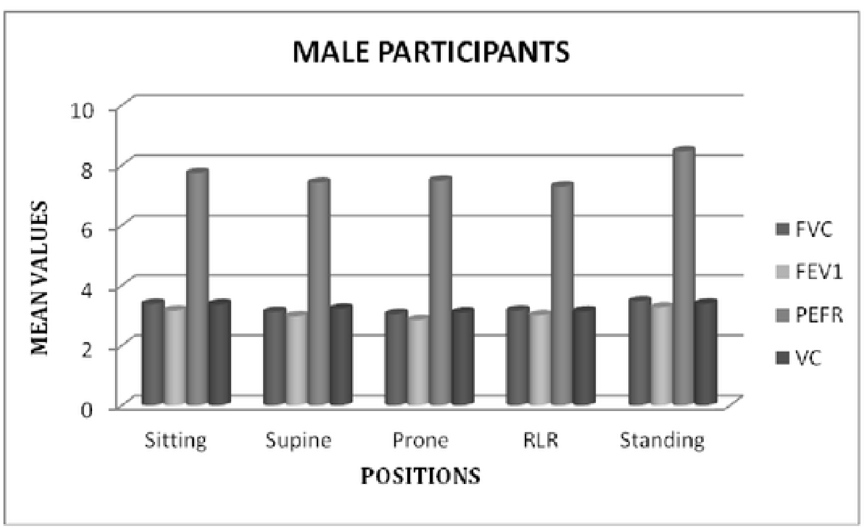

Figure 2. *Mean values of FVC, FEV1, PEFR and VC parameters at five positions in male participants.*

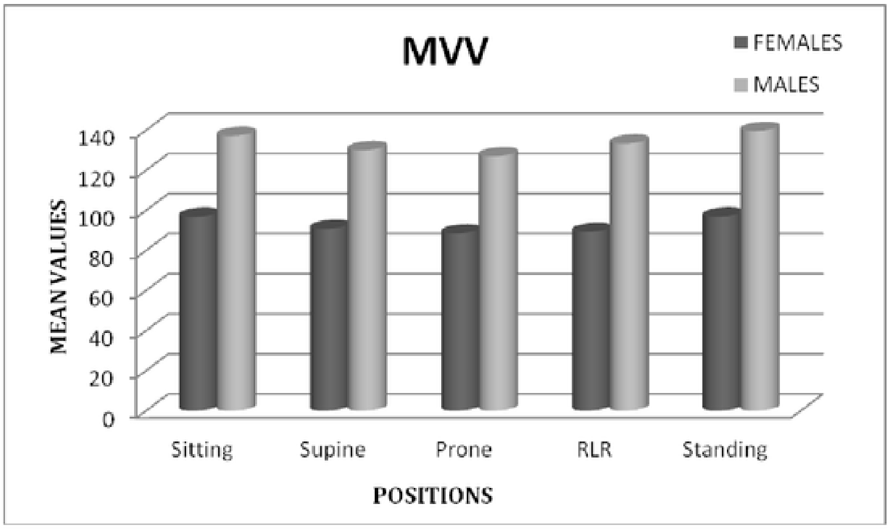

Figure 3. *Mean values of MVV parameter at five positions in female and male participants.*

Therefore, males have higher mean values compared to females; standing position elicited higher mean values than other positions. This might be due to the body size, height and physiological characteristics of lungs in different positions.

However, the mean differences were observed between positions and between gender for all the parameters, in order to find out the statistical difference between the positions and between genders repeated measures of ANOVA were used. Table 4 represents the F values and significance levels for all the parameters.

Table 4.

F values between positions and gender for each parameter.

	FVC	FEV1	PEFR	MVV	VC
Positions	23.46*	18.26*	18.75*	12.04*	3.96*
Genders	145.5*	122.81*	73.85*	65.38*	89.24*

*P < 0.01 significance level.

Results of repeated measures ANOVA reveal that there was a statistical significance difference between positions for FVC, FEV1, PEFR, MVV and VC parameters was observed. Between males and females also significant difference was found for all the five parameters as a whole. Independent t test was used to check the differences between females and males in each position for all the parameters. A study investigated those higher lung volumes in the standing position than the sitting and supine (Castile et al., 1982; Hough 1984).

Lallo, Becklace, and Goldsmith (1991) examined the effect of the standing versus sitting position on respiratory measures and reported that higher respiratory values were seen in standing position than sitting position except for peak expiratory flow rate (PEFR). Whereas, in the all parameters FVC, FEV1, PEFR and MVV, has made known next highest lung volumes in sitting position (Jerkins et al 1988; Fang et al., 2006; Badr et al., 2002) compared to other positions. Pierson, Dick and Petty (1976) studied standing and sitting positions revealed small differences for Forced Vital Capacity and Forced Expiratory Volume in one seconds.

Badr et al., (2002) found no significant difference between side lying and supine position. Previous researches have shown only small changes in total lung capacity between these side lying and supine (Jerkins et al., 1988). Prone position has lowest lung volumes compared to sitting, standing, supine, right lateral recumbent (RLR) in all the parameters. Gary et al., (2000) found significant difference between prone and sitting, supine positions and in vital capacity there is no significant difference between sitting, standing, and supine positions and there is significant difference seen in RLR and prone positions. Townsend (1984) empirically examined the larger expired volumes measured in the standing position in the study were probably due to subjects taking slightly larger inspirations in this posture than in the sitting position. Lumb and Nun (1991) also reported significant increase in vital capacity when sitting compared with supine position.

Thus, literature shows that standing position elicited higher respiratory values compared to other positions which are in support to the present study findings.

Table 5.

Pairwise comparison between each position for five parameters.

POSITIONS	Sitting	Supine	Prone	RLR	Standing
Sitting		FVC** FEV1** PEFR** MVV** VC#	FVC** FEV1** PEFR** MVV** VC*	FVC** FEV1** PEFR** MVV* VC*	FVC* FEV1* PEFR** MVV* VC#
Supine	FVC** FEV1** PEFR** MVV** VC#		FVC** FEV1** PEFR# MVV# VC#	FVC# FEV1# PEFR# MVV# VC#	FVC** FEV1** PEFR* MVV** VC*
Prone	FVC** FEV1** PEFR** MVV** VC*	FVC** FEV1** PEFR# MVV# VC#		FVC* FEV1** PEFR# MVV* VC#	FVC** FEV1** PEFR* MVV** VC**
RLR	FVC** FEV1** PEFR** MVV* VC*	FVC# FEV1# PEFR# MVV# VC#	FVC* FEV1** PEFR# MVV* VC#		FVC** FEV1** PEFR** MVV** VC**
Standing	FVC* FEV1* PEFR** MVV* VC#	FVC** FEV1** PEFR* MVV** VC*	FVC** FEV1** PEFR* MVV** VC**	FVC** FEV1** PEFR** MVV** VC**	

**** Highly Significant, P<0.01, * Significance difference, P<0.05, # No significance difference.**

Pair wise comparison between positions in ANOVA demonstrates that, significant difference was observed between sitting to other positions for five parameters except sitting to standing for vital capacity. Supine to other positions also similar difference was observed but supine to prone and supine to RLR positions difference was not observed for three and all parameters respectively. For prone to other positions, the difference was not observed for two parameters in RLR and three parameters in supine positions. Standing to all other positions, similar results were observed like sitting position. Therefore, sitting and standing positions were significantly differed from other positions except in vital capacity.

Table 6.

t values between genders for each parameters in different positions.

Parameter / Position	FVC	FEV1	PEFR	MVV	VC
Sitting	10.71*	9.77*	7.20*	6.86*	7.30*
Supine	10.18*	9.40*	7.91*	7.65*	8.57*
Prone	10.45*	8.14*	6.87*	7.07*	6.42*
RLR	10.98*	10.50*	7.42*	8.53*	6.11*
Standing	11.64*	11.13*	8.69*	6.91*	7.48*

* $P<0.01$ significance level

Table 6 indicates t values between genders for each parameters in different positions, there was a significant difference identified between females and males. Mean values indicates that males have higher mean values compared to female values. Males had significantly higher respiratory volumes compared to females in the all parameters at different positions. Pulmonary function tests (PFTs) is influenced by body build, muscular strength and nutritional status thereby showing higher values in males as compared to females whose body framework is fragile and muscle mass is replaced with more of fat deposits (Da Costa,1971; Sider, Peter 1973; Hutchinson, 1979; Zemlin., et al 1981; Cotes, ward, 1996).

Conclusion

Present study was a preliminary attempt to study the effect of body position on respiratory measures in Indian context. The present study aimed to study effect of body position (Sitting, supine, prone, RLR and standing) on respiratory measures in both males and females. Spirometry was used to assess FVC, FEV1, PEFR, MVV and VC in above mentioned positions.

The mean values for all the positions was higher in males compared to females, but standing position elicited higher mean prone position lesser mean than other positions in males and females. This might be due to increasing the vertical diameter of the thorax, condensed anterior ribs due to body weight which limits the expansion of lungs resulting in less volume. Difference in all positions for all parameters was observed except in vital capacity.

Comparisons of five respiratory parameters between males to females at five positions have exposed significant differences. Males had significantly higher respiratory parameters compared with females. This boldness is due to body build, muscular strength and nutritional status thereby showing higher values in males as compared to females whose body construction is delicate and muscle mass is replaced with more of fat deposits.

Implications of the study

Body position has an effect on the respiratory function test. Change in position alters the lung volumes and capacities. The more standing position the higher the lung volumes. The normative data serve as a reference standard for estimation of lung measurements among subjects with stroke patients, Parkinson's disease, Cerebellar disease, Cervical spinal cord injury, cerebral palsy, voice disorders, chronic obstructive pulmonary disease and asthma other respiratory diseases etc.

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