P-ISSN: 2394-1685
E-ISSN: 2394-1693
IJPESH 2015; 1(3): 42-45

www.kheljournal.com
Received: 05-11-2014
Accepted: 06-12-2014

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Effect of Different Postures on Peak Expiratory Flow Rate and Peak Inspiratory Flow Rate on Healthy Individuals

N. Siva Jyothi, G. Yatheendra kumar

Abstract
The main purpose of the study was 1) to differentiate the effects of the therapeutic body positioning from the routine body positioning. 2) Physiological effects of different body positions on cardiopulmonary function and oxygen transport. The study includes both males and females of age between 20-30 years; non obese (Body mass index ≤ 30), non-smokers and none of the participants have been engaged in athletic training. Peak inspiratory flow rate and peak expiratory flow rate was taken in standing, sitting, supine and prone positions. Data was analyzed using ANOVA (Analysis of Variance**)** one way classification at a significance of P<0.05. Mean values of peak expiratory flow rate and inspiratory flow rate differ significantly with the different postures. Coefficient of variation is less for standing compared to sitting, supine and prone. The parameters Peak expiratory and Peak inspiratory flow rate shown a significant change with each positions in the order of standing>sitting>supine>prone.

Keywords: Peak expiratory flow rate, peak inspiratory flow rate, postures

1. Introduction
Lung function is varied by the position of the body which in turn is influenced by gravity. Gravity exerts its influence on the human body and importantly on lung capacities. The combined effects of gravity on the lungs, heart and peripheral circulation is central to their interdependent function and establishing normal oxygen transport [1].

Because of its potent and direct effects on oxygen transport, therapeutic body positioning is a primary non-invasive physical therapy intervention to augment arterial oxygenation so that invasive, mechanical and pharmacological forms of respiratory support can be postponed, reduced or avoided. Thus with the effects of gravity lung function can be improved, maintained or worsened with changes in body position [2].

Body position has shown to affect lung volumes [3] and muscle biomechanics [4]. The implications of these positions were discussed for both the patients and for the individuals who may be at risk for developing pulmonary complication. Peak expiratory flow rate has been used as surrogate measure of cough and huff strength [5]. It is influenced by lung volumes which in turn are influenced by body position. Peak inspiratory flow rate is the highest point of inspiration in the flow volume maneuver. The study aimed to distinguish whether there is any change in the peak expiratory flow rate and peak inspiratory flow rate with the change of posture and also to determine which position will lead to the generation of highest peak expiratory flow rate and peak inspiratory flow rate in the normal individuals among positions sitting, standing, supine and prone.

2. Materials and Methods:
The study includes total of 30 volunteers, both males and females of age between 20-30 years, non obese (Body mass index ≤ 30), non-smokers and none of the participants have been engaged in athletic training. The subjects excluded from the study are smokers, obese individuals, having history of respiratory or cardiac diseases, any airway disorders or thoracic, abdominal, ENT or ophthalmic surgery, chest wall deformities such as kyphosis, scoliosis, diaphragmatic palsy, rib fractures, spinal cord injured patients, pregnant women, psychologically disabled subjects, non co-operative subjects. The test was carried out in a place convenient and comfortable for the volunteers. The participants were first given an explanation about the purpose and procedure of the experiment.

Basic information about the participant like his or her name, age, weight, height was documented.
On the day of test, the participants rested in each of the specified test position approximately for 10 minutes prior to measurement. Subject's nose was blocked with a nose clip. The participants instructed to blow forcefully in to the mouth piece of Spiro win after a maximum inspiration. This was repeated three times. Sufficient time interval was given between, so that the breathing pattern returned to normal prior to the next testing. Hygiene was ensured by changing the mouth piece after every use. Peak expiratory flow rate and peak inspiratory flow rate are measured by placing the subjects in supine, side lying, standing and prone lying positions. Three successive measurements were obtained in each of the four positions and recorded.

3. Results & Discussion

The peak expiratory flow rate and peak inspiratory flow rate were measured as mean and standard deviation.
To know whether there is any change in the parameters with body posture ANOVA (Analysis of Variance) one way classification was carried out. A difference was considered statistically significant if $P<0.05$.

3.1 Tables and charts

Table 1: ANOVA - PEFR in different postures.

PEFR	Sum of square	df	Mean square	F	P value
Between groups	15.4095	3	5.136499	3.18933	0.026347
With in groups	186.8209	16	1.610525		
Total	202.2302	119			

F critical value -2.68281
Level of significance- 0.05

From the table it is observed that the F statistical value F=3.18933 are significant at 5% level of significance. It implies that mean values of peak expiratory flow rate differ significantly with the different postures.
To determine which position is more consistent, coefficient of variation was calculated.

Table 2: coefficient of variation

Posture	Mean	Standard Deviation	Coefficient of variation
Sitting	5.008433	1.263112	25.219704
Standing	5.3987	1.286272	23.825584
Supine	4.630667	1.22884	26.410088
Prone	4.4728	1.302576	29.1226

From the table it is observed that the coefficient of variation is less for standing compared to sitting, supine and prone. The less the coefficient of variation, the more the consistency. From the results standing position is more consistent followed by sitting. The consistency of the positions for peak expiratory flow rate are in the order of standing >sitting>supine>prone

Table 3: ANOVA for significance in difference between PIFR in different postures.

PIFR	Sum of squares	df	Mean squares	F value	P value
Between groups	8.976417	3	2.992139	3.123202	0.0286
With in groups	111.1321	116	0.958036		
Total	120.1085	119			

F critical value-2.68281
Level of significance-0.05

From the table it is observed that the F statistical value F=3.123202 which is significant at 5% level of significance. It implies that mean values of PIFR differ significantly between different postures.
To determine which position is consistent coefficient of variation was calculated.

Table 4: coefficient of variation

Posture	Mean	Standard deviation	Coefficient of variation
Sitting	2.887833	0.921076	31.895058
Standing	3.193	0.976833	30.592953
Supine	2.629633	0.909958	34.603992
Prone	2.4712	1.096146	44.356831

From the table it is observed that the coefficient of variation is less for standing compared to sitting, supine and prone. The less the coefficient of variation more is the consistency. From the result- standing posture is more consistent followed by sitting. The consistency of the posture for peak inspiratory flow rate in the order of standing >sitting>supine>prone.

Chart 1. Mean Peak Expiratory Flow Rate

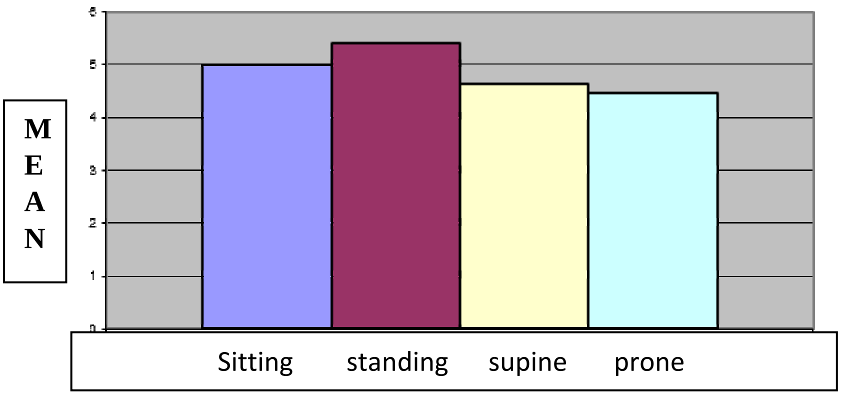
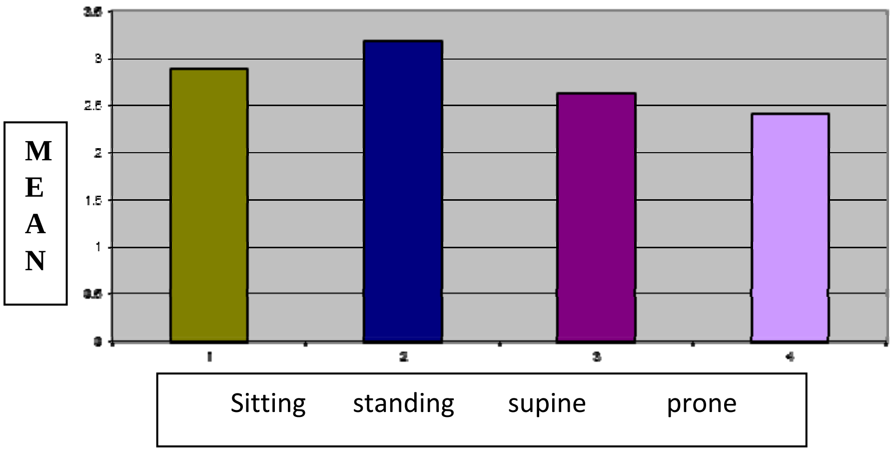


chart 2. Mean peak inspiratory flow rate



4. Discussion

Standing has been shown to lead to highest lung volumes and when standing was not measured, upright sitting resulted in the highest lung volumes. As higher the lung volumes the greater the elastic recoil of the lungs and chest wall [6] and the expiratory muscles are at a more optimal part of the length tension relationship curve which are capable of generating higher intra thoracic pressure, this is due to

- Gravity pulls the abdominal contents caudally within the abdominal cavity, increasing the diameter of the thorax [7].
- Unlike Positions such as supine, the bases of the lungs are not compressed by weight of heart and abdominal contents. This allows alveoli that had been compressed to reopen and increase lung compliance.
- Inspiratory muscles are able to expand the unrestricted thorax in all directions, as a result the diaphragm is able to contact even further caudally and increase lung volume, which leads to greater elastic recoil [8].

Following deep inspiration the contracting diaphragm increases pressure on abdominal contents pushing them forward which places the abdominal muscles at a stretch that makes the abdominal muscles to be more capable of stronger contraction and helps in the generation of higher expiratory pressure. Other factor that may have influenced the result in standing position includes patient comfort and higher arousal level.

Chair sitting often leads to the highest lung volumes results after standing. It may be due to subjects taking in slightly less inspiration than in standing position because the abdominal contents are higher in the abdominal cavity interfering with diaphragmatic motion. In sitting position, the back of the chair may slightly limit thoracic expansion, thus limited thoracic expansion in the sitting position appears to results in lower lung volumes. It has been shown that in normal subjects [9, 10] as well as in patients with sleep apnoea syndrome, pharyngeal size decreases significantly in supine position compared to upright posture. The probable explanation for the recumbency induced change in flow rate is a decrease in the lung volume parameter such as Total lung capacity, Residual volume& Vital capacity, these changes are small in the order of 10% or less are related mainly to an increase in the intra thoracic blood volume.

In supine, the diaphragm is known to be 4 cms higher with decrease in functional residual capacity [11].

The Peak expiratory flow rates are best in standing with a Mean of 5.3987 followed by sitting with a Mean of 5.008433 followed by supine with a Mean of 4.630367 followed by prone with a Mean of 4.4728.

The peak inspiratory flow rates are best in standing with a Mean of 3.193 followed by sitting with a Mean of 2.887833 followed by supine with a Mean of 2.629633 followed by prone with a Mean of 2.4172.

5. Conclusion

Measurement of Peak expiratory flow rate in different positions increases the sensitivity for detecting upper airway or assessing the effects on upper airway patency.

The parameters Peak expiratory and Peak inspiratory flow rate shown a significant change with each positions in the order of standing>sitting>supine>prone. Thus the study concludes that standing position is the most preferred for gaseous exchange and prone least.

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