International Journal of Physiotherapy and Research,
Int J Physiother Res 2020, Vol 8(6):3680-87. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2020.174

Original Research Article

INFLUENCE OF DIFFERENT SITTING POSITIONS ON THE MAXIMAL RESPIRATORY PRESSURES IN HEALTHY INDIVIDUALS OF VARIOUS AGE GROUPS: AN EXPERIMENTAL STUDY

Sneha J. Koraith *[1], Rajani S. Pagare [2].

*[1] D. E. S. Brijlal Jindal College of physiotherapy, Pune, Maharashtra, India.

[2] Professor and Head of the Department, Cardiovascular and Respiratory Physiotherapy, D. E. S. Brijlal Jindal College of physiotherapy, Pune, Maharashtra, India.

ABSTRACT

Background: Variation in the position of the body influences the orientation and length of the muscle. The ability of the respiratory muscles to generate force depends upon its length. There is a dearth of literature about the effect of pressures generated by the respiratory muscles due to the different sitting positions.

Purpose of the study: Due to the importance of body positioning in the optimization of breathing exercises, a need was felt to compare maximal respiratory pressures of the respiratory muscles in different sitting positions and identify a suitable position in which respiratory muscles work the best.

Participants: Total 144 participants were included in the study according to the inclusion and exclusion criteria. Participants were divided into age groups of 18-40years, 41-60years and 60years and above. Equal representation was given to sample number and gender in each group.

Method: MIP and MEP were measured in three different sitting positions i.e. upright sitting position, forward leaning position and semi fowlers position by using the Micro RPM (Micro Medical/Care Fusion, Kent, United Kingdom). The best of the three measurements was taken.

Results: There is a significant difference in the values of MIP and MEP in different sitting positions in all the age groups with p-value < 0.05. In each age group it was found that the values of MIP was better in upright sitting position as compared to forward leaning position (p-value <0.01) with no difference found in the values of MIP between the upright sitting position and semi-fowlers position (p-value > 0.05). The values for MEP was found to be increased in forward leaning position as compared to upright sitting position and semi-fowlers position p-value <0.05

Conclusion: The present study concluded that, there is a significant influence of different sitting positions on the maximal respiratory pressures in healthy individuals of various age groups.

Implication: The results of this study can be used to make a good clinical decision about which sitting position should be adapted while giving the various types of breathing exercises to the patient.

KEY WORDS: Maximal respiratory pressures, MIP, MEP, body positioning, sitting positions, breathing exercises.

Address for correspondence: Dr. Sneha J. Koraith (PT), D. E. S. Brijlal Jindal College of physiotherapy, Pune, Maharashtra, India. **E-Mail:** sneha.koraith@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Physiotherapy and Research** ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr
	Article Information
DOI: 10.16965/ijpr.2020.174	Received: 29 Sep 2020 Peer Review: 29 Sep 2020 Revised: None Accepted: 12 Nov 2020 Published (O): 11 Dec 2020 Published (P): 11 Dec 2020

INTRODUCTION

The strength of the respiratory muscles is an integral part of lung function [1].

It important to know the ability of the respiratory muscles to produce the force required for normal lung functioning thereby identifying the respiratory muscle weakness in both sick and healthy population [1].

Maximal Inspiratory Pressure (MIP) and Maximal Expiratory Pressure (MEP) are simple, convenient, and non-invasive outcome measures for evaluating the respiratory muscle strength [2]. MIP is the maximal negative pressure measured at the mouth after complete exhalation to residual volume followed by a single sustained maximal inspiratory effort from that lung volume against an occluded airway [2]. MEP is the maximal positive pressure measured at the mouth after inhalation to total lung capacity followed by a maximal expiratory effort from that lung volume against an occluded airway [2].

The muscles of respiration include diaphragm being the major muscle for inspiration along with other muscles which are the intercostals, abdominals and scalene. The diaphragm has its nerve supply from the Phrenic nerve (C3,C4,C5) and it performs about 70-80% work of breathing [3]. During contraction, it moves downwards from its dome shaped position to increase the vertical diameter of the thoracic cage. But it is soon opposed by the elongation of the vertical mediastinal elements and resistance of the abdominal viscera. At this point the central tendon becomes fixed and the muscle fibres now acts from the periphery of this tendon elevating the lower ribs thus increasing the transverse diameter of the rib cage [4].

We know that, the diaphragm is the primary muscle of inspiration and the abdominals are the accessory muscles of expiration which helps in producing forced expiration [4]. Though the action of both the muscles are antagonistic to each other, they also act in synergy during the different phases of respiration [4]. Therefore, according to Kapandji the diaphragm will be less effective without the presence of the abdominals.

When inspiration occurs, we know that the diaphragm contracts and pulls the central tendon downwards increasing the vertical diameter of the chest wall [4].

This motion is soon opposed by the elongation of the vertical mediastinal elements and the resistance offered by the abdominal viscera [4. This abdominal viscera is surrounded by the 'abdominal girdle' formed by the strong abdominal muscles. These muscles keep a check on the displacement of the abdominal viscera. Without the support of these muscles, the abdominal viscera would be displaced anteriorly and inferiorly, and this would not help the central tendon to stabilise thereby not allowing the diaphragm to elevate the lower ribs [4]. Therefore the abdominals perfectly act as synergists to assist in inspiration.

When expiration occurs, the diaphragm relaxes and the abdominals start contracting [4]. Also, as the abdominals contract it pushes the abdominal viscera upwards thus decreasing the vertical diameter of the chest wall [4]. In this way the abdominals also acts as antagonists by decreasing all the three diameters of the chest wall during expiration [4].

Therefore, this antagonistic and synergistic action of the abdominals is essential for increasing the efficacy of the diaphragm [4].

In accordance with the above overview, the mechanics of ventilation largely depends upon the muscle action and its length tension relationships. Like any other muscle of the body, the ability of the respiratory muscle to generate force depends upon its length and velocity of the muscle contraction [5]. The force of the respiratory muscles are determined by the pressures [6]. The pressures in the thoracic cavity varies with the length of the muscle and lung volume [6]. Variation in the position of the body influences the orientation and length of the muscles as well as the lung volumes [6]. Hence, change in the position of the body may influence the ability to generate tension [6].

As we know, Breathing exercises and ventilatory training are fundamental interventions for the prevention or comprehensive management of impairments related to acute or chronic pulmonary disorders [3]. Controlled breathing techniques, which emphasize diaphragmatic breathing, are designed to improve the efficiency of ventilation, decrease the work of breathing, Increase the excursion (descent or ascent) of the diaphragm, and improve gas exchange and oxygenation [3]. While administering breathing exercises to a patient, position of the body is of major concern. Change in the strength of the respiratory muscle may have an effect during breathing exercises.

Different positions are being suggested to give breathing exercises to a patient. Upright sitting position and semi-fowlers position are the most adapted positions given to the patient by the physical therapist while performing breathing exercises. However, studies have not provided definite results on this regard. Some showed that in healthy individuals, body position does not have any influence on body position [7], whereas some observed greater values of MIP in upright sitting position [6] as compared to semi-upright [6] and supine position [8]. According to various literatures, semi-fowlers position is the best and commonly used position to administer breathing exercise [3,9], whereas other literatures contradict the same [10]. Studies reveal that forward leaning position should be adapted while giving expiratory type of exercise [3], but this position causes compression of the diaphragm [10].

There is a knowledge gap existing in this field as to which position will place the diaphragm into a mechanical advantage thereby achieving the maximum benefits of breathing exercises There is a dearth of literature about the effect of maximal respiratory pressures generated by the respiratory muscles due to the different sitting positions. Due to the importance of body positioning in the optimization of breathing exercise, a need was felt to compare and identify suitable position in which the respiratory muscles work the best thus optimizing the effect of breathing exercise.

METHODOLOGY

An experimental study was conducted in college and hospital settings for a duration of 1 year. 144 participants were included in the study through non- random convenient sampling. Normal healthy individuals from the age group of 18 and above years. Samples were grouped in 18-40 years, 41-60 years and 60 years and above. Athletes, smokers, obese, current or previous cardiopulmonary, neuromuscular or orthopaedic disorders involving thorax were excluded.

Micro RPM was used to measure the maximal respiratory pressures of the individuals. The MicroRPM (Micro Medical/CareFusion, Kent, United Kingdom) is a modern manovacuometer /manometer that recorded MIP and MEP [11]. It is a small, portable, light weight, non-invasive, mouth-pressure manometer with a rubber flanged mouthpiece and a small monitor that displays the test results in cm H2O [1]. Reproducibility was evaluated by Dimitriadis et al. [1] who observed a high value of intraclass correlation coefficient (ICC) for both MIP (0.78 and 0.87, respectively) and for MEP (0.82 and 0.90, respectively) [1].

Clearance was obtained from the institutional and university ethics committee to conduct the study. Normal healthy individuals from the age group of 18 and above years were selected according to the above mentioned inclusion and exclusion criteria. The need, purpose and nature of the study was properly explained to the participant. Information sheet was distributed to all the subjects and a written consent form about their willingness to participate in the study was taken from each participant. Demographic data such as age, height, weight was collected from the participants. Participants were divided into age groups of 18-40 years, 41-60 years and 60years and above age groups. Few trial sessions were given to each participant before the actual assessment to negate the learning effect. On the day of assessment, each participant was made to acquire each of the assigned positions (upright sitting, semi-fowlers position and forward leaning position).

Upright Sitting position Picture 1. shows the participant sitting erect on a chair with spine completely supported by the backrest of the chair.

Forward Leaning Position Picture 2. shows the participant sitting on a chair with arms rested on the thigh and the trunk leaning forward.

Semi-Fowler's Position Picture 3. shows the participant sitting on a bed with head end inclined up to 30-45 degrees and hip flexion up to 45 degrees.

Participants held the instrument in their hand during the assessment in each position. MIP and MEP was measured in these three positions using MicroRPM.

To measure MIP Firstly, the participant was instructed to first exhale completely to the residual volume. Then they were asked to hold the instrument in the mouth via the mouth piece. MIP was now measured by asking the participant to inhale with as much force possible and maintain the pressure for at least 2 seconds [16].

To measure MEP- Firstly, the participant was made to inhale deeply. Then they were asked to hold the instrument in the mouth via the mouth piece. MEP was measured by asking the participant to exhale with as much force possible and sustain for 2 seconds [16].

A rest period of 1minute was given between each trial and 10mins rest period was given between each position [16]. Three trials were given to the patient for each manoeuvre in each position. The best of the three measurements were taken.[16] This data was then entered in excel. DATA analysis and interpretation was done using One-way ANOVA test.

Statistical Analysis:

Table 1: Illustrates the types of data analysis used.

Purpose	Test	Set p-value	Inference
Descriptive data of patients	Mean, standard deviation and percentage	-	-
Comparison of MIP in different sitting positions for the age group 18-40years	One-way ANOVA	P-value - 0.0062	Statistically significant
Comparison of MEP in different sitting positions for the age group 18-40years	One-way ANOVA	P-value - 0.0342	Statistically significant
Comparison of MIP in different sitting positions for the age group 41-60years	One-way ANOVA	P-value-0.0011	Statistically significant
Comparison of MEP in different sitting positions for the age group 41-60years	One-way ANOVA	P-value<0.01	Statistically significant
Comparison of MIP in different sitting positions for the age group 60years and above	One-way ANOVA	P-value-0.0008	Statistically significant
Comparison of MEP in different sitting positions for the age group 60years and above	One-way ANOVA	P-value-0.001	Statistically significant
Comparison of MIP in all sitting positions for all the age groups	One-way ANOVA	P-value <0.001.	Statistically significant
Comparison of MIP in all sitting positions for all the age groups	One-way ANOVA	P-value <0.001.	Statistically significant

Table 2: Shows the means of the MIP in different sitting positions in the age group.

	Mean and Standard Deviation of the MIP (cmH2O) 18-40yrs	Mean and Standard deviation of the MIP (cmH_2O) 40-60 yrs	Mean and standard deviation of the MIP (cmH_2O) 60 and above
Upright sitting position	82.76 $\pm$ 21.50	82.43 $\pm$ 18.49	67.91 $\pm$ 15.19
Forward leaning position	69.48 $\pm$ 18.68	69.16 $\pm$ 17.73	56.54 $\pm$ 14.77
Semi-fowlers position	76.4 $\pm$ 19.81	75.77 $\pm$ 16.83	64.93 $\pm$ 14.92

Table 3: Shows the means of the MEP in different sitting positions in the age group.

	Mean and Standard Deviation of the MEP (cmH2O) 18-40yrs	Mean and Standard deviation of the MEP (cmH_2O)) 40-60 yrs	Mean and standard deviation of the MEP (cmH_2O) 60 and above
Upright sitting position	67.22 $\pm$ 20.43	64.72 $\pm$ 18.67	55.65$\pm$12.42
Forward leaning position	77.09 $\pm$21.04	74.81 $\pm$ 18.85	65.27$\pm$13.43
Semi-fowlers position	67.62 $\pm$ 20.91	62.96 $\pm$ 18.30	54.04$\pm$12.41

RESULTS

Table 2. shows the comparison of means of MIP in different sitting positions in all the age group of was done by One-Way ANOVA test and the difference was found to be statistically very significant with the P-value 0.0062, P-value 0.0011 and P-value 0.0008 respectively. Thus, a significant influence of different sitting position on the MIP values along the age group was observed. (Picture 4.)

Table 3. shows the comparison of means MEP in different siting positions in all the age groups was done by One-Way ANOVA test and the difference was found to be statistically extremely significant with the p- values <0.05, p-value <0.01and p-value 0.001 respectively. Thus, there is an influence of different sitting position on the MEP values along the age groups. (Picture 5.)

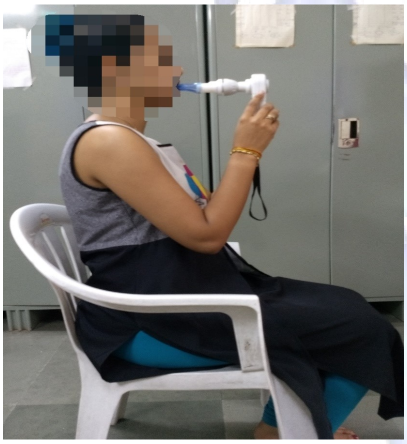
Post hoc analysis was done by Tukey's Cramer test to compare each sitting position. It was found that MIP values were significantly higher in the upright sitting position as compared to the forward leaning position with p- value < 0.01. P-values were not found to be statistically significant for the comparison done between upright sitting and semi-fowlers position as well as forward lean and semi-fowlers position.

The MEP values were found to be significantly higher in forward leaning position as compared to upright sitting position and semi-fowlers position with p- values <0.05. There was no difference seen between semi-fowlers and upright sitting position in the MEP values.

The comparison of means MIP was done in different siting positions between the age groups by One-Way ANOVA test. It was found that there is a significant decrease in the values of MIP and MEP for the age group of 60years and above with p-value <0.001.

(Picture 4. & 5.)

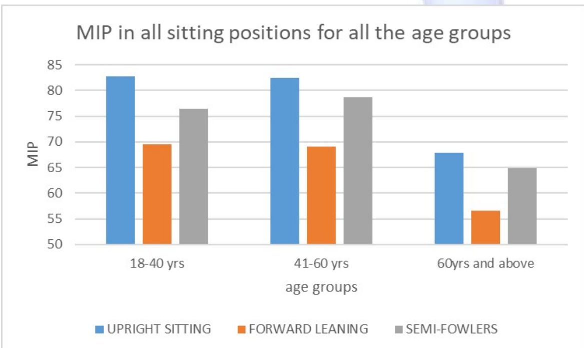
Picture 1: Upright sitting position



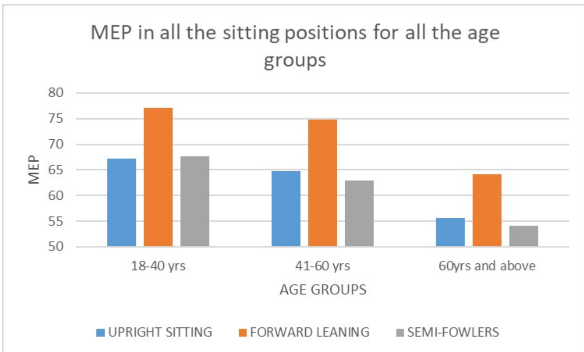
Picture 2: Forward leaning position

Picture 3: Semi fowlers position

Picture 4: shows the comparison of MIP in all the sitting positions for all age groups



Picture 5: comparison of MEP in all the sitting positions for all the age groups



DISCUSSION

This study was done to find the influence of different sitting positions on the maximal respiratory pressures in healthy individuals of various age groups. This study provided the evidence that there is a significant difference in the values of maximal respiratory pressures due to the influence of different sitting positions in healthy individuals of various age groups. In each age group it was found that the values of MIP were better in upright sitting position as compared to forward leaning position which was statistically significant. There was no difference found in the values of MIP between the upright sitting position and semi-fowlers position as it was found to be statistically not significant. Similarly, in all age groups, the values for MEP was found to be increased in forward leaning position as compared to upright sitting position and semi-fowlers position which was statistically significant.

These changes are seen since, the orientation and length tension relationship of the muscle fibers change in every sitting position [5]. Hence, the ability to produce tension in the muscles of respiration during any breathing maneuver is affected by the variation in the sitting positions [6]. We know that, the act of respiration is largely dependent on the muscles around the rib cage. The optimal functioning of these muscles depends upon the orientation and length tension relationship of the muscle fibres. Therefore, our study shows the same result as concluded by Rui Costa that, body position has an influence on the respiratory muscle strength of healthy individuals [6].

This study showed that in all the age groups, the upright sitting position had the greatest MIP as compared to the forward leaning position, supported by the study conducted by Rui Costa which concluded that upright sitting position helps to generate the active tension needed in the inspiratory muscles, thereby increasing the pressure gradients needed for ventilation [6]. According to Elizabeth Dean, all the upright positions whether standing, walking or sitting optimizes the transport of oxygen needed in ventilation and perfusion. All the lung volumes and capacities except the closing volume are more in upright position [22]. In the upright sitting position, the diameter of the main airway increases thus reducing the airway resistance [22]. All the dimensions of the chest wall i.e the anteroposterior diameter, vertical diameter and lateral expansions are more.

According to Kapandji, slight amount of tone in the abdominals is required for effective inspiration [4]. If the abdominals are kept relaxed, it will not be able to provide active tension required to stabilise the diaphragm during inspiration rendering this position not very useful for administering breathing exercises [9]. Our study compared the MIP values in upright sitting and semi-fowlers position and the difference in both the positions was not found to be statistically significant. There-fore we can conclude that semi-fowlers position does not have any added benefit over upright sitting position. However, it is cumbersome to put the patient in semi-fowlers position. Alexandra Hough states that, if we position the patient in the half-lying position or the semi-fowlers position, the patient tends to slide down and obtain the slumped sitting position [10]. Hojat and Mahdi concluded that in young healthy subjects with a normally positioned diaphragm, the slumped sitting posture results in increased intra-abdominal pressure by approximating the ribs to the pelvis, making it difficult for the diaphragm to descend caudally during inspiration [12]. Therefore due to the technical problems occurring in semifowlers position in practical scenario, upright sitting position can be recommended for administering breathing exercises.

The comparison of MEP done in upright sitting and forward leaning in our study showed that MEP values are greater in forward leaning position. This was contradicted by the study which stated that upright sitting resulted in the highest lung volumes (Jenkins et al 1988). At higher lung volumes there is greater elastic recoil of the lungs and chest wall (Leith 1968) and the expiratory muscles are at a more optimal part of the length-tension relationship curve and thus are capable of generating higher intrathoracic pressures (McCool and Leith 1987) [13]. In all the other positions except upright, the inspiratory muscles are unable to expand the thorax in all directions (De Troyer and Loring 1995). As a result, the diaphragm cannot contract caudally [13]. Our result is supported by Kisner & Colby who state that in forward leaning position, the abdominal viscera shifts anteriorly creating space for the diaphragm to descend caudally [3]. This shift of the abdominal viscera also lengthens the abdominal musculature. The probable reasons of achieving better MEP in forward leaning position could be attributed to the

Frank- Starling law, if a muscle is put into a slightly lengthened position within the physiological limit, the effect of its contraction is better. Therefore, if the abdominals are in slight tension, effective contraction will be produced to achieve a forceful expiration.

We also found that MIP and MEP decreases with increasing age in every position. Significant decrease was found in the MIP and MEP values in the age group of 60 and above. This is in accordance with the study by Black and Hyatt(2), who reported a linear regression of MIP on age in both males and females; however, the regression was not significant in subjects <55 years of age.(14) Tolep and Kelsen analyzed the work of Black and Hyatt and others who examined and compared changes in ventilatory muscle strength with age. All investigators noted that maximal static respiratory pressures declined 15% to 20% over the age span from 20 to 70 years. The decline, however, did not become significant statistically until age 55 [14].

CONCLUSION

In conclusion, the current study proves that there is a significant influence of different sitting positions on the maximal respiratory pressures in healthy individuals of various age groups. The results of this study also state that a decrease in maximal respiratory pressure is seen with increase in age.

ABBREVIATION

MIP – Maximal inspiratory pressure
MEP- Maximal expiratory pressure
Micro RPM- Micro Respiratory pressure meter

ACKNOWLEDGEMENTS

I owe a deep sense of gratitude to Dr. Aparna Sadhale (PT), Principal, Brijlal Jindal College of Physiotherapy, Pune, Maharashtra, for giving us the opportunity to conduct this research. I thank all my professors and colleagues at Brijlal Jindal College of Physiotherapy for their kind help and cooperation helped me to complete my research. I genuinely thank all the research participants who participated in the study loyally to help me gather the data required for my research.

Conflicts of interest: None

REFERENCES

[1]. Dimitriadis Z, Kapreli E, Konstantinidou I, Oldham J, Strimpakos N. Test/retest reliability of maximum mouth pressure measurements with the microrpm in healthy volunteers. Respir Care. 2011 Jun;56(6):776-82. https://doi.org/10.4187/respcare.00783 PMid:21310113

[2]. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis. 1969 May;99(5):696-702.

[3]. Kisner C, Colby LA. Therapeutic Exercise: Foundations and Techniques. F.A. Davis; 2007. 928 p.

[4]. Kapandji IA. The Physiology of the Joints. Churchill Livingstone; 2007. 360 p.

[5]. Cormie P, mcguigan MR, Newton RU. Developing maximal neuromuscular power: Part 1—biological basis of maximal power production. Sports Med Auckl NZ. 2011 Jan 1;41(1):17-38.
https://doi.org/10.2165/11537690-000000000-00000 PMid:21142282

[6]. Costa R, Almeida N, Ribeiro F. Body position influences the maximum inspiratory and expiratory mouth pressures of young healthy subjects. Physiotherapy. 2015 Jun;101(2):239-41.

[7]. Ng GY, Stokes MJ. Maximal inspiratory and expiratory mouth pressures in sitting and half-lying positions in normal subjects. Respir Med. 1991 May;85(3):209-11.
https://doi.org/10.1016/S0954-6111(06)80081-8

[8]. Koulouris N, Mulvey DA, Laroche CM, Goldstone J, Moxham J, Green M. The effect of posture and abdominal binding on respiratory pressures. Eur Respir J. 1989 Nov;2(10):961-5.

[9]. DOWNIE P. CASH TEXTBOOK OF CHEST HEART AND VASCULAR DISORDERS FOR PHYSIOTHERAPISTS. 4ED edition. JAYPEE BROTHER; 1993. 703 p.

[10]. Hough A. Physiotherapy in Respiratory Care Third Edition: A Problem-solving Approach. 3rd Revised edition edition. Cheltenham: Cengage Learning EMEA; 1980. 550 p.

[11]. Pessoa IMBS, Pereira HLA, Aguiar LT, Tagliaferri TL, Silva LAM da, Parreira VF, et al. Test-retest reliability and concurrent validity of a digital manovacuometer. Fisioter E Pesqui. 2014 Sep;21(3):236-42.

[12]. Hojat B, Mahdi E. Effect of different sitting posture on pulmonary function in students. Journal of Physiology and Pathophysiology 2011;2(2):29-33.

[13]. Badr C, Elkins MR, Ellis ER. The effect of body position on maximal expiratory pressure and flow. Aust J Physiother. 2002;48(2):95-102. https://doi.org/10.1016/S0004-9514(14)60203-8

[14]. Damone M. Geriatric Physical Therapy By Guccione 2nd Edition Pdf.

How to cite this article:

Sneha J. Koraith, Rajani S. Pagare. INFLUENCE OF DIFFERENT SITTING POSITIONS ON THE MAXIMAL RESPIRATORY PRESSURES IN HEALTHY INDIVIDUALS OF VARIOUS AGE GROUPS: AN EXPERIMENTAL STUDY. Int J Physiother Res 2020;8(6):3680-3687. **DOI:** 10.16965/ijpr.2020.174