Research Paper Medical sciences

Aerodynamic Measures in Wind Instrument Players

*Deepa N. Devadiga | Department of Audiology and Speech Language Pathology,Kasturba Medical College, Mangalore, 575001 (Unit of Manipal University), Karnataka, India. (*Corresponding Author)

Jayashree .S. Bhat | Department of Audiology and Speech Language Pathology,Kasturba Medical College, Mangalore, 575001 (Unit of Manipal University), Karnataka, India.

Anitha.V | Department of Audiology and Speech Language Pathology,Kasturba Medical College, Mangalore, 575001 (Unit of Manipal University), Karnataka, India.

ABSTRACT

Aerodynamic Measures in Wind Instrument Players

Introduction: Singing and musical performances are one of the basic human social activities. Although singing is older, wind instruments appeared at least 20,000 years ago1. Training in voluntary breath control is essential in playing wind instruments. An important aspect in professional training is the management of breath support. Wind instrument players require larger lung volumes for effective playing. There is very little understanding of aerodynamic measures of voice in wind instrument players used by the Indian population.

Method:The clinical group consisted of ten adult male saxophone players in the age range of 18 to 40 years. The control group consisted of ten age matched adult males. The aerodynamic measures peak flow, vital capacity and phonation quotient was measured.

Results: The results revealed significant differences for the aerodynamic measures between the wind instrument players and non-wind instrument participants.

KEYWORDS: Aerodynamic measures, Wind instrument players, peak flow

Introduction

Singing and musical performances are one of the basic social activitiesof human beings. Although singing is older, wind instruments appeared at least 20,000 years ago[1]. Various instruments have been designed to produce floral musical quality among which are the wind instruments. There has been significant interest in understanding the role and influence of the physical principles governing sound production and the physiological variables involved among the wind instrument players.

A wind instrument is a musical instrument that contains a type of resonator, where a column of air is set into vibration by the player blowing into (or over) a mouthpiece set at the end of the resonator. When playing a wind instrument the air passes from the lungs into the upper respiratory tract and is eventually channelled into the mouthpiece of the instrument via some form of reed mechanism. Depending on the instrument class, variable rates of air flow and duration are necessary to produce optimal tone quality. Wind instruments use the breath of the player as their energy source, and the resonances of the vocal tract can contribute to both timbre and to pitch control.

Wind instrument players are a very specific group of individuals who make intense use of their vocal tract by blowing their instrument in their professional activities. Playing a wind instrument is a complex neuromuscular task that requires increased ventilation and increased orofacial muscle activity.

An important aspect in wind instrument training towards professional level is the idea of breath support. Training in voluntary breath control is essential in playing wind instruments. Breath control training in musicians is directed at improving abdominal muscular and diaphragmatic function. This is accomplished with exercises designed to increase resistance against these muscles on inspiration and to produce controlled slow expirations with open glottis. Through practice the wind instrument players learn to control both the passive and active forces to control required air to produce the sound while playing. Wind instrument players require larger lung volumes for effective playing. Several studies that have been conducted in wind instrument players have shown that wind instrument players have superior pulmonary function (i.e., spirometric values) compared with non-musicians or musicians playing other instruments (Tucker, 1971; Fiz,1993; Khuje&Hulke, 2011) These findings are in conflict with other authors who have found no differences among the different respiratory measures.Wind instrument players may be seriously impaired by respiratory diseases that might appear trivial to the nonperformer. The cause of respiratory disease in wind instrument players may be related to these increased airway pressures in terms of a barotrauma. Wind instrumentalists may suffer from laryngoceles, velopharyngeal insufficiency, hemoptysis, eye defects, cardiovascular problems, orofacial defects, gastroesophageal reflux disease, asthma, cancer etc due to their musical performance. Asthma is the most common chronic pulmonary disorder among wind players (Marks, 1974; Gilbert, 1998) This indicates that there are numerous factors related to lifestyle and body morphology that can affect the wind instrument player and can be a serious threat to their professional activ-

ities. Aerodynamic measures of voice involve measuring the air volume, air flow and pressure. There has been significant interest in understanding the role and influence of a player's vocal tract in wind instrument performance.There is very little understanding of the aerodynamicmeasures of voice in wind instrument players inIndian context, in spite of technological advancement and availability. The present study is in this direction.

Method

The participants for the study comprised of two groups. Group I consisted of 30 wind instrument players, 10 each of Flute, Saxophone, and Nadaswaram players in the age range of 18-40years. Group II consisted of 30 age matched non-wind instrument participants.

The aerodynamic measures were assessed usingAerophone II (Voice function analyser), Manufacture F.J Electronics, Ellebuen 3 DK-290 Vedback, Denmark was used to assess Aerodynamic measures. The parameters chosen for this study were Vital Capacity, Peak Flow and Phonation Quotient.

Vital Capacity: Vital Capacity is defined as the maximum volume of air which can be exhaled following deep inhalation. This measure is important as it provides an estimate of the amount of air potentially available for the phonation. The unit used for Vital Capacity registrations is ml. High value of the Vital Capacity is correlated to a longer duration of the phonation and to a higher flow rate.

Peak Flow: The Peak Flow measure gives information about the force of the contraction of the expiratory muscles. A higher value means a faster velocity of the exhaled air, and thus astronger and more sudden contraction of the expiratory muscles. The unit used for Peak Flow registrations is ml/second.

Phonation Quotient: Phonation Quotient is the highest Vital Capacity divided by the Maximum Phonation Duration.

Procedure: The evaluation was carried out in a sound treated room. For the measurement of Vital Capacity, the participants were instructed to take a deep breath and blow slowly as long as possible into the mouth piece connected to the Aerophone. The participants were asked to make an inspiration as deep as possible, and then to make an expiration as fast and strong as possible for the measurement of Peak Flow. The Phonation Quotient was calculated as Phonation Quotient= Vital Capacity / Maximum Phonation Duration.

Results

Aerodynamic measures between wind instrument players and non-wind instrument participants:

The mean value (Fig 1) was found to be higher for Peak Flow measure among the wind instrument players compared to the non-wind instrument participants and it was statistically significant ($p<0.05$). There was no difference observed for the Vital Capacity and Phonation Quotientmeasures between wind instrument players and the non-wind instrument participants.

Aerodynamic measures within wind instrument players (Flute, Saxophone and Nadaswaram)

The mean values (Fig 2) for Peak Flow and Phonation Quotient were high in Saxophone and Nadaswaram players compared to Flute players. There was significant difference found in Peak Flow ($p<0.05$) and Phonation Quotient ($p<0.05$) measures within the groups. No significant difference was found in Vital Capacity within the groups.

The Bonferroni post hoc analysis was done to explore means within the wind instrument players to obtain information on which means are significantly different from each other.

The results of Bonferroni post hoc analysisfor the aerodynamic measures such as Vital Capacity, Peak Flow and Phonation Quotient within the groups revealed significant difference ($p<0.05$) within these groups.

Comparing Table 1, it is observed that the Peak Flow was higher in Saxophone and Nadaswaram players compared to Flute players. There were no significant differences between Saxophone and Nadaswaram players.

Comparing Table 2, it is evident that, the Phonation Quotient was higher in Saxophone and Nadaswaram players compared to Flute players. There were no significant differences observed between Saxophone and Nadaswaram players.

Discussion

The results obtained for the aerodynamic parameters in the present study indicate that there was significant difference in the Peak Flow in the wind instrument players compared to the non-wind instrument participants. There was no significant difference observed for the Vital Capacity and Phonation Quotient measures included in the study. Peak Flow relates to the strength of the expiratory muscles. Higher Peak Flow indicates that the wind instrument players have good strength of the expiratory muscles which are required for efficient playing of the wind instrument[7, 6, 9]. In contrast, a highly significant reduction in Peak Flow among the military music band players was found[5].

Vital Capacity differs in individuals secondary to the age, body weight and size of the individual. There are three factors that can affect Vital Capacity, which includes the position of body during the measurement, the strength of the respiratory musculature and the distensibility of the thorax-lung unit or, in other words, pulmonary compliance. In addition to the size and sex of an individual, lung volumes and capacities vary with age [12]. In the present study, no significant difference was found between the Vital Capacity and Phonation Quotient among both the groups. These results are in consensus with the research findings by investigators who found no significant difference between wind instrument players and the non-wind instrument participants[1, 8, 3, 10, 12]. These findings suggest that playing the wind instrument did not increase the Vital Capacity. In contradiction to this, some of the investigators found significantly greater Vital Capacity in brass players than in non-wind instrument participants[4, 11]. Moreover, if wind players do have greater Vital Capacity than normal healthy individuals it may be because those people with small Vital Capacity may find it difficult to achieve professional levels of performance on the wind instruments and therefore less likely to pursue wind instrument performance as a career[4]. But the results of the current study indicate that large Vital Capacity is not necessary for successful wind instrument playing. It is worth mentioning here that all the participants had more than 6 years of training/experience in playing wind instrument. It was interesting to know that Vital Capacity in one participant who played the Nadaswaram for 10 years was found to be greater. Whereas, the training and experience of about 6 years did not show an increase in Vital Capacity among the Flute and Saxophone players. This increase in the Vital Capacity can be confounded by various factors such as age, body mass index etc[12].

Conclusion

To conclude, the wind instrument players included in this study had higher Peak Flowindicating good strength of the expiratory muscles which are required for efficient playing of the wind instrument. It is understood by the results that the Vital Capacity is not mandatory for successful wind instrument playing.Future research on this aspect could consider factors such as height, weight and body mass index while measuring the aerodynamic and acoustic parameters and may also be attempted on a larger sample with varieties of musical instruments.

Post hoc results for Peak Flow:

Groups	Flute	Saxophone	Nadaswaram
Flute		0.00 *	0.00 *
Saxophone	0.0*		1.0
Nadaswaram	0.0*	1.0	

Table 1: Representing the post hoc results for Peak Flow within the wind instrument players.

Post hoc results for Phonation Quotient:

Groups	Flute	Saxophone	Nadaswaram
Flute		0.02*	0.05*
Saxophone	0.02*		1.0
Nadaswaram	0.05*	1.0	

Table 2: Representing the post hoc results for Phonation Quotient within the wind instrument players.

Illustration for the figures

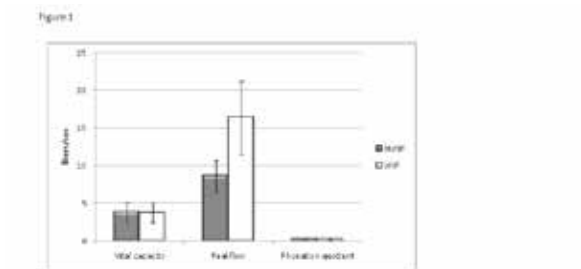


Fig 1: Represents the aerodynamic measures with mean± standard deviation between the wind instrument players and non-wind instrument participants.

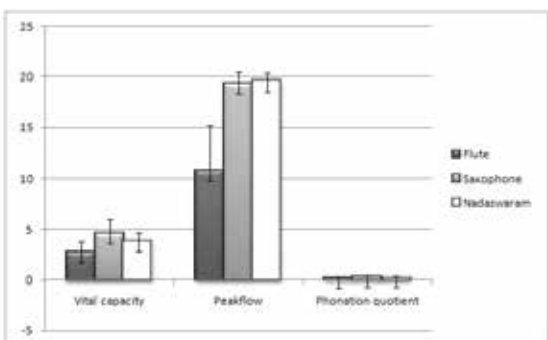


Fig 2: Represents the aerodynamic measures with mean± standard deviation within the wind instrument players.

REFERENCES

1. Akgün, N., &Ozgönül, H. Lung volumes in wind instrument (zurna) players. American Review of Respiratory Disease 1967, 96, 946-51. | 2. Baines, A. (1967). Woodwind instruments and their history. London: Faber and Faber. | 3. Borgia, J. F., Horvath, S. M., Dunn, F. R., Von Phul, P. V., &Nizet, P. M..Some physiological observations on French horn musicians. Journal of Occupational Medicine1975, 17, 696-701. | 4. Bouhuys, A. Lung volumes and breathing patterns in wind-instrument players. Journal of Applied Physiology 1964, 19, 967–75. | 5. Deniz, O., Savci, S., Tozkoparan, E., Ince, D.I., Ucar, M., &Ciftci, F.Reduced pulmonary function in wind instrument players.Archives of Medical Research 2006, 37(4), 506–510. | 6. Khuje, P. D., &Hulke, S. M. Comparative Study of Pulmonary Functions of Clarinet and Trumpet Players.Research Journal of Pharmaceutical, Biological and Chemical Sciences 2012, 3(2), 746. | 7. Middlesworth, J. L. (1978). An analysis of selected respiratory and cardiovascular characteristics of wind instrument performances. Unpublished dissertation. University of Rochester. | 8. Nauratil, M., &Rejsek, K. Lung function in wind instrument players and glassblowers. Annals of the New York academy of Sciences 1968, 155, 276-282. | 9. Sagdeo, M. M., &Khuje, P. K. Pulmonary Functions in Trained and Untrained Wind Instrument Blowers. People's Journal of Scientific Research 2012, 5 (2), 9-12. | 10. Schorr - Lesnick, B., Teirstein, T. A., Brown, L. K., & Miller, A. Pulmonary function in singers and wind-instrument players. Chest 1985,88 (2), 201–205. | 11. Tucker, A., Faulkner, M. E., & Horvath, S. M. Electrocardiography and lung function in brass instrument players. Archieves of Environmental Health 1971, 23 (5), 327–34. | 12. Zemlin, W. R. (1997). Speech and Hearing Science: Anatomy and Physiology (4thed.). University of Michigan. Allyn& Bacon. |