Research Article

Pulmonary Functions in Trained and Untrained Wind Instrument Blowers

Mohan Manohar Sagdeo, *Prashant Devidas Khuje

Department of Physiology, NKP Salve Institute of Medical Sciences & Research Centre, Nagpur (M.H.), *Chirayu Medical College & Hospital, Bhopal-462030 (M.P.)

(Received October, 2011) (Accepted June, 2012)

Abstract:

The present cross-sectional study was designed to ascertain whether regular and trained wind instrument blowers develop higher pulmonary functions than untrained or part time blowers.

The study included 155 trained & regular blowers (Group A), 100 untrained part-time blowers (Group B) and 100 non-blowers (Group C). They were investigated by a computerized spirometer (RMS medspiror).

Group A subjects showed a significantly higher (p<0.001) percentage predicted value for Forced Vital capacity (FVC), Forced expiratory volume in the 1st second (FEV_1), Peak Expiratory Flow Rate (PEFR), Maximum Voluntary Ventilation (MVV), Forced Expiratory Flow at 25% & 50% of FVC (FEF25% & FEF50%), Forced Expiratory Flow between 25% & 75% of FVC (FEF 25-75%), FEF50% of FVC, than the other two groups. However, FEV_1/FVC % in group A was not statistically higher than the other two groups (p=0.3699). Thus, regular training of wind instrument blowing increases the pulmonary functions which may be a physiological advantage of blowing.

Key Words: Wind Instrument, Pulmonary function test, Physiological effects.

Introduction:

Few studies conducted on wind instrumentalists have concluded that the wind instrument blowers have higher pulmonary functions (PFT) due to increased respiratory muscle strength, most probably the consequence of regular ventilatory muscle training (Fiz et al, 1993; Munn et al, 1990).

The study conducted by Bouhuy (1964) revealed higher vital capacity in brass players than the non-blowers. Barbenel et al (1988) showed that mouth pressure got increased with the increase in loudness in trumpet blowers as compared with the non-blowers. In similar study in trumpeters, Fiz et al (1993) found higher maximum inspiratory pressure (PImax) and maximum expiratory pressure (PEmax). Kahane et al (2006), concluded that the bassoon players had higher subglottic pressure during prolonged expiratory blowing activity. Cossette (2002) and Cossette et al (2008) showed that flute blowers developed higher mouth pressure during high intensity blowing and also observed that flautists used 72-83% of their vital capacity during flute blowing. Schorr-Lesnick et al (1985) found higher percentage predicted FVC in singers than the non-blowers i.e string and percussion instrumentalists.

The study conducted in similar occupation i.e. glass blowers by Zuskin et al (1993) revealed that glassblowers showed a significant increased forced vital capacity (FVC), forced expiratory volume in 1st second of FVC (FEV_1) and the maximum flow rates at 25% and 50% of FVC (FEF25% and FEF50%) as compared to non-blower controls. In all of the above studies, blowers were compared with the non- blowers, but there were no comparison between the trained and untrained blowers.

The present study was conducted to determine the effect of blowing the wind instrument by trained, untrained and non blowers on PFT.

Material and Methods:

The present cross sectional study included 355 male non-smoker normal subjects of age ranging between 20 to 50 years; out of which 155 were regular trained blowers currently employed in a performing role (Group A), 100 untrained part-time blowers who performed blowing only on occasions (Group B) and 100 non-blowers (Group C).

After obtaining the approval from the institutional ethical committee, we conducted the study at military music training center, Pachmarhi (M.P), various local band party centers at Nagpur & N.K.P Salve Medical College & Hospital, Nagpur (Maharastra).

Smokers and those suffering from any prevailing illness were excluded from the study. For purpose of study, a smoker was defined as a regular cigarette, cigar, bidi or pipe smoker up to a month prior

Corresponding Author: Dr. M.M. Sagdeo, Charushree Appt., Khare Town, Dharmpeth, Nagpur
Phone No.: 0712-2555859, 9823155859
E-mail : drsagdeo@gmail.com, drpdkhuje@ymail.com

to testing while a non-smoker was either an ex-smoker (ceased smoking for more than a month ago) or had smoked less than 1 cigarette or bidi per day in one year or 1 cigar per week in one year (Blackburn et al, 1959). Prevailing illness included any recent viral infection (within 2-3 weeks) or other acute illness (especially that involved the respiratory tract) and a serious illness such as recent myocardial infarction, pulmonary emboli, moderate to severe ascitis (Ferris, 1978).

The pulmonary function tests were performed by Medspiror, an automated, computerized flow sensing turbine type of Spirometer with an internal correction of volume with body temperature and pressure saturated (BTPS). All the subjects were made familiar with the procedure. The baseline data that is name, age, height, weight, body mass index, years of blowing, date of performing the test and atmospheric temperature was fed to the computerized medspiror. The test was performed in sitting position (Pierson et al, 1976). The parameters like FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 second, FEV1/FVC %: ratio of FEV1/FVC in %, FEF-25%: Forced expiratory flow of 25% of FVC, FEF-50%: Forced expiratory flow of 25% of FVC, FEF-75%: Forced expiratory flow of 75% of FVC, FEF25-75%: Forced expiratory flow between 25% & 75% of FVC, PEFR: Peak Expiratory flow rate, MVV: Maximum voluntary ventilation were recorded three times & the best of the three was noted. The percentage predicted values rather than the actual values were used for analyzing the data. The data was analyzed by using ANOVA one way for all the parameters except 'period of blowing' where unpaired *t* test was applied.

Results:

Out of 355 enrolled subjects, there were 255 trained and untrained blowers put together. Out of 255 blowers, 58 were trumpet blowers, 56 clarinet blowers, 36 euphonium blowers, 30 bag pipers, 23 cornet blowers, 17 saxophone blowers, 11 trombone blowers, 8 bugle blowers, 4 flutist, 3 each were French-horn blowers oboe blowers and bass blowers; 2 were sousaphone blowers and 1 was bassoon blower.

Table I: Age distribution of subjects in all the 3 groups.

Age in Years	Group A (n = 155)	Group B (n = 100)	Group C (n =100)
20 – 30	61 (39)	32 (32%)	38 (38 %)
31 – 40	62 (40%)	43 (43%)	40 (40%)
41 – 50	32 (21%)	25 (25 %)	22 (22%)

Age wise distribution of subjects is depicted in Table I. When overall age distribution in three groups was analyzed, it was observed that the mean age of Group B (35.5 yrs) was more than Group A (33.16 yrs.) and Group C (33.65 yrs). However, it was not statistically significant (p=0.0536). Basal metabolic index (BMI) was comparable in the three groups and the difference was not statically significant (p=0.3916). The mean period of blowing in years was more in Group B (14.08 yrs) than Group A (12.23 yrs), but the difference was not significant (*p*=0.0552; Table II).

Table II: Mean age, BMI and period of blowing in various groups.

Baseline Parameters	Group A (n = 155)	Group B (n =100)	Group C (n =100)	*p* value
Age (years)	33.16 ± 6.77	35.5 ± 7.74	33.65 ± 8.14	*p*=0.0536 NS
BMI (Kg/m2)	22.63 ± 2.17	22.44 ± 2.82	22.21 ± 2.18	*p*=0.3916 NS
Period of blowing in years	12.23± 7.23	14.08 ± 7.78	-	*p*=0.0552 NS

The mean predicted value of FVC, FEF25-75%, PEFR, FEF 50%, FEF 75% and MVV was significantly higher ($p<0.001$) in regular trained wind instrument blowers (Group A) than in Group B & C. However, when FEV1/ FVC% and FEF 25%, were considered no statistical difference was found in regular trained blowers and untrained non blowers (Table III).

Discussion:

The voluntary breath control is essential for playing wind instruments and the wind instrumentalists undergo continuous ventilatory muscle training (Fiz et al, 1993; Schorr-Lesnick et al, 1985). Training of ventilatory muscles follows the basic principle of training any striated muscle with regards to specificity, intensity and duration of training (Kisner & Colby, 2007; Kreuter et al, 2008, Wang et al, 2002).

Our findings of higher FVC and FEV1 values and slightly reduced FEV1/FVC value in trained blowers were supported by the study conducted by Schorr-Lesnick et al (1985) on brass wind instrument players where the percentage predicted FVC value (98.7 ± 13.1) and FEV1(103.5 ± 15.5) were higher in the blowers than the non-blowers (FVC=97.2 ± 13.8

Table III. Spirometric parameters in all the groups

Spirometric Parameters	Group A (n = 155)	Group B (n =100)	Group C (n =100)	*p* value
	Mean ± SD	Mean ± SD	Mean ± SD	
FVC (lits)	108.66 ± 12.17	104.17 ± 13.03	98.2 ± 10.87	< 0.001 *
FEV1 (lits)	110.34 ± 11.48	105.89 ± 11.53	100.6 ± 10.92	< 0.001*
FEV1/FVC %	101.74 ± 4.95	102.03 ± 4.75	102.59 ± 4.16	0.3699 NS
FEF 25-75% (lits)	84.60 ± 17.8	73.55 ± 9.08	71.49 ± 7.45	< 0.001 *
PEFR (lits)	104.61 ± 12.7	67.6 ± 10.04	67.56 ± 10.49	< 0.001 *
FEF 25% (lits)	96.20 ± 16.81	69.45 ± 8.65	67.56 ± 8.42	0.1057 NS
FEF 50% (lits)	73.83 ± 17.52	62.02 ± 9.19	60.3 ± 7.45	< 0.001 *
FEF 75 % (lits)	53.29 ±13.35	51.65 ± 8.83	50.42 ± 7.29	<0.001*
MVV (l/m)	109.53 ± 12.69	79.93 ± 10.09	76.08 ± 9.91	< 0.001 *

and FEV1=101.9 ± 17.6). Similarly in the blowers, the percentage predicted FEV1/FVC (78.0 ± 6.8) value was slightly less than the non-blowers FEV1/FVC (79.1 ± 9.4). Likewise, in the blowers percentage predicted MVV (118.2 ± 22.2) was higher than the non-blowers MVV (112.5 ± 25.2).

The studies conducted in a similar occupation i.e. glass blowers, by Munn et al (1990) and Navratil & Rejsek (1968) also supported our results of FVC, FEV_1 & FEV_1/FVC. In their study, the percentage predicted FVC and FEV1 were significantly more in full time glass blowers than part time blowers, and non-glass blowers.

Munn et al (1990) also showed higher percentage predicted mid expiratory flow (MEF), FEF 25-75% and MVV than part-time blowers and the non-blowers.

According to the hypothesis given by Schorr-Lesnick et al (1985), the musicians have exceptional pulmonary functions, a physiological advantage due to the respiratory muscle training. We also found higher pulmonary functions in our trained blowers. An explanation for higher FVC values in our trained wind instrument blowers might be due to their regular breathing pattern of using the whole vital capacity skillfully during the play with deep inspiration followed by prolonged expiration through the instrument. The greater FEV_1, FEF25-75%, FEF25 %, 50% & 75% and PEFR might be due to higher FVC in trained blowers. The low value of FEV_1/FVC in trained blowers than the other two groups might probably be due to greater FVC. The greater MVV in trained blowers could be due to the increased respiratory muscle strength, probably the result of regular ventilatory muscle training (Bouhuys, 1964; Munn et al, 1990; Fiz et al, 1993; Fletcher, 2000; Kreuter et al, 2008).

Other factors that were thought to influence the results included the motivation of the trained blowers and their regular physical (military) training. It would seem that our trained blowers may be motivated more by the traditionally adapted blowing maneuvers in military, related to an ability which the trained military blowers played in high regards. The physical military training in addition, might also cause strengthening of the respiratory muscles (Huang & Li, 1993).

It could be concluded that the trained wind instrument blowers had higher pulmonary functions than the untrained blowers and the non-blowers, which might be a physiological advantage due to regular training of blowing. The untrained blowers if blow regularly, can adapt proper blowing techniques.

Bibliograph:

1. Barbenel JC, Kenny P, Davies JB: Mouthpiece forces produced while playing the trumpet. *Journal of Biomechanics*, 1988; 21(5):417-424.
2. Blackburn H, Brozek J, Taylor HL: Lung volume in smokers and nonsmokers. *Annals of Internal Medicine*, 1959;51(1):68-77.
3. Bouhuys A: Lung volumes and breathing patterns in wind-instrument players. *Journal of Applied Physiology*, 1964:19:967-975.

4. Cheng YJ, Macera CA, Addy CL, Sy FS, Wieland D, Blair SN: Effects of physical activity on exercise tests and respiratory function. *British Journal of Sports Medicine*, 2003;37(6):521-528.
5. Chen FC, Weinreich G: Nature of the lip reed. *The Journal of Acoustical Society of America*, 1*996*; 99(2):1227-1233.
6. Cossette I, Monaco P, Aliverti A, Mackem P: Chest wall dynamics and respiratory muscle recruitment during flute playing. *The Journal of Acoustical Society of America*, 2008;123(5):3241.
7. Cossette I: Respiratory mechanics in professional flutist. *Revue des Maladies Respiratoires*, 2002;19 (2):197-206.
8. Ferris BG: Epidemiology standardization project (American Thoracic Society). *The American Review of Respiratory Diseases*, 1978;118 (6 pt-2):1-120.
9. Fiz JA, Aquilar J, Carreras A, Teixido A, Haro M, Rodenstein DO, Morera J: Maximum respiratory pressures in Trumpet players. *Chest*, 1993;104(4):1203-1204.
10. Fletcher NH: The physiological demands of wind instrument performance; *Acoustics Australia* 2000;28(2):53-56.
11. Hough A: Clinical assessment-Respiratory function Tests, Obstructive disorders & Pulmonary rehabilitation; An evidence-based approach to respiratory & cardiac management. In: Physiotherapy in respiratory care. 3rd Edn.; Nelson Thompson Ltd. U.K. 2001; pp55-59,90-91, 232-240.
12. Huang G, Li J: Study of respiratory mechanics in soldiers. *Hua Xi Yi Ke Da Xua Xue Bao*. (*The Journal of West China Medical University of Sciences)*, 1993;24(4):409-413.
13. Kahane JC, Beckford NS, Chorna LB, Teachey JC, Meclelland DK: Videofluoroscopic and Laryngoscopic evaluation of the upper airway and Larynx of professional bassoon players. *Journal of Voice*, 2006;20(2):297-307.
14. Kisner C, Colby LA: Management of pulmonary conditions, Breathing exercises & ventilation training. In: Therapeutic Exercise Foundations and techniques. 5th Edn.; E.A. Davis Company Philadelphia. 2007; pp.861-866.
15. Kreuter M, Kreuter C, Herth F: Pneumological aspects of wind instrument performance-Physiological, Patho-physiological and therapeutic considerations. *Pneumologie*, 2008;62(2):83-87.
16. MedSpiror Users guide/manual; Recorder & Medicare System, Chandigarh, India. Version 01;2004: pp5-46.
17. Munn NJ, Thomas SW, De Mesquita S: Pulmonary function in commercial glass blowers. *Chest* 1990;98(4):871-874.
18. Navratil M, Rejsek K: Lung function in wind instrument players and glassblowers. *Annals of New York Academy of Sciences*, 1968;155(1):276-283.
29. Padmavathy KM: Comparative study of pulmonary function variables in relation to the type of smoking. *Indian Journal of Physiology & Pharmacology*, 2008; 52(2):193-196.
20. Pierson DJ, Dick NP, Petty TL: A comparison of Spirometric values with subjects in standing and sitting position. *Chest*, 1976; 70(1):17-20.
21. Schorr-Lesnick B, Teirstein AS, Brown LK, Miller A: Pulmonary function in singers and wind instrument players. *Chest*, 1985;88(2):201-205.
22. Singh V: Pulmonary Function testing for Clinicians. Indian Asthma Care Society, Jaipur (India) 1999; p6-31.
23. Wang TG, Wang YH, Tang FT, Lin KH, Lien IN: Resistive inspiratory muscle training in sleep-disordered breathing of traumatic paraplegia. *Archives of Physical Medicine & Rehabilitation*, 2002;83(4):491-496.
24. Wanger J: Forced spirometry and related test. In: Pulmonary Function Testing: A Practical Approach. Williams & Wilkins Publication, Baltimore. 3rd Edn.;1992; p1-70.
25. Withers RT, Bourdon PC, Crockett A: Spirometric standards for healthy male lifetime non-smokers. *Human Biology*, 1989;61(3):327-342.
26. Zuskin E, Butkovic D, Schachter EN, Mustajbegovic J: Respiratory functions in workers employed in the glassblowing industry. *American Journal of Industrial Medicine*, 1993; 23(6): 835-844.

Source of Support : Nil.
Conflict of Interest: None declared.