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ORIGINAL PAPER

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Respiratory Function in Wind Instrument Players

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ABSTRACT

Introduction: Wind instrumentalists require a sophisticated functioning of their respiratory system.

Aim: The purpose of this research is to examine the function of the respiratory system of wind instrumentalists. **Material and Methods:** Thirty-two adult professional musicians from two philharmonic bands (Piraeus and Zografou Municipality) participated in the survey. Each participant, after completing a questionnaire given, went through two spirometric tests, one before and one after the rehearsal. The rehearsal lasted one hour and a half and included low-mid and high frequency notes. Respiratory volumes measured and analyzed were, vital capacity (VC), maximum expiratory volume of air in 1st second (FEV₁), forced vital capacity (FVC), forced expiratory flow (FEF), and Tiffenau index (FEV₁/FV%). **Results:** The results showed that: 1) Participants did not show any noticeable change in their respiratory volumes before and after rehearsal. 2) Wind instrument players do not have a VC greater than their predicted age, height, weight and gender. 3) There is no statistically significant difference between the first and second assessment of respiratory indicators for smokers and non-smokers. 4) Regarding the type of instrument: a) Those who played wooden instruments improved the FEV₁/FVC% indicator to a remarkable percentage between the first and second spirometry and b) individuals playing wooden instruments had a lower FVC, FEV₁ and VC score than those playing bronze. **Conclusion:** There is no significant strain sign in respiratory system even in smokers after exercising in wind instrument. There is an improvement in Tiffenau index in those who played wooden instruments between the two rehearsals. Undoubtedly, new research is needed to combine a respiratory disease scenario with a respiratory treatment program that involves practicing a wind instrument.

Keywords: Respiratory system, wind instruments, wind instrumentalists, Brass/wood wind instru-

ments, vital capacity, spirometry.

1. INTRODUCTION

Playing a wind instrument has been described as a breathing activity of the respiratory system. Its practice, which although is not a primary function of our respiratory system, is probably the most stressed respiratory activity. To be able to play a musical instrument, you must first learn how to accurately handle the flow of exhaled air, and you should also be able to create and maintain the proper pressure and flow of air required by each instrument (1). The physical properties of the wind instruments, in relation to the respiratory system, have been the subject of theoretical and practical studies. The results of these, however, are few and contradictory. Some authors claim that wind instrument players may have better pulmonary function due to the continuous exercise of respiratory muscles (2, 3, 4). Others found no difference (5, 6, 7, 8, 9) and some reported a reduction in respiratory function (10).

2. AIM

It is important to see whether factors such as smoking, a pathological respiratory tract, warm-up before rehearsal and the type of the wind instrument that they played are affecting performance. This will be investigated by this research, in which we will measure the pulmonary volumes of the participants before and after their practice.

3. PATIENTS AND METHODS

Sample: Twenty-three men and nine female professional wind instrument players, thirteen people from the band of Zografou and nineteen people from the Philharmonic Orchestra of the Municipality of Piraeus, aged 20-53 (average: 32,69 years old) participated in this research.

Their height ranged from 1.60 to 1.90 meters (average: 1.76 meters), while the weight was from 55 to 143 kg (average: 82.91). The professional experience of the players ranged from 3 to 35 years of practice (average: 17.75 years). Four participants out of thirty-two suffered from a respiratory disease (three asthmatic individuals, one with symptoms of emphysema), and two had heart diseases (one person with coronary artery disease, one with angina), and all the rest were healthy. Twelve people out of the total were smokers (37.5%), among them eight were serious smokers (up to 10 cigarettes per day) three people smoke 10 to 30 cigarettes per day and five heavy smokers, smoke more than 30 cigarettes per day. Four brass instruments (trumpet, trombone, tuba and horn) and three wooden instruments (flute, saxophone and clarinet) were studied. The ratio of brass and wooden instruments was 50/50.

Procedure: In order to proceed with the research we received approval from the National and Kapodistrian University of Athens (approval number:#20110070) and had the verbal consent of the members of the Philharmonic. Before the start of the spirometric procedure, each volunteer completed a questionnaire that provided information on the practice of the wind instrument, the history of respiratory diseases, and other personal data (smoking, height, weight, age, type of instrument, years of practice, etc.).

Spirometry: Cosmed's Pony spirometer was used for the spirometry in this study. Before each recording, the spirometer was calibrated to insure reliable operation. Each subject was asked to perform the following two maneuvers.

A. Forced Expiratory Maneuver: Subjects was asked to take a maximum inhalation, pinch their nose and then expire forcefully.

B. Maximum Ventilation Volume Maneuver: Subject was asked to take a maximum inhalation, pinch his nose and then exhale as deeply and rapidly as possible for 6 seconds. With the help of these two maneuvers three readings were taken and best of these was taken for calculation. The following parameters were chosen for the study: VC and FEV1 (forced expiratory air volume in 1st sec.). During these procedures, the spirometer also calculated the forced expiratory capacity (FVC), the forced expiratory flow (FEF 25-75%) as well as the Tiffenau index (FEV1 / FVC%). This process was repeated after 90 minutes of music rehearsal.

The statistical analysis was performed using the SPSS ver.14 (statistical package for social science).The Kolmogorov-Smirnov test and the normal probability plot were used to check the regularity of the distribution of measurements.

The comparison between the 1st and 2nd assessments was done using paired samples t-tests.

The comparison of the categorical variables associated to the respiratory indexes was performed using the independent samples t-test, while the correlation of the continuous variables with the above indexes was done by the Pearson correlation. P-value <0.05 was defined as a level of statistically significant difference.

4. RESULTS

Thirty two individuals, members of the Philharmonic bands participated in this study twenty three of which

	Average	Median	Standard Deviation	Minimum	Maximum	
Demographics	Age	32,69	31,00	7,65	20,00	53,00
	Height	1,76	1,76	0,08	1,60	1,93
	Weight	82,91	80,50	18,72	53,00	143,00
	BMI	26,48	24,90	5,01	19,47	44,14
	Professional Experience	17,75	16,50	8,24	5,00	43,00
	Professional Experience/ Age %	53,59	52,94	17,35	16,67	81,13

Table 1. Demographics of the sample.

	N	Percentage (%)	
Smoking	Yes	12	37,5
	No	20	62,5
Gender	Male	23	71,9
	Female	9	28,1
Participants	Zografou	13	40,6
	Pireaus	19	59,4
Warm up	< 30 minutes	23	71,9
	> 30 minutes	9	28,1
Instruments	Trumpet	7	21,9
	Trombone	4	12,5
	Saxophone	5	15,6
	Clarinet	9	28,1
	Flute	2	6,3
	Tuba	4	12,5
Instruments	Brass	16	50,0
	Wood	16	50,0

Table 2. Characteristics of the sample.

Variables	Rehearsal	Average	Standard Deviation	Average Deviation	95% Confidence interval	p-value	
FEV1	1st	3,85	1,26	0,07	-0,10	0,25	0.402
	2nd	3,78	1,09				
FVC	1st	3,47	1,05	0,00	-0,15	0,16	0,958
	2nd	3,46	0,91				
FEV1 / FVC%	1st	90,67	9,58	-2,93	-5,65	-0,22	0.065
	2nd	93,60	5,35				
VC	1st	4,21	1,11	0,08	-0,08	0,25	0.307
	2nd	4,13	1,03				
FEF	1st	4,65	1,39	-0,19	-0,49	0,12	0.218
	2nd	4,84	1,52				

Table 3. Comparison of respiratory indices over time.

were males and nine females. They were wood and brass wind instrument players (16 wood, 16 brass instruments). Table 1 and table 2 summarize the demographics and the characteristics of our sample, such as age, height, weight, BMI, professional experience, smoking condition, gender, warm up and instruments. We already know that male and female lung volumes will be different and our aim is to see the difference between the first and the second rehearsal.

As can be seen in table 3 there is no noticeable difference exist in all respiratory volumes after practice (for 1,5 hour) with the wind instrument (VC, FEV1, FVC, FEV1/FVC% and

	Variables	Rehearsal	Average	Standard Deviation	p-value
Smokers	FEV ₁	1 st	3,60	1,32	0,126
		2 nd	3,42	1,17	
	FVC	1 st	3,18	1,18	0,843
		2 nd	3,20	1,10	
	FEV ₁ / FVC%	1 st	87,98	10,70	0,067
		2 nd	92,38	6,49	
VC	1 st	3,91	1,19	0,650	
	2 nd	3,87	1,04		
FEF	1 st	4,26	1,23	0,412	
	2 nd	4,53	2,06		
Non Smokers	FEV ₁	1 st	4,00	1,23	0,963
		2 nd	4,00	1,01	
	FVC	1 st	3,64	0,95	0,853
		2 nd	3,62	0,76	
	FEV ₁ / FVC%	1 st	92,29	8,73	0,275
		2 nd	94,34	4,56	
	VC	1 st	4,40	1,05	0,364
		2 nd	4,28	1,01	
	FEF	1 st	4,89	1,45	0,375
		2 nd	5,03	1,11	

Table 4. Difference between 1st and 2nd rehearsal for smokers and non-smokers.

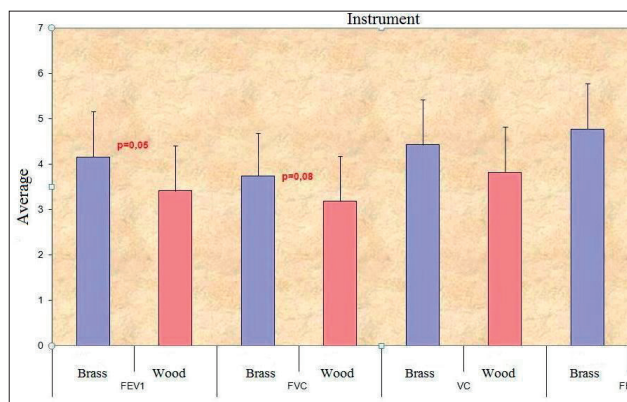


Figure 1. Respiratory volumes and type of wind instrument

FEF had a p -value $> 0,05$). This result is in alignment with recent research but is contradicted by past studies. We discuss the differences in the discussion section.

One interesting finding of our spirometry test can be seen in Table 4. In Table 4 we can see that there is no statistically significant difference between the first and second assessment of respiratory indicators for smokers and non-smokers. We have to consider that 37,5% of the participants were smokers and some of them heavy smokers (7 out of 12). That finding indicates that smokers and non-smokers stress their respiratory system the same way and smoking could not be a deterring factor for those who want to play a wind instrument.

In Figure 1 it is observed that there is a statistically significant difference between the individuals playing the brass and wooden instruments for the FEV₁ and FVC variables. Finally, in Table 5, we notice another significant difference according to instrument material.

We notice a statistically significant difference between the first and second rehearsal in FEV₁/ FVC% recordings

for those who play wooden instruments and in particular there is an improvement. Playing a wood wind instrument requires less effort because of the lower mouth pressure needed to reproduce sound.

5. DISCUSSION

The results from this research provide an introductory study for healthy individuals with an average age of about 33 years. Due to the limited sample, there is no possibility of generalizing the results of this survey. It is important to start surveys that will measure a significant number of people so that they can be generalized. In this study no significant change in their respiratory volumes was observed before and after the instrument was exerted. This is in contrast to Rohwer and Coffman (3), who observed a small increase, and agrees with the results of the research by Rohwer (8) who did not find any change. This may be due to the fact that playing techniques, such as stagger breaths and instant breathing, help the musicians to blow air intermittently. A further finding was that the wind instrumentalists did not show a higher VC than the predicted demographic data, despite the assumption that they need a large enough vital capacity to cope with intense respiratory work required for rehearsal. The same was supported by Van Middlesworth (6) and Anna Brzek (11). A few years ago, Borgia (5) and Nauratil (7) also found no significant difference in the wind instrument players' respiratory system compared to other individuals. Schorr-Lesnack (9) also argued that there was no significant increase in the respiratory volumes of instrumentalists (and singers) as a consequence of their practice Stauffer (4), Tucker (12) and Bouhuys (13) have shown that wind instrument players may indeed have greater vital capacity than the control group. It should be noted, however, that the control groups that participated in the Tucker and Bouhuys study were several unhealthy people. Finally, the sample of the Stauffer survey was entirely from the US military. The physical condition of soldiers is required to be good enough. Another important part of Stauffer's (4) research that makes it questionable is that there were no wind instrumentalists in his control group. On the contrary, Akgun and Ozgonul (14) showed that vital capacity and maximum exhaled airflow were remarkably sensitively smaller in zurna players than in the control group. This may be due to the fact that a significant number of smokers existed in their research sample. Omer Deniz et al (10) also found that there may be a reduction in respiratory function. In their sample, however, there were several people with respiratory problems (asthma and barotrauma) which predisposed the decline in pulmonary function.

Another finding of this research is that respiratory function of smokers and non-smokers showed no differences in their changes after the rehearsal. This homogeneity of the sample means that smokers strain their respiratory system, when practicing wind instruments, as well as the non-smokers. Also, despite the presence of four people with a history of respiratory disease, the sample was homogeneous in the statistical analysis of the measurements. Regarding changes in respiratory volumes and, consequently, respiratory distress, we did not find any differences between sub-

jects suffering from pulmonary diseases and other healthy subjects in the sample. Four elements were also found in the research on the type of instrument: A) Those who played wooden instruments improved the FEV1/FVC% marker to a remarkable percentage between the first and second spirometry (average: 89.54 first spirometry, 93.82 second, p-value = 0.030). B) People who played wooden instruments had a smaller FVC of 0.49 units than those playing brass. C) People playing wooden instruments had a lower FEV1 by 0.7 units compared to those playing bronze. D) People playing wooden instruments had a smaller VC index of 0.58 units compared to those playing bronze. The players of wooden instruments in this research had, from the first spirometry, smaller respiratory indexes than those playing brass. People with lower respiratory volumes may choose instruments with low airflow and air pressure levels, such as wooden ones. In particular, the trumpet and horn require very high pressures and low air flow rates (15, 16). The flute on the other hand requires low pressures to produce a note (17). The highest oral pressure refers to the tuba and in particular the production of high notes with it (pressure = 60-70 mm Hg) (2, 5,16,17, 18, 19). However, due to the limited number of investigations on the relationship between the type of wind instruments, respiratory volumes, and their changes, the above findings are an important reason for further research. Bouhuys' research (13) helps us understand the intraoral pressures and airflow levels required in each instrument (20, 21). However, it should be noted that the measurement of the pressures in his research was done with a tube which was placed at the tip of the mouth, which affected the production of high notions.

6. CONCLUSIONS

This research, as deduced from the relevant research, statistical analysis and the discussion above, confirms the international literature and agrees with the results of many researches of distinguished scientists. The finding that smokers did not show any differences in their respiratory stress compared to non-smokers can lead to the conclusion that the practice of a wind instrument can function proactively in the respiratory system of individuals who are chronic smokers, with regard to the appearance of a respiratory disease. Certainly, there is a need to investigate this issue as it concerns a large part of the population. Still, future research would be beneficial in terms of the prospects and pulmonary function of musicians who are in the process of quitting smoking. The fact that findings regarding the four individuals with respiratory problems did not vary compared to the other healthy subjects leads us to the likely conclusion that the practice of a wind instrument may have a positive effect on the respiratory function of a respiratory patient.

Undoubtedly, new research is needed which should combine a respiratory disease scenario with a respiratory treatment program that involves learning and practicing a wind instrument. In addition to the potential benefits these people will have in terms of their health and their daily routine (for example, reducing dyspnea, improving endurance, etc.), they will have the opportunity to socialize within the learning procedure.

Finally, in future research, it would be important to investigate the issue of breathing in the longer term, as there were several participants who noticed long-term rather than short-term benefits of breathing capacity from musical participation. Still, particular interesting would be to involve in research adults who have just started learning a wind instrument in order to collect elements that would create a clear cause-effect sign in the practice of a wind instrument and the improvement of pulmonary operating in the long run.

- **Author's contribution:** Bouros Evangelos (A) conceived of the presented idea. A and Vasileios Protogerou (B) developed the theory and performed the computations. Ourania Castana (C) and Georgios Vasiliopoulos (D) supervised the findings of this work. A. Carried out the experiment. A. wrote the manuscript with support from D. A. and B. performed the analytic calculations and performed the numerical simulations. All authors discussed the results and contributed to the final manuscript.
- **Conflict of interest:** None declared.

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