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Article

Do trumpet players have a greater expiratory capacity than those who do not play a wind instrument?

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SUMMARY

The following experiment tested whether students who play the trumpet have a greater expiratory capacity than students who do not play a wind instrument. To do this, we tested the peak expiratory flow (PEF) of two groups — the experimental group (the trumpet players) and the control group (the students who do not play a wind instrument). We matched 12 trumpet players and 12 controls for similar age, height, sex, and race. After students performed three attempts to blow into the peak flow meter, we recorded the highest PEF for each student. In order to test whether the data was statistically significant, a t-test was performed. The mean PEF for the experimental group was 378 L/min, and the mean PEF for the control group was 337 L/min. The *p*-value was 0.2433, indicating that there was no statistically significant difference in the peak expiratory flow between the experimental and the control group.

INTRODUCTION

The main function of the lung is to facilitate gas exchange between inspired air and the circulatory system. Breathing is a complex process that relies heavily on the coordinated action of the respiratory muscles, patency of the airways, ability of the lung and the chest to expand, and the control center in the brain. Each respiratory cycle begins with inspiration and ends with exhalation (1).

Many tests have been developed to measure the function of the respiratory system. For example, a laboratory test called spirometry can evaluate the inspiratory and the expiratory function by measuring the Forced Vital Capacity (FVC) and the Forced Expiratory Volume in the first second (FEV1), respectively (2). A portable device called a peaked flow meter has the ability to measure the peak expiratory flow (PEF), and this device is commonly used in asthmatic patients where their expiratory capacity needs to be monitored (3). Other types of tests are more complex, and they are able to measure the respiratory muscle power, lung volume, and gas exchange (4). According to the American Thoracic Society (ATS) and European Respiratory Society (ERS) statement on lung function testing, the measured value of a tested individual should be compared to healthy controls after matching for age, height, sex, and race (5,6).

Exercises to strengthen the respiratory system have been suggested to maintain healthy lungs. Healthy lungs are important to fight pathogens that attack the body and improve daily functionality and physical health (7). Many sports, especially swimming and running, require optimal air flow during exercise. Wind instrument players train to regulate the air flow during their musical performance. If playing a wind instrument has a positive impact on optimizing air flow during exhalation, it could be considered as a useful method to enhance respiratory function in sports programs for healthy athletes or even in pulmonary rehabilitation programs for patients with lung disease.

Many studies were previously conducted to evaluate whether playing a wind instrument helps lung function. A research team from the University of Sheffield performed a study on brass bands that were members of the Brass Bands England (BBE). Surveys were sent to all of the 200 bands that were part of the BBE. A total of 346 individuals above the age of 18 responded. 75% of the survey respondents had more than 10 years' experience, with 53% of the participants having over 20 years' experience. Of those 346 participants, 203 stated that they experienced improvement in respiratory health. Based on the reports of these respondents, playing a brass instrument helped their breath control and developed their lung capacity (8). Another study showed that playing brass instruments can improve symptoms and quality of life in patients with respiratory illnesses such as COPD (Chronic Obstructive Pulmonary Disease) (9).

The effect of playing wind instruments on the strength of respiratory muscles was also investigated with a study that evaluated twelve experienced male trumpet players between the ages of 19 and 26 and compared them to twelve inexperienced males between the ages of 20 and 26. The results showed that trumpet players developed stronger respiratory muscles and higher respiratory pressure, but this did not affect their spirometry (10). Similarly, Studer *et al.* investigated in a case control study whether playing trumpet affects lung function by using spirometry and found no difference between the study group and the control group (11). On the other hand, Arend Bouchuys showed in a different study that vital capacity was larger than expected for all brass players (12).

Since playing trumpet requires driving out a regulated air flow through the instrument, it is expected that this mechanic would have a strong effect on improving exhalation capacity. We hypothesized that if an individual plays the trumpet, then they will have a better peak expiratory flow than one who does not play the wind instrument. The purpose of this experiment was to evaluate whether playing the trumpet strengthens respiratory functions to the degree that it can improve peak expiratory flow. We conducted this study in healthy young individuals and tried to account for all confounding variables that could have affected the results of the prior studies such as age, height, sex, wind instrument type, race, and illness such as asthma, COPD, or chronic bronchitis. We found no difference in the peak expiratory flow between the students who play trumpet and the students who do not play a wind instrument.

RESULTS

The following experiment tested whether students who play the trumpet have a greater expiratory capacity than students who do not play a wind instrument. We tested the peak expiratory flow (PEF) of two groups — the experimental group (the trumpet players in the Pulaski Academy Band) and the control group (the students who do not play a wind instrument). There was a total 12 trumpet players and 12 controls. We used a peak flow meter to measure the rate of air that can be forcefully breathed out of the lungs after full lung expansion and we recorded the highest peak flow of three attempts for each student.

We matched the experimental group students with healthy controls based on age, height, sex, and race. The average age and height for the experimental group were 14.5 years and 165.4 cm, respectively. Twenty-five percent of the players in the experimental group were female and seventy-five percent were male. The experimental group had a mean peak expiratory flow (PEF) of 378 L/min and a median PEF of 365 L/min (**Figures 1, 2**), whereas the control group had had a mean PEF of 337 L/min and a median PEF of 340 L/min (**Figures 1, 3**). Though a majority of the trumpet players displayed higher PEFs than the control group, there were a few individuals from the control group who had a PEF greater than those in the experimental group (**Table 1**).

Both sets of data had a bell-shaped graph, indicating that the distributions were approximately normal and that the median and mean for each group was similar, suggesting that the average is a good representation of the sample (**Figures 4, 5**). To determine if there is a significant difference between the means of two groups, statistical analysis was done using t-test. The t-test resulted in a p-value of 0.2433. Since this value is not less than or equal to 0.05, the data is not statistically significant.

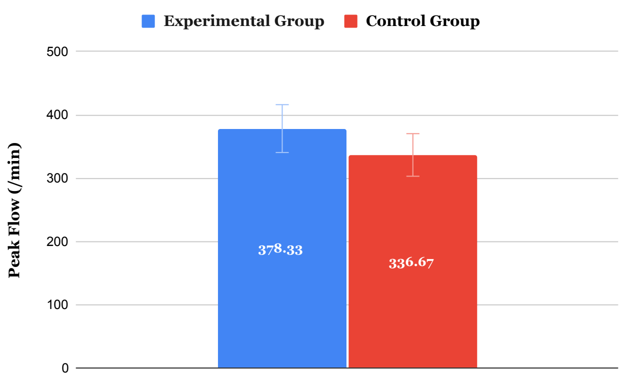

Figure 1: Comparison between the highest peak flow of the experimental group with the highest peak flow of the control group. The peak flow rate (L/min) was measured for students who play the trumpet (experimental group, blue, n = 12) and for students who do not play a wind instrument (control group, red, n = 12). The peak flow values (one value per student) were averaged, and the two groups were compared using a t-test (p-value = 0.2433). Error bars represent the standard deviation.

	Percentiles	Smallest		
1%	240	240		
5%	240	280		
10%	280	280	Obs	12
25%	295	310	Sum of Wgt.	12
50%	365		Mean	378.3333
		Largest	Std. Dev.	106.5861
75%	420	410		
90%	510	430	Variance	11360.61
95%	620	510	Skewness	.9112524
99%	620	620	Kurtosis	3.302141

Figure 2: Peak expiratory flow values for the experimental group. The experimental group had a mean peak expiratory flow (PEF) of 378 L/min with standard deviation of 106 l/min, and a median (50%) PEF of 365 L/min. Skewness of 0.9 is suggesting more normal distribution. (If the skewness number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution.)

DISCUSSION

Our experiment tested whether students who play the trumpet have a greater expiratory capacity than students who do not play a wind instrument. We found that students who play trumpet (experimental group) had a mean peak expiratory flow (PEF) of 378 L/min and a median PEF of 365 L/min, whereas the students who do not play a wind instrument (control group) had had a mean PEF of 337 L/min and a median PEF of 340 L/min. However, the p-value was 0.2433.

	Percentiles	Smallest		
1%	240	240		
5%	240	250		
10%	250	300	Obs	12
25%	310	320	Sum of Wgt.	12
50%	340		Mean	336.6667
		Largest	Std. Dev.	54.99311
75%	375	370		
90%	390	380	Variance	3024.242
95%	430	390	Skewness	-.2985287
99%	430	430	Kurtosis	2.541556

Figure 3: Peak expiratory flow values for the control group. The control group had had a mean PEF of 337 L/min with standard deviation of 55 L/min and a median PEF of 340 L/min. Skewness of -0.29 is suggesting more normal distribution. (If the skewness number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution.)

Trumpet Players	Grade	Peak Expiratory Flow	Non-Wind Instrument Players	Grade	Peak Expiratory Flow
Student A	8	310 L/min	Student A1	8	300 L/min
Student B	9	340 L/min	Student B1	8	320 L/min
Student C	9	390 L/min	Student C1	8	390 L/min
Student D	7	280 L/min	Student D1	7	370 L/min
Student E	7	280 L/min	Student E1	7	340 L/min
Student F	10	350 L/min	Student F1	11	380 L/min
Student G	10	410 L/min	Student G1	9	350 L/min
Student H	11	510 L/min	Student H1	11	430 L/min
Student I	12	620 L/min	Student I1	11	250 L/min
Student J	6	380 L/min	Student J1	6	340 L/min
Student K	6	240 L/min	Student K1	6	240 L/min
Student M	11	430 L/min	Student M1	10	330 L/min

Table 1: Data table showing Peak Expiratory Flow L/min for all students in the experimental group and control group.

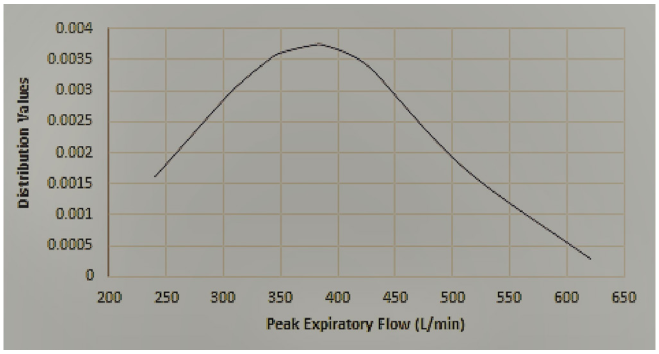

Figure 4: Distribution of the experimental group. Data had a bell-shaped graph, indicating that the distributions were approximately normal for the experimental group.

Since the result of the t-test was higher than 0.05, the null hypothesis (There is no difference in the peak flow between the experimental group and control group) was not rejected. Following experimentation and analysis, it was evident that several non-wind instrument players were not the most fitting controls for the students from the experimental group. A substantial number of students from the control group were student athletes and were more physically fit than the students in the experimental group and theses students have the highest peak flow value in the control group. While age, height, sex, and race contribute to the PEF (4-6), factors such as athleticism may also have an impact on a student's peak expiratory flow. Furthermore, beginning band students have less time practicing wind instruments when compared to the older trumpet players. More than likely, experience blowing into a wind instrument for a few months may not be enough to create a significant effect on the PEF of the beginner band students relative to their pairs in the control group.

Prior studies were conducted to evaluate the effect of playing a wind instrument on the symptoms only and have suggested some benefit (8,9). However, in conducting such a design, it is unclear whether the improvement in symptoms was related to the improvement in lung function. Other factors such as improvement of pre-existing lung disease related to the change in the medications or other metabolic factors in the body such as anemia or thyroid function may affect the symptoms. Also, it is not clear whether there is any correlation between the improvement of symptoms and the improvement in lung function as improving respiratory muscle strength in one study did not translate into a positive effect on vital capacity and airflow (10).

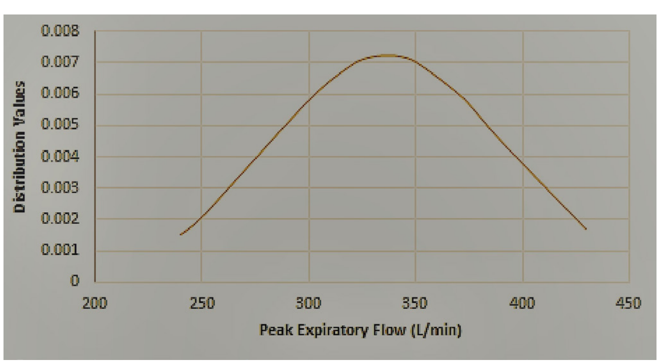

Figure 5: Distribution of the control group. Data had a bell-shaped graph, indicating that the distributions were approximately normal for the control group.

Studer *et al.* (11) previously addressed the same question of this study and investigated whether playing trumpet affects lung function. He used spirometry instead of a peak flow meter. His study found no difference between the study group and the control group. However, he did not address the major confounding variables that may affect the results of the spirometry. In his study, the control group was substantially younger than the study group and more commonly male. Male and younger individuals tend to produce higher FVC and FEV1 comparing to female and older individuals (5,6).

In this study, we accounted for variables that may affect our test results, and we matched the players in the experimental group with healthy individuals of the same age, height, sex, and race. We used one type of wind instrument to avoid the possible effect of different mechanics of blowing techniques on the experimental outcome. Also, we corrected for environmental factors that may affect the airflow through the device such as temperature, humidity, and atmospheric pressure. However, post-result analysis showed that there are more variables that should be addressed such as athletic level and the experience level of the wind instrument player.

Further studies repeating this experiment should choose students more scrupulously, taking in consideration factors such as the experience of trumpet players and the level of athleticism of the participants.

MATERIALS AND METHODS

In this experiment, the peak expiratory flow of trumpet players (experimental group) in the Pulaski Academy Band and the peak expiratory flow of students who do not play a wind instrument (control group) were tested. The independent variable of this experiment was the status of the participants: whether they were a wind instrument player or not. The dependent variable of this experiment was the peak expiratory flow of the students. The confounding variables were the age, height, sex, and race of the participants. The students were paired based on the confounding variables.

To measure the dependent variable, a peak flow meter device was used. A peak flow meter is a portable, hand-held device used to measure how air flows out from the lungs in one "fast blast". It measures the rate of air that can be forcefully breathed out of the lungs after full lung expansion. The device has a one-way valve that allows exhalation but no inhalation through the device. This device measures the peak expiratory flow in units of liters per minute (L/min). The peak expiratory flows of the general population for adolescent females and males based on age and height were used as a reference. If the measured value of an individual was below the low normal reference range or the student being tested had an active lung disease, then they were excluded from the experiment.

Before experimentation, consent forms were created, and all the students signed consent forms. The students were tested by using the same flow meter device, changing the mouthpiece filter between each individual. Each student had three attempts to blow into the device, and after each attempt, the result was recorded. The participants were tested at the same sea level altitude, room temperature, and humidity level (13). The highest peak expiratory flow of each student was selected and entered into the data table. After the results were recorded, a statistical analysis was performed using a t-test. This was done using Excel and the STATA 16 program. If the *p*-value of the t-test was less than 0.05, then results were statistically significant. Mask, hand sanitizer, and gloves were used for COVID 19 pandemic safety.

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