IB Biology HL

Independent Research Project – Vital Lung Capacity

Introduction

Breathing is an essential element for all corporeal organisms. In humans, and most mammals, it is done involuntary. This means that the brain maintains a constant automatic breathing pattern; in other words, we do not have to remember to breath. The four main elements that primarily consist of an inhalation are Oxygen, Hydrogen, Nitrogen and Carbon. These gases pass through our ventilation system, supplying our blood with the required oxygen to further deliver the oxygenated blood to the rest of the body. Oxygen is inhaled in our body through the mouth and/or the nostrils, and then passes through the trachea followed by the lungs and the diaphragm. When we breathe in these gases, our lungs expand. Much like balloons, lungs can only expand up to a certain volume. As for the lungs, this limit is referred to as the maximum amount of air that the lungs are able to contain, or the vital capacity. In this lab experiment, the following condition will be investigated. This study is focused on the differences in the vital capacity between subjects that have asthma and those that do not. Individuals with asthma have trouble breathing due to blockage of the airways.

A spirometer was used in order to measure and determine the vital capacity of each of the two participant groups: individuals with asthma and individuals without asthma. Respectively, the mean vital capacity values of both these groups were calculated and compared and contrasted with each other.

Based on medicinal investigation, it is hypothesized that there will be a minor difference between the average lung capacity of individuals with asthma and individuals without asthma. Confounding variables in this experiment such as the age of the subjects, the equipment used and the environmental factors in the testing situation are closely inspected to avoid any invalid results.

Design

Research Question:
Does having asthma affect the vital lung capacity of an individual?

Variables:

The independent variable was the individuals with asthma (or the asthma affliction itself). The dependent variable was vital lung capacity of each individual. It was measured through the use of a spirometer. The controlled variables in this experiment are as follows. The age of each participant was systematically checked in order to avoid the different stages that the asthma might be in within each individual. Also, the same spirometer for each participant, with a clean mouth piece as well. The gender of each participant was correspondingly checked to create equal experimental groups for it is well known that males have sturdier reparatory skills than that of compared to females. Lastly it was important to make sure that no par ticipant had any affliction of any kind that would have the capability to alter to final results such as a cold or a cough.

Materials and Procedure:

Material List:

- Clear Spirometer (1)
- Respective amounts of mouth pieces
- Appropriate calculating tools
- Individuals afflicted with asthma
- Individuals asthma free

Procedure:

Pre-procedural notes:

If you have any affliction such a cold or a cough, do not do this experiment. Certain factors such as prior vigorous physical activity with the hour of doing to experiment could alter the data. It is very important that the participant remains standing throughout the entire procedure in order to obtain the most accurate data recording possible. As for the technique on using the spirometer, the participant must exhale as hard and as fast as possible whilst making sure that all the air goes through the spirometer.

Procedure:

Procedurally, the experiment partakers must follow a few guidelines in order to be able to effectively collect data, individually, for the experiment. To begin with, participants must indicate if they are afflicted with Asthma. It is then very important that the spirometer is clean; this can be done by unscrewing the spirometer and wiping the inside compartment of the instrument with a paper towel . Then, once the spirometer is clean, attach a supplied mouthpiece onto the blowing tube of the spirometer to avoid any contagious afflictions from one participant to another. Next comes the actual measuring of data. First, make sure that the indicator loc ated at the top of the spirometer is clearly set to 0ml. Then, if required, take a few deep breaths in preparation to blow. Then, once ready, take as deep of a breath as possible and then exhale all of the inhaled air out o f the lungs as fast as possible, through the mouth piece while making sure that no air escapes. After completing the recorded breath, read the dial of the spirometer and write down the data (in units of ml). Repeat these steps for a total of 3 to 4 trials.

Data Collection and Processing

Table 1: A representation of the results of the vital capacity amongst participants not afflicted with asthma.

Participant number with Asthma	Trial	Vital Capacity in Liters (±0.1 liters)	Maximum VC Trial in Milliliters (±0.1 liters)
1	1	2.5	2.9
	2	2.9	
	3	2.8	
2	1	3.0	3.5
	2	3.5	
	3	3.4	
3	1	3.3	3.3
	2	3.0	
	3	3.3	
4	1	3.2	3.4
	2	3.2	
	3	3.4	
5	1	3.2	3.3
	2	3.2	
	3	3.3	
			Total Average: 3.28

Table 2: Each participant was asked to give 3 trails; hence on this table all three are shown. The maximum trial was used to calculate the total average of non-asthmatic contributors. Like numerous measurement devises, the uncertainty is the smallest division possible, (instrumental uncertainty) which is 0.1.

Table 2: A representation of the results of the vital capacity amongst participants afflicted with asthma.

Participant number with Asthma	Trial	Vital Capacity in Milliliters (±0.1 liters)	Maximum VC Trial in Milliliters (±0.1 liters)
1	1	2.1	2.3
	2	2.1	
	3	2.3	
2	1	1.9	2.3
	2	2.3	
	3	2.1	
3	1	3.0	3.0
	2	2.9	
	3	3.0	
4	1	2.8	2.9
	2	2.9	
	3	1.9	
5	1	3.2	3.3
	2	3.3	
	3	3.3	
		ml	Total Average: 2.76

Table 2: Each participant was asked to give 3 trails; hence on this table all three are shown. The maximum trial was used to calculate the total average of asthmatic afflicted contributors. Like numerous measurement devises, the uncertainty is the smallest division possible (instrumental uncertainty), which is 0.1.

Sample Calculation

The mean of participants who had asthma:

$$\bar{X} = \frac{\Sigma X}{N}$$

Mean = (2.3+2.3+3.0+2.9+3.3) / 5

Mean = (13.8) / 5

Mean = 2.76

The mean of participants who didn't have asthma:

$$\bar{X} = \frac{\Sigma X}{N}$$

Mean = (2.9+3.5+3.3+3.4+3.3) / 5

Mean = (16.4) / 5

Mean = 2.76

Data Presentation

Figure 3: The comparison between the average vital capacity of asthmatic and non asthmatic participants.

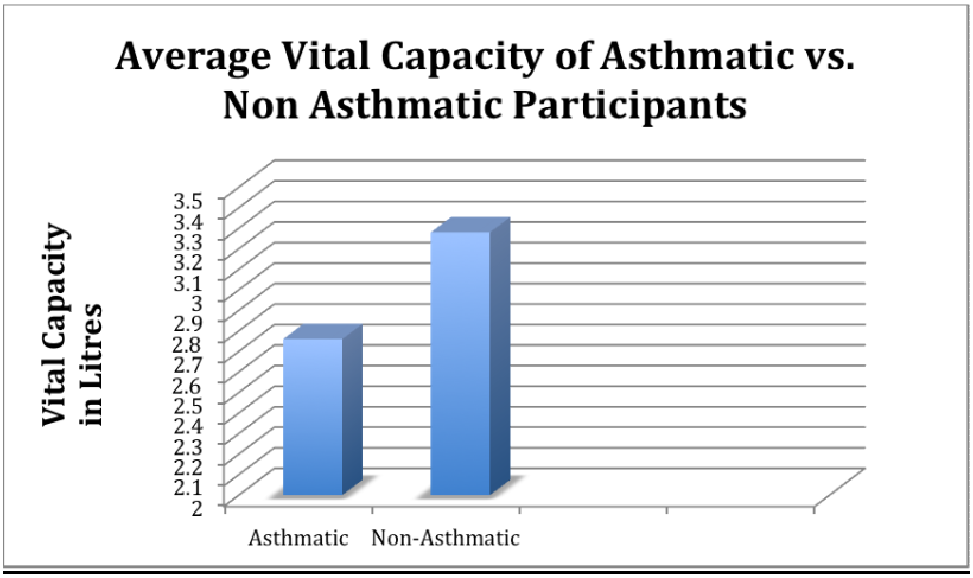

Figure 3:
The data shows the relationship between non asthmatic and asthmat ic afflicted participants. There is not much of a difference, but it is still clear that the non asthmatic participants do in fact have a higher mean.

Unpaired *t* test results

The following is an unpaired t-test calculated using graphpad.com and its Quick Calcs function.

P value and statistical significance:
The two-tailed P value equals 0.0485
By conventional criteria, this difference is considered to be statistically significant.

Confidence interval:
The mean of Asthmatic Participants minus Non -Asthmatic Participants equals -0.520
95% confidence interval of this difference: From -1.036 to -0.004

Intermediate values used in calculations:
t = 2.3255
df = 8
standard error of difference = 0.224

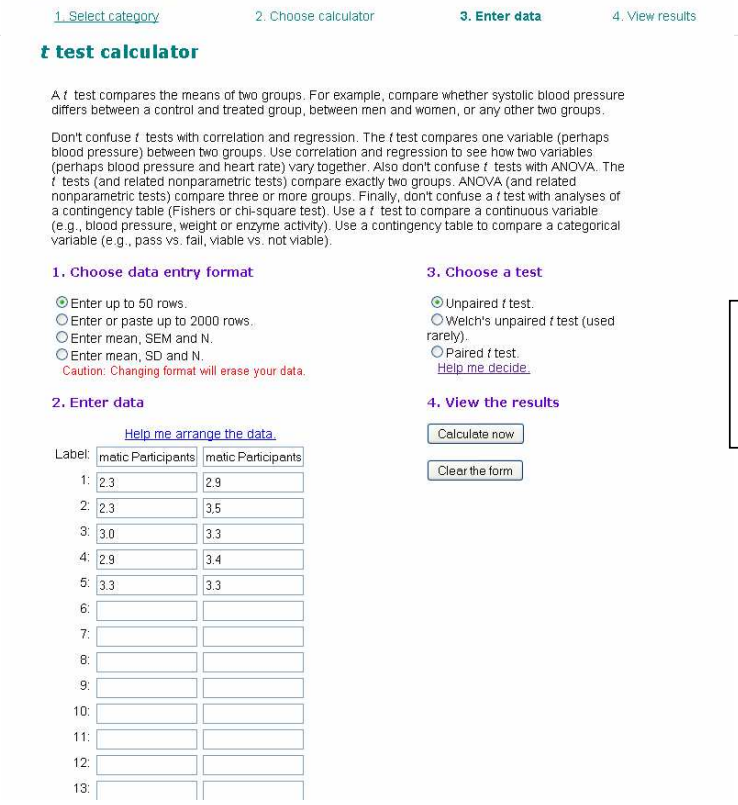

Figure 4:
A screen shot of the website and the data used to calculate a t-test.

Data:

Group	Asthmatic Participants	Non-Asthmatic Participants
Mean	2.760	3.280
SD	0.445	0.228
SEM	0.199	0.102
N	5	5

The degree of freedom of 8 and the P-value of 0.485 conclude that the null hypothesis can be accepted. The difference between the experimental groups is considered to be statistically significant.

Conclusion and Evaluation

Conclusion:

While following proper procedure, five participants were chosen to be part of the data after having their vital capacity measured through a spirometer. Each individual had to record three trials of their vital capacity

and their highest recorded data was used to calculate the mean of the experimental group, whether it was the asthmatic participants or the non asthmatic participants. While taking the instrumental uncertainty into account (which was ± 0.01) the average of the non asthmatic participant group turned out to be 3.28 liters. The average of the asthmatic afflicted participants was 2.76 liters. It was concluded, through the use of an unpaired t-test, that the data was statistically significant.

After the analyzing the data in this experimental research, it can be concluded that there is merely a slight difference in the liters of vital capacity exhaled by participants whom suffer from asthma and those whom do not. Specifically, there is only a difference of 0.52 liters. This isn't a big difference in but nonetheless it does support the original experimenter's hypothesis. Of course the reason why there is in fact this difference between the two groups can be reasoned from modern studies and research done for the cause of asthmatic symptoms. Asthma distresses the airways in the throat causing decreased stamina as well as hardiness of breath. Each individual afflicted with asthma has different variations in the severity of the swelling in the airways; some individuals might have only minor symptoms and other might have much more major symptoms. When the actual airways are swollen, air must travel through the esophagus in a much smaller and tighter manner hence, depending on the state of severity of asthma, the vital capacity can limited to those whom are afflicted with asthma.

In order to make the experiment as sound and efficient as possible, a few steps and precautions were set up in order to create a errorless method. Firstly, a modern type of spirometer was used to ensure validity in the data as well as the results. It was very important that no external factors were to negatively affect the data collection process for anyone. Such external factors included the regular cleaning of the inner workings of the spirometer itself as well as the constant use of mouth pieces to insure all the air to pass through the spirometer without escaping. Another factor that was called for was the variation of females to males, age and nationality. It is not clear if all these factors would in fact affect the data in any way, nonetheless caution was necessary. The amount of females and males in this experiment specifically controlled for it is known that males have higher vital capacities that females do, and a majority of either gender would affect the results. Lastly and most importantly, it was extremely imperative to make sure that no participant was enduring any asthmatic attack during their data recording.

There are always was in which experiments can be expanded in answering more broad and useful research question. Ascertaining in this very lab research, the experimenter could of have been able to include other forms of measurements such as the vital capacity of specifically females with asthma or only males with asthma. Also something as simple as the adding of more trials to the experiment for the participant could broaden and better the results when comparing individuals with and without asthma. Another conceivable approach would be to considerably change the variables of the

experiment. Such a change could be the comparison of the vital capacity of individuals with different ages, or even individuals with an athletic sensibility compared to those that are not.

Affiliated with this experiment is the assertion that researchers do not need to focus only on vital capacity with asthmatic patients but other factors as well when attempting to discover a cure. The more knowledgeable we are a bout such diseases, the more successful we will be in finding a cure .

Evaluation

In many experiments limiting factors and confounding variables make themselves present. In this experiment, such factors and limitations are a s follows. As stated earlier, asthma has been classified into different stages of severity; minor, moderate and severe. In this unambiguous experiment, there were no real instruments that were able to measure these different stages of asthma; hence this da ta was not used in the end result. This could of have lead to unconstructive changes in the current data processing result. The reason why it is important to include such information into this lab experiment

is because, depending on the state of the asthma tic symptoms that a patient has, not all of the inhaled air would of have been able to fully pass through the spirometer because of swollen (blocked) airways which could lead to changing the end result. Another solution so such limitations would be to include an aerobic aspect into the procedure, which would be able to somewhat identify the level of severity of an individual's asthmatic symptoms.

Another limitation that could of have affected this lab experiment was the time of day in which each of the t rials were recorded. Depending on the time of day, individuals might of have had different levels of energy and some might even of have had done physical exercise prior to the experiment. This could of have affected the result because of the correlation be tween psychical activity and the vital capacity measurements. Vital capacity is increased and strengthened after physical activity and the rate of breathing also is increased depending on the different energy outputs. This issue could be easily solved in only allowing participants to record their measurements on a certain time of day, making it a controlled variable.

Lastly, height is a factory that affects the vital capacity of the lungs. Height and vital capacity share a positive correlation, meaning t hat the taller and individual is, the higher the vital capacity will be. One way to fix this problem would be to spend more time in choosing the participants, having them measured in height before getting their vital capacity measured.