

Introduction

Background information

When I lived at home in Paris, I was relatively fit, I attended the an athletics club regularly and lived an active lifestyle. Seven months ago, I moved to a new school and stopped exercising for few months. Half a term into my school career, I decided to go jogging and found myself out of breath after only ten minutes. I was surprised that not having done any exercise in a couple of months could cause such breathing trouble. Another student told me that every time she goes jogging she's out of breath too. When I asked my friends more than half said they felt out of breath when running. I decided to try to find out why so many people get out of breath when they try running.

The lungs have a huge surface of alveoli, about 100m^2 of alveoli for a gas exchange surface. Air is moved into the lungs using the diaphragm muscle and the external intercostal muscles which contract to increase the volume of the thorax. Air enters the lungs down the trachea to fill the space in the thorax and equalise the pressure, as this happens the lungs fill with air and expand.

In the alveoli oxygen gas diffuses into blood capillaries through type I pneumocytes and carbon dioxide diffuses out in the same place. The movement of blood, and blood cells carries oxygen away from the alveoli and maintains a concentration gradient. This causes oxygen to continually diffuse into the blood in the capillaries of the lung. The same happens in reverse for carbon dioxide, blood continually brings more carbon dioxide to the alveoli, so there is always a higher concentration of CO_2 in the blood than in the alveolus, so the CO_2 is always diffusing out of the blood.

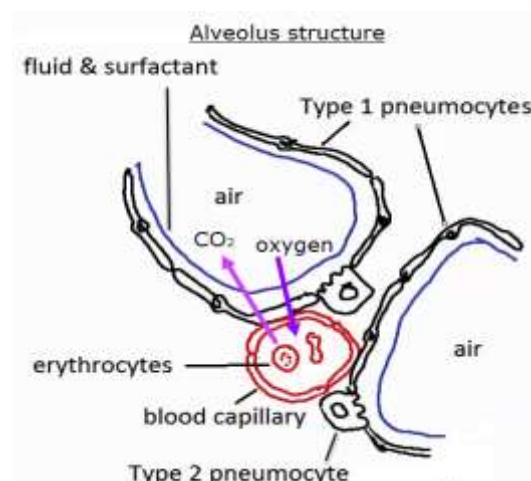


Figure 1 Diffusion in alveoli, D. Faure 2015



Research Question

By how much does the breathing rate increase when exercising? In particular does the breathing rate increase more from resting to gentle exercise, or more from gentle exercise to more intensive exercise?

Scientific rational – how is the experiment going to work?

So what are the factors which affect breathing rate?

1. People have different sized lungs
2. Some people smoke, or have lung damage from other causes
3. It is possible to breathe deeply or with shallow breaths
4. The pressure and temperature of the air may have an effect
5. When people think about their breathing it changes the rate.
6. The amount of respiration going on in the muscles
7. The carbon dioxide in the blood produced by respiration

If this experiment is going to answer the research question we need to control all the variables except the amount of respiration in the muscles and the carbon dioxide in the blood. These two are, hopefully, closely linked.

To control variables 1 and 2 we will use volunteers of approximately the same size, who don't smoke.

To control variable three we will do a simple singers' breathing exercise before the experiment which will encourage deep breathing.

By conducting all the experiments on the same day, variable 4, the pressure and temperature of the air, should be the same, so long as the exercises all take place in the same place, i.e. the lab, or outside.

Lastly to avoid the problem of participants thinking about their breathing rate we will measure pulse rate as a "distraction activity". Participants will count their own pulse for one minute while their partner counts the breaths that they take.

The experiment will test the resting breathing rate of all the subjects under three different conditions; resting, walking on the spot, jogging on the spot. This should provide data which will either support the hypothesis that rate increases more when doing vigorous exercise, or it will support the alternative, which is that the rate increases more from rest to gentle exercise.

The independent variable is the intensity of the exercise

The dependent, or experimental variable is the breathing rate, and as a bi-product of the method, the pulse rate.



Ethics / Safety

Ethics/Safety: students should be informed of the purpose of the experiment and asked to sign a consent form if they were happy to participate.

All students will be given access to the results and participants will be assigned numbers to preserve anonymity.

Students should be warned that if they feel light-headed they should stop the experiment and immediately sit down.

Trip hazards should be removed from the area near to the walking / jogging participants

Method

1. All participants do the breathing warmup, 3 times.
 - a. Take a deep breath, then breath out and say Ha Ha Ha Ha Ha five times
 - b. Allow yourself to breath in naturally
 - c. Repeat steps a & b two more times.
2. In pairs volunteers decide who is to be the experimenter and who will be the participant and do the exercises. The participant then sits calmly in a chair for 2 minutes.
3. After this the participant counts pulse beats, either on the wrist or on the neck, for one whole minute. The experimenter observes carefully the chest and abdomen of the participant to count breaths.
4. Record the two results in the table.
5. The participant then walks on the spot, at a rate of 80 steps per minute for two minutes.
le: complete 20 steps every 15 seconds.
6. The participant sits down and counts pulse beats, either on the wrist or on the neck, for one whole minute. The experimenter observes carefully the chest and abdomen of the participant to count breaths for one minute
7. The participant then jogs on the spot, at a rate of 160 steps per minute for two minutes.
le: complete 40 steps every 15 seconds.
8. After the 2 minutes, the participant sits down and counts pulse beats, either on the wrist or on the neck, for one whole minute. The experimenter observes carefully the chest and abdomen of the participant to count breaths
9. If there is time, the participant and the experimenter should now swap roles and repeat the whole experiment.
10. Make a note of any qualitative observations you have made while doing the experiment.



Figure 2 : taking a pulse
CC-BY from IABI on Flickr



Experiment: Observing breathing rates

Results

Student Number	Breathing rates / breaths per minute (+/- 1 beat per minute)			Pulse rate / beats per minute (+/- 1 beat per minute)		
	Resting	walking	jogging	resting	walking	jogging
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

** uncertainty figure is an estimate of the error, given that counting may begin just before or just after a breath / beat.

Analysis

The data processing must allow for a valid conclusion related to the research question.

Take another careful look at the research question and then analyse the results as if this was your IA Investigation. Present any calculated values in separate tables and show one example of the calculation method. Remember to include units and clear labels in tables and graphs.



Conclusion & Evaluation

Once the results have been processed, and trends are visible, if they exist, you have to write a conclusion which is

1. Relevant to the RQ
2. Uses the data to justify the conclusion
3. Is compared to the scientific context of the investigation

You should then evaluate the investigation by

Discussing

1. limitations of data
2. limitations of the method
3. sources of error/uncertainty

Suggesting

4. realistic and relevant improvements
5. realistic and relevant extensions to any unanswered questions.

