International Baccalaureate

Extended essay cover

Diploma Programme subject in which this extended essay is registered: BIOLOGY

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: IS BLOOD PRESSURE BEFORE AND AFTER EXERCISE INFLUENCED BY BODY MASS INDEX (BMI)?

Candidate's declaration

If this declaration is not signed by the candidate the extended essay will not be assessed.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: [signature] Date: 05/12/08

IB Cardiff use only: A: _____ B: _____

Supervisor's report

The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.

Name of supervisor (CAPITAL letters) _____

Comments

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

Kemunto wants to study Public Health at university and so chose this field of research for her essay. She modified her RQ to simplify her variables and finally investigated the relationship between BP and BMI. She consulted many websites during her research. She has a cross-trainer with sphygomanometer at home and so her experimental subjects visited her there. The statistical testing of data was a new challenge for her, as was writing an essay of this depth.

This is all her own work.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [K2.5] hours with the candidate discussing the progress of the extended essay.
Less than.

Supervisor's signature: _____ Date: 9/12/08

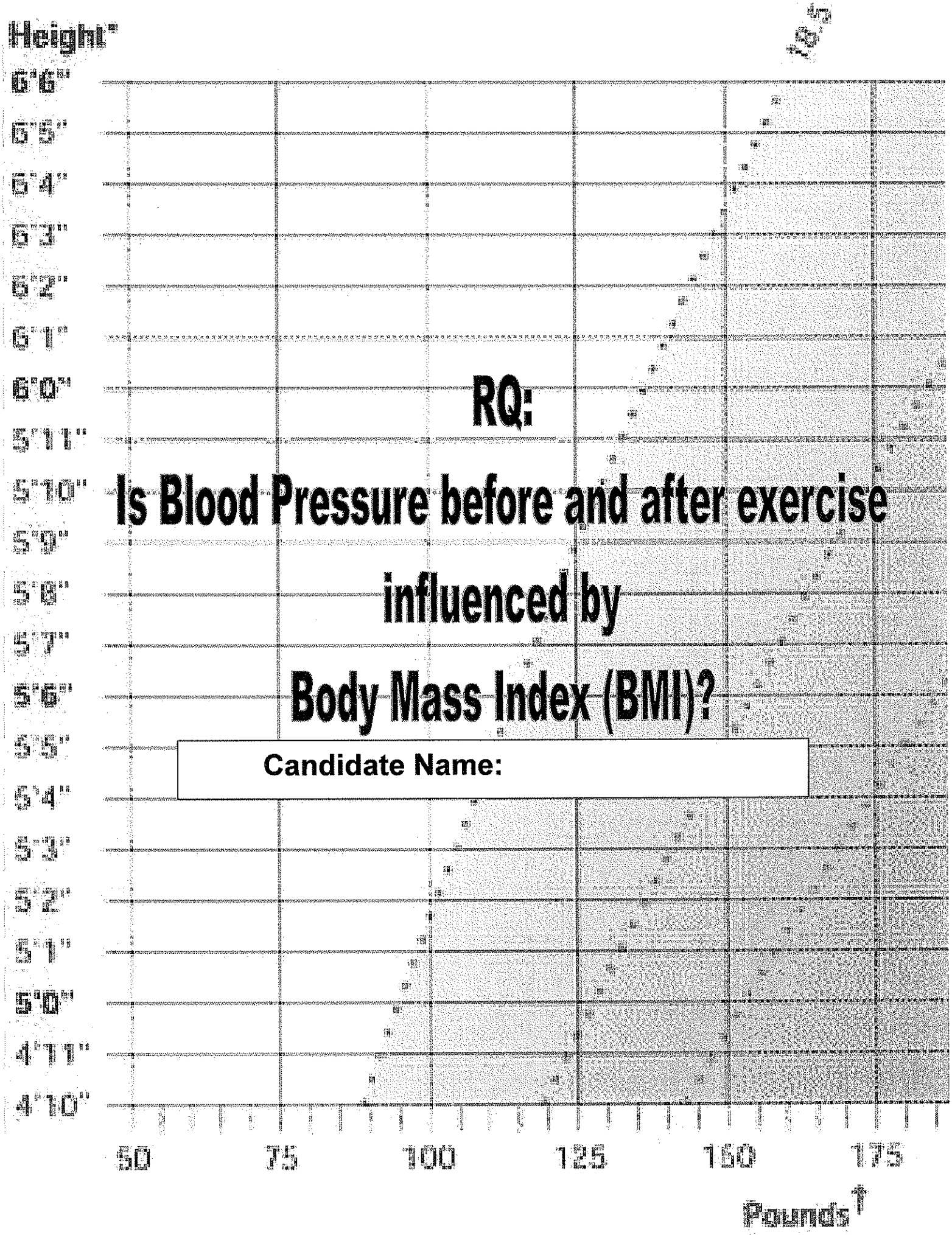
Assessment form (for examiner use only)

Candidate session number	0	0	

		Achievement level		
		First examiner	maximum	Second examiner
Assessment criteria	**A** research question	2	2	2
	B introduction	1	2	1
	C investigation	2	4	3
	D knowledge and understanding	2	4	2
	E reasoned argument	2	4	2
	F analysis and evaluation	3	4	3
	G use of subject language	3	4	3
	H conclusion	1	2	1
	I formal presentation	3	4	3
	J abstract	2	2	2
	K holistic judgment	3	4	3
	Total out of 36	24 ✓		25 ✓

Name of first examiner: _____ Examiner number: _____
(CAPITAL letters)

Name of second examiner: _____ Examiner number: _____
(CAPITAL letters)



RQ:

Is Blood Pressure before and after exercise influenced by Body Mass Index (BMI)?

Candidate Name:

Is Blood Pressure before and after exercise influenced by Body Mass Index (BMI)?

IB EXTENDED ESSAY

Supervisor:
Candidate No.:
Centre No.:
Centre name:
Session: 2009
Word Count: 4000
Date: 10th October 2008

ABSTRACT

There is little scientific evidence by the international community of there being a positive correlation between Body Mass Index (BMI) and blood pressure. I have decided to do my own research to try and see whether BMI has any effect on blood pressure before and after exercise and if so what these effects are. I then came up with my research question which reads: "Is Blood Pressure before and after exercise influenced by Body Mass Index (BMI)?" I came up with a simple practical method which involved calculating a sample of 30 of my friends' BMI and blood pressure before and after doing a short and mild exercise. I used a cross trainer for the exercise and measured their blood pressures with a sphygmomanometer. My friends then ran a short distance of 200 meters on the cross trainer and after I measured their blood pressures. I also had to measure their blood pressure before they did the exercise so as to compare the results. I used the formula (weight/height^2) in order to get their BMIs. These were my findings. In general the individuals with the lower BMIs who are considered to be either underweight or normal had a lower rise in pressure after the exercise than the individuals with the higher BMIs. After doing some extensive research I found out that there are plenty of other variables that influence blood pressure and so I drew up the conclusion that BMI is only one of the many factors that influences blood pressure.

TABLE OF CONTENTS

Not completely annotated.

INTRODUCTION

I was interested in finding out whether Body Mass Index (BMI) had any effect on blood pressure and this is how I came up with the research question; "Is Blood Pressure before and after exercise influenced by Body Mass Index (BMI)?" I decided that I would test this by carrying out a simple method that would allow me to calculate a person's BMI and have them do a small form of exercise while having checked their blood pressure and pulse rate before and after the exercise. I struggled to come up with a way to regulate the exercise in order for it to become a fair test and finally came up with a practical solution. I decided to use a cross trainer which made it possible for me to set the same pressure and distance my subjects would have to run. The exercise my friends had to do was run on the cross trainer for a distance of 200m. My friends were eager to help me carry this out so it was not a problem in getting a good sample size of at least 30 students.

Background Information:

What is Body Mass Index (BMI)?

BMI is the common acronym given to Body Mass Index

Definitions:

1. The Body Mass Index is a number calculated from your weight and height that roughly correlates to the percentage of your total weight that comes from fat, as opposed to muscle, bone or organ.[1]
2. The body mass index (BMI), or Quetelet index, is a statistical measure of the weight of a person scaled according to height. Body mass index is defined as the individual's body weight divided by the square of their height.[2]

If an individual's BMI is high this therefore means that they have a high percentage of fat in their body. According to scientists a person with a BMI under 18.5 is considered to be an underweight person. A person with a BMI ranging from 18.6-24.9 is a person with normal weight. A person whose BMI is between 25-34 is considered to be overweight and one whose BMI is over 35 is an obese person.

Unfortunately BMI is not a true reflection of your total body fat and this is one of the disadvantages of my investigation. BMI allows professionals to discuss over and underweight problems with their patients but is not relied upon for medical diagnosis because there are certain factors that influence whether or not your BMI is a true reflection of your total body fat.

The following is a BMI chart which shows a range of weights and heights with their corresponding BMI readings. The blue shaded area of the chart is a BMI that is considered to be underweight; the green shaded area is considered to be

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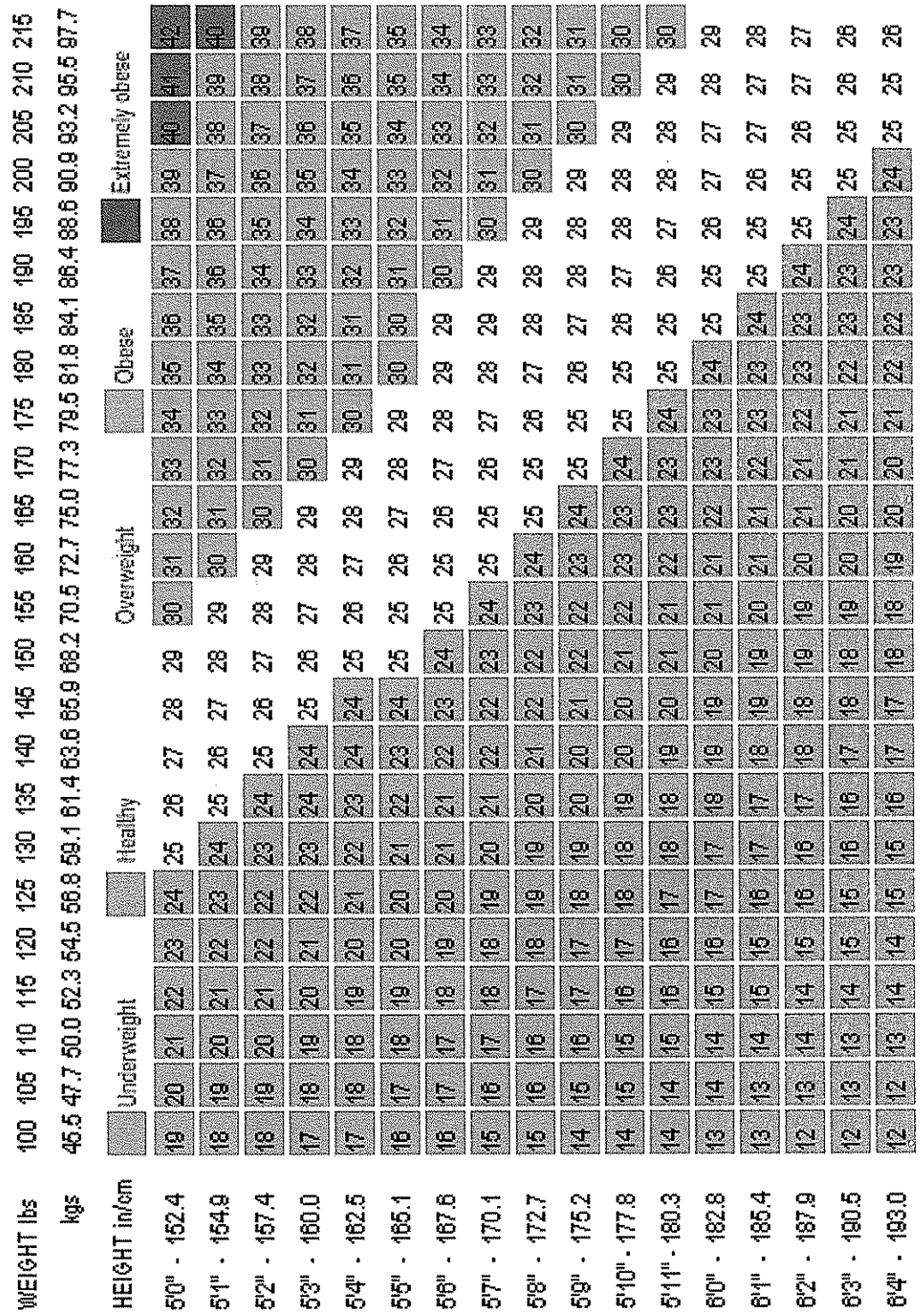
[1] http://www.wisegeek.com/what-is-bmi.htm#

[2] ^Eknoyan, Garabed (Jan 2008). "Adolphe Quetelet (1796-1874)—the average man and indices of obesity". *Nephrol Dial. Transplant.* **23** (1): 47-57. doi:10.1093/ndt/gfm517.PMID 17890752.

a healthy person; the yellow shaded area is considered to be an overweight person; the orange shaded area is considered to be an obese person and the red an extremely obese person.

BMI Chart



More about BMI

Adults whose BMI is between 18.5 and 22.9 have a low risk of developing heart disease and other health related problems such as diabetes. Those with a BMI between 23 and 27.4 are at moderate risk while those with a BMI of 27.5 and above are at risk of heart disease and other health related problems.[3]

BMI and heart disease are linked together in the sense that if you have a high BMI and are considered to be overweight, there is a high percentage chance of you getting some types of heart disease. This is not the case in all people because Lance Armstrong's BMI 22.8 (he is 5'11" and 165 lb) (180cm and 74kilo).[4] Your eyes can tell you that he is not overweight even though he was classified to be overweight by his BMI number. Although he did have cancer and I found that there is some evidence that BMI has been linked to cancer in some small populations.

Types of Heart disease linked with BMI

These heart diseases are linked to individuals with high BMI readings (those who are considered to be overweight).

- 'Atherosclerosis- The major underlying cause of cardiovascular disease has been associated with atherosclerosis. This is the buildup of fatty deposits within the walls of arteries that restricts the flow of blood.
- Angina- Arteries that supply the heart with blood may become narrowed due to atherosclerosis. This condition is called coronary artery disease.
- Heart Attack- If a blood clot in a narrowed artery blocks the flow of blood to the part of the heart muscle, a heart attack occurs. The section of heart muscle that does not receive the blood begins to die.
- Congestive Heart Failure- Prolonged high blood pressure, heart attack, and other cardiovascular diseases can cause congestive heart failure. The heart muscles may then lack the strength to keep blood circulating normally through the body. Blood flow slows and is inadequate to supply the body's needs. Blood returning to the heart is backed up, causing swelling. This is generally predominant in the ankles and legs. Kidneys may not work properly. As a result, fluid may collect in the lungs.'[5]

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[3] http://www.webmd.com/hypertension-high-blood-pressure/news/20031009/healthy-bmi-prevents-high-blood-pressure.com

[4] "Doctors Expose BMI shortcomings ." Freerepublic.com. 3 October 2008 <http://www.freerepublic.com/focus/f-news/1686387/posts>.

[5] "Types of Heart Disease, Atherosclerosis, Angina, Heart Attack, Congestive Heart Failure." Holsticonline.com. 3 October 2008 <http://www.holisticonline.com/remedies/Heart/heart_types-of-heart-disease.htm>.

Looking back at the idea that Your BMI is not a true reflection of your total body fat; I can use this as an example. Muscle is much denser than fat and also happens to occupy less space than fat does. Therefore a more muscled individual may have the same weight than a same sized overweight individual. This basically means that two individuals with the exactly identical BMI might have widely different percentages of fat in their bodies. Due to this limitations of BMI body composition for all athletes is often better calculated using measures of body fat as determined by such techniques as underwater weighing. It is also possible to use an immersion tank because fat is more buoyant than muscle. This therefore means that two same weight individuals will float at different levels if they have different percentages of fat in their respective bodies. Buoyancy is the ability of an object to float in a liquid, such as water.

The females typically carry more subcutaneous fat than the males. This fat is particularly spread around the beast and hips of the female body which means that the percentage of fat in their bodies may be higher without it always being reflected in their BMI or having any harmful health effects. On the other hand extremely low body fat which may not necessarily reflected in a BMI reading, depending on the person's musculature, may have some health hazards as well. This is because the human body needs store of fat. This fat is converted into energy when needed so as to keep us alive and breathing. If fat quantities are low, our bodies begin to consume the muscle mass so as to provide the extra energy needed. This explains why some athletes who over train may find themselves losing strength as opposed to their main goal which was to gain strength. BMI in approximation is a useful tool for us to evaluate whether we need to loose, gain or maintain our current weight. [6]

Some positive factors of BMI

- BMI is an indication for us to determine whether we need to loose, gain or maintain our current weight
- BMI is pretty simple for anyone to calculate and is also not time consuming
- BMI calculation is cheap because there is no expensive equipment used
- BMI has been used by the WHO as the standard for recording obesity statistics since the early 1980s
- BMI is used differently in children which allows for comparison with children of the same sex and age

[6] http://www.who.int/bmi/index.jsp?intropage=intro_3.com

Some negative factors of BMI

- BMI is dependent only upon net weight and height
- BMI makes simple assumptions about the distribution of muscle and bone mass
- BMI cannot be used in medical diagnosis
- A healthy individual may be classified as an overweight person using BMI due to the muscle mass in their body. E.g. Lance Armstrong when he was a competitor in the 1993 *Tour de France*
- BMI does not take into account other factors such as frame size and muscularity
- BMI is not a true percentage of body fat

Correction to BMI and BP?

✓

Agree! there needs to be more explanation of the correlation between BMI, heart disease and blood pressure

the academic content is not fully satisfactory.

✓

The human heart.[7]

The human heart pumps the blood into a system of arteries which branch into arterioles. Deep within the tissues the arterioles branch into capillaries where exchange of materials between blood and cells take place. From these capillaries, blood is collected up into a series of venules which then go up to form veins where the blood returns to the heart.
The heart goes through contraction (systole) as well as relaxation (diastole) rhythmically throughout our lives. In the course of a normal human life span the heart beats slightly over $2.5 * 10^9$ times, pumping a total over $1.5 * 10^6$ liters of blood from each of the two ventricles.

The rate at which the blood flows through the heart varies according to the body's need for the supply of oxygen and glucose, and for a need to remove metabolic products. The total volume of blood that is expelled from the heart per minute is known as cardiac output. Cardiac output is influenced by a few physical factors some of which include:-

- Rate of pumping – In the circulatory system, this rate is known as the heart rate which is the rate at which the blood is pumped by the heart. The higher the rate the higher the arterial pressure assuming that the stroke volume is the same.
- The volume of the blood – This is the amount of blood that is currently present in the body. The more blood in the body the higher the rate of blood return to the heart and the resulting cardiac output.
- Viscosity or thickness of the blood – If the blood at one point gets thicker then the result will be an increase in arterial pressure. Red blood cell concentration increases the viscosity and this is the reason why anemic people have low blood pressure.

When at rest the cardiac output is approximately 5 litres min^{-1}

What is Blood Pressure?[8]

Blood pressure is the term given to describe the pressure in the aorta and other major arteries in the human body. It is normally highest when the ventricles contract which is the systolic pressure and is at its lowest when the ventricles relax which is known as the diastolic pressure.

Blood pressure is often if not all the time measured in the brachial artery in the arm using a sphygmomanometer, a stethoscope, and a blood pressure cuff. A sphygmomanometer is an inflatable arm band connected to a manometer. The cuff is placed around the upper arm and filled with air. This tightening effect is used to stop the blood from flowing

[7] http://www.medphys.ucl.ac.uk/heart.com
[8] http://www.medphys.ucl.ac.uk/teaching/undergrad/projects/2003/group_03/whydet.com

through the brachial artery of the arm. The stethoscope is placed over the artery in front of the elbow and the pressure in the cuff is slowly released. No sound is heard until the cuff pressure falls below the systolic pressure in the artery, at this point, a pulse is heard.

As the cuff pressure continues to fall slowly, the pulse continues, first becoming louder, then dull and muffled. These sounds are called Korotkoff sounds. They are caused by the disturbance of the blood flowing through the vessel. The cuff pressure at the point at which the first sounds are heard, is defined as the systolic blood pressure. The cuff pressure at the point at which the sounds stop, is defined as the diastolic blood pressure. Any factor that increases resistance of the vessels to the flow of blood or that affects the amount of blood pumped by the heart will change the blood pressure. Therefore, the blood pressure reading is usually taken when the person is resting. Systolic blood pressure describes the pressure that is found in the arteries that carries blood away from the heart at its highest point. Diastolic blood pressure describes the pressure in the arterial system at its lowest point.

Blood is carried from the heart to all parts of your body in vessels called arteries. Blood pressure is the force of the blood that pushes against the walls of the arteries. Every single time that the heart beats (about 60-70 times a minute at rest); it pumps out blood into the arteries. Your blood pressure is at its highest when the heart beats, pumping the blood. This is called systolic pressure. When the heart is at rest, between beats, your blood pressure falls. This is the diastolic pressure.

A rise in blood pressure basically means that the heart is overworking and this really outs a major strain on the circulatory system. A fall in blood pressure can affect the functioning of some organs in the body such as the kidneys and this can be fatal. This is why it is crucial for blood pressure if possible be kept constant and within normal limits.

Blood pressure is always given as these two numbers, the systolic and diastolic pressures with both numbers being equally important. Usually they are written one above or before the other, such as 120/80 mmHg. The top number is the systolic (the contraction) and the bottom the diastolic (relaxation). When the two measurements are written down, the systolic pressure is the first or top number, and the diastolic pressure is the second or bottom number (for example, 120/80). This blood pressure is read as 120 over 80.Blood pressure changes constantly during the day. It is at its lowest when you are asleep and rises when you get up. It also can rise when you are excited, nervous, or active.

[9]Still, for most of your waking hours, your blood pressure stays pretty much the same when you are sitting or standing still. That level should be lower than 120/80. When the level stays high, 140/90 or higher, you have high blood pressure. With high blood pressure, the heart works harder, your arteries take a beating, and your chances of a stroke, heart attack, and kidney problems are greater.

[9] http://www.highbloodpressure.about.com/od/highbloodpressure101/a/sympart.com

What causes it?

In many people with high blood pressure, a single specific cause is not known. This is called essential or primary high blood pressure. Research is continuing to find causes. In some people, high blood pressure is the result of another medical problem or medication. When the cause is known, this is called secondary high blood pressure. There are some factors that are known to be correlated with high blood pressure. Some of which are:-

- Bad diet - consuming fatty foods, excess salt and so on
- Diseases such as diabetes
- Excess consumption of drugs or alcohol
- Obesity or excess weight and so forth
- Stress from work or anywhere else

What is high blood pressure?

A blood pressure of 140/90 or higher is considered to be high blood pressure. Both numbers are important. If one or both numbers are usually high, you have high blood pressure. If you are being treated for high blood pressure, you still have high blood pressure even if you have repeated readings in the normal range.

There are two levels of high blood pressure: Stage 1 and Stage 2

Category	Systolic (Top number)	Diastolic (Bottom number)
Normal	Less than 120	Less than 80
Prehypertension	120-139	80-89
High Blood Pressure	Systolic	Diastolic
Stage 1	140-159	90-99
Stage 2	160 or higher	100 or higher

(*starlit*:Health consequences of Anorexia and Bulimia and BMI calculations (part 3))

Low arterial pressure

In some circumstances people also do experience low arterial pressure and this is known as orthostatic hypotension. It can happen when someone who was sitting stands up dramatically. Gravity reduces the rate at which the blood returning from the body via the veins beneath the heart thus reduces stroke volume as well as cardiac output.

Other causes of low arterial pressure include:

-Hemorrhage – blood loss
-Toxins including toxic doses of blood pressure medicine
-Hormonal abnormalities such as Addison's disease
-Anorexia nervosa and bulimia nervosa. Anorexia if sever can also be the cause of some health problems which include:

- abnormally low heart rate, and risk for heart failure due to weakened muscles in the heart
- Reduction of bone density (osteoporosis)

- Muscle loss and weakness
- Severe dehydration, which can result in kidney failure
- Fainting, fatigue, and overall weakness
- Dry hair and skin, hair loss
- Growth of a downy layer of hair called lanugos all over the body, including the face, in an effort to keep the body warm.

BP + BMI Connection 2.

Connect in between BP and BMI not well established.

Difficult to follow the line of argument up to here.

METHODS

Methodology

This is the way I carried out my practical work of the investigation.

- Gather up a sample of at least 30 of my peers from the ages 16 – 19 whether male or female
- Set up cross trainer to same pressure
- Measure the teenagers' weight and height in order to calculate their BMI
- Take their blood pressure reading before doing the exercise
- Before doing the exercise check using the cross trainer that the person is at rest and their heart is not already beating fast to make it a fair test
- If their pulse is between 60 and 70 then you can begin the exercise. If not then wait for the person to be calm and if the reading is till not 60 – 70 do not use that individual.
- The exercise involves the individual getting on it and pushing the pedals on it as if one were riding a bicycle whilst standing
- Get the teenagers one by one to run on the cross trainer for a distance of 200 metres
- Take their blood pressure reading after doing the exercise
- Calculate their BMIs and record them in your results table
- Plot scatter graphs
- Test Hypothesis using Pearson coefficient test

Hypothesis

1. BMI influences blood pressure.

Variables

- Independent variables: - Body Mass Index (BMI), height, weight
- Dependent variables:- blood pressure, pulse
- Controlled variables:- type of exercise, length of exercise

The controlled variables will be kept constant by using the cross trainer so that the same amount of pressure applied to it is already set and this will make it a fair test rather than having people run a sprint. The cross trainer will make it easier for the individuals to run at a constant speed as opposed to determining the speed without the machine. This will try and make the results come from comparing the change in blood pressure after with the BMI rather than the amount of force put in the exercise.

what other factors were controlled and how?

Planning weak

RESULTS

RAW DATA

Results Table showing the sample of individuals with their corresponding blood pressures before and after exercise

Individual no.	Blood Pressure before (mm/Hg)	Blood Pressure after(mm/Hg)
1	120/80	123/83
2	124/82	129/87
3	124/80	127/83
4	121/82	127/87
5	120/83	123/83
6	122/81	126/86
7	119/80	122/84
8	120/80	122/82
9	113/78	117/81
10	120/83	125/82
11	122/81	127/84
12	120/80	125/80
13	115/75	119/80
14	120/80	124/85
15	124/82	129/82
16	124/80	127/88
17	121/82	124/82
	126/85	136/94
19	120/83	126/87
20	119/80	123/79
21	120/83	124/85
22	115/75	119/80
23	118/78	121/79
	128/87	139/96
25	121/82	128/90
26	120/83	127/89
27	121/81	125/88
28	120/80	124/84
29	124/82	128/88
30	124/80	132/88

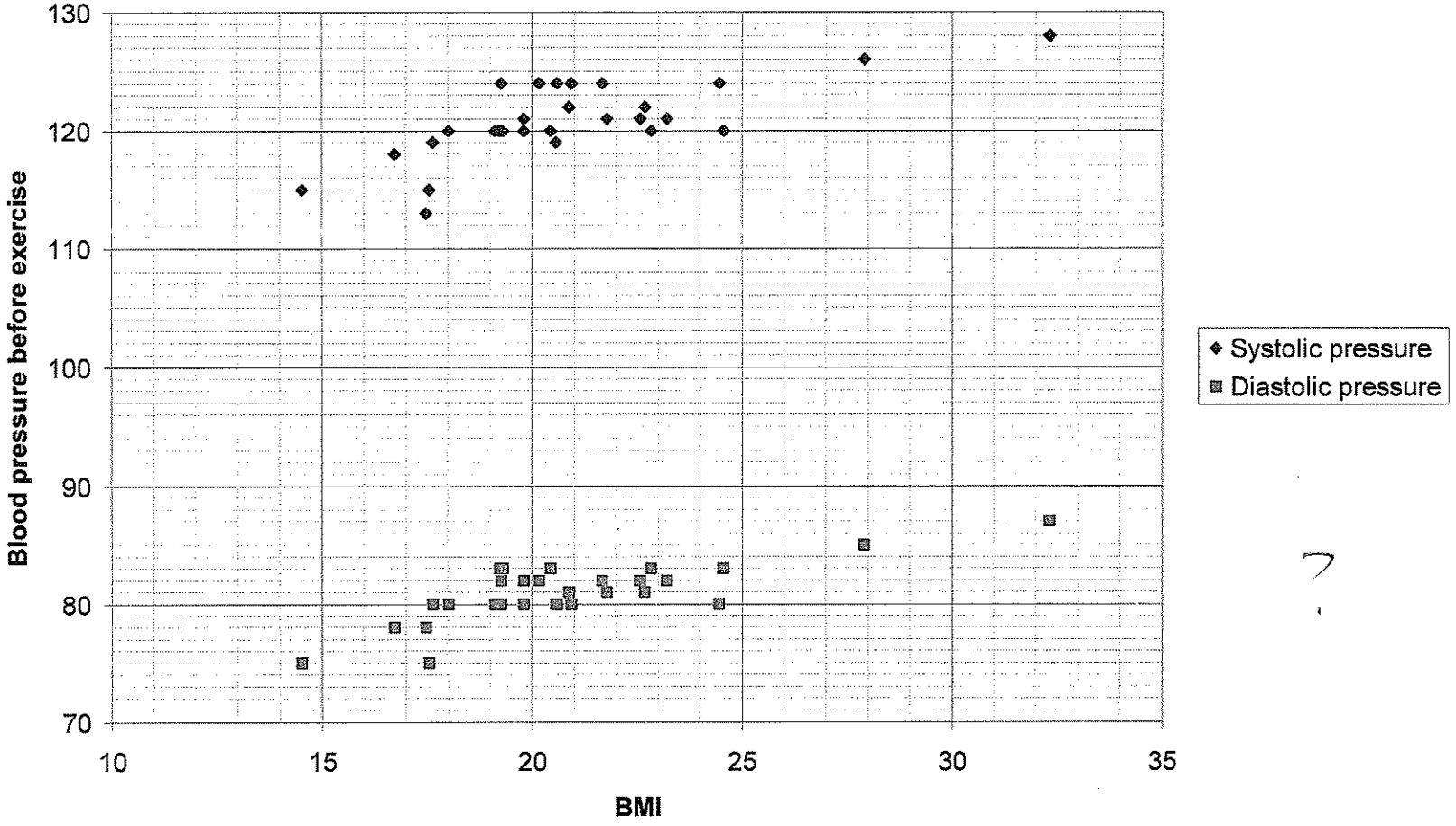
PROCESSSED DATA

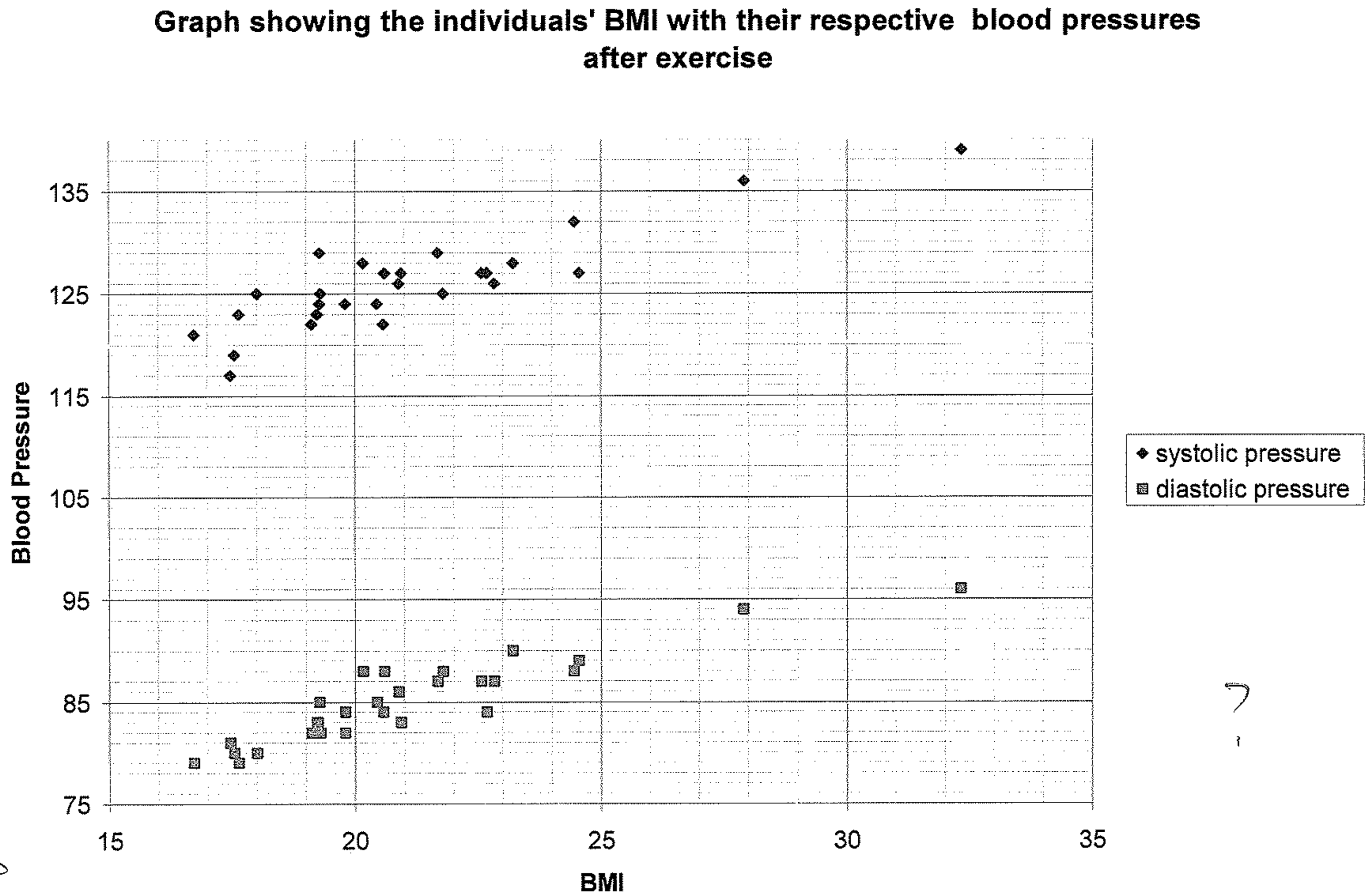
Results Table showing the sample of individuals with their corresponding heights and weights with their BMIs

Individual no.	Height (m) ±0.1 cm	Weight (kg) ±0. 05 kg	BMI[10]
1	1.56	45.56	19.21
2	1.60	55.45	21.66
3	1.80	67.78	20.92
4	1.83	75.54	22.56
5	1.56	46.77	19.22
6	1.78	66.13	20.87
7	1.66	56.65	20.56
8	1.67	53.28	19.10
9	1.75	53.46	17.46
10	1.65	52.52	19.29
11	1.57	55.89	22.67
12	1.76	55.76	18.00
13	1.66	48.32	17.54
14	1.56	48.87	19.26
15	1.72	56.98	19.26
16	1.63	54.67	20.58
17	1.71	57.87	19.79
	1.66	76.89	27.90
19	1.65	62.12	22.82
20	1.65	47.98	17.63
21	1.79	65.45	20.43
22	1.83	48.63	14.52
23	1.58	41.75	16.72
	1.56	78.64	32.31
25	1.55	55.73	23.20
26	1.55	58.96	24.54
27	1.76	67.42	21.77
28	1.66	54.54	19.79
29	1.65	54.87	20.15
30	1.75	74.85	24.44

[10] BMI calculation = weight(kg)/ height^2(m)

Graph showing the individuals' BMI with their respective blood pressures before exercise





Other relationships should be graphed!

ANALYSIS AND EVALUATION

Pearson correlation coefficient (*r*) test

I decided to do a Pearson correlation coefficient test to test for a correlation between blood pressure after exercise and Body Mass Index (BMI). My scatter graphs do suggest that there could be a correlation because there is an increasing gradient in the two graphs for both data. I used an excel spreadsheet which worked out the *r* values for both systole and diastole readings after exercise. The correlation is between the BMI and systole reading and BMI and diastole reading separately.

Hypothesis #2
There is no correlation between BMI and Blood Pressure

Pearson correlation coefficient test	Before exercise		After exercise	
	Systole	Diastole	Systole	Diastole
r =	0.74	0.78	0.89	0.91

Looking at these sets of data that I got in all cases they are greater than 0.7 which suggests that there is a good positive correlation between BMI and Blood Pressure after exercise. This is according to the types of correlation and their associated Pearson's rank co-efficient. Although this is the case I will not draw to quick conclusions because there are other variables that could be affecting the blood pressures. I will therefore agree with my first hypothesis and reject this second one because all the co-efficients are more than 0.7.

The graphs that I have are both scatter graphs. Generally if you take a look at it you can see that they both have positive gradients. The graph after the exercise has a slightly steeper gradient than the one before the exercise. Although because of the moderate positive correlation in both scatter diagrams it implies that blood pressure being the dependent variable is dependent on BMI which is the independent variable in the diagram. However this is not true because it may not be a causal relationship. In other words BMI is not the cause in the significant increase in blood pressure. It is but a mere factor which contributes in to the increase in the blood pressure. There are many other factors that do contribute to high blood pressure as I mentioned earlier. BMI is also not a true percentage of your body fat and therefore I cannot use it to say that it does influence blood pressure after exercise because I don't know the person's true percentage of body fat.

The tables of results that I drew show the individuals with their respective blood pressures before and after the exercise. All the individual's blood pressures did increase after the exercise which was expected but I did notice something. Even before the exercise, after I had taken the blood pressures, the individuals with lower BMIs also had lower blood pressures. The individuals with higher BMIs also had higher blood pressures. This could be a reflection on the relationship between the two factors; BMI

and blood pressure overlooking that there could be other reasons for this observation. The reason could be that high blood pressures could be hereditary in some cases or it could even be the dietary of the individuals. Those with high salt intake in their diets could be the ones with the higher blood pressures and the ones with the low salt intake could be the ones with the lower blood pressures. The individuals with high saturated fatty foods in their diets could also be the same ones with higher blood pressures than the ones with lower blood pressures. Other variables are the person's smoking status but I made this a fair test as my whole sample size was non-smokers. This should be something that I should not overlook next time. If and when I do this experiment a second time I must check my samples' dietary habits to find out how much salt they use in their diets and how much fatty foods they eat. Another possible reason for the higher blood pressures could be because the individual's heart is working harder than normal due to the person's relaxed lifestyle. This is something that I shouldn't overlook next time. I should beforehand inquire about my samples' lifestyle such as how often they exercise and also whether they are smokers or non smokers, etc. I think that the way I managed to control the exercise with the cross trainer to make it a fair test is a positive evaluation. Another modification that I should pay attention to is the sample size of the experiment. Although I had 30 samples which was a good thing, I only did the trial once. If I wanted to suggest anything from my hypothesis I would not be able to say that I am confident due to the relatively small number of trials. My method of picking the samples was not systematic or random; I basically just rounded up a bunch of my friends which in my opinion is biast and therefore not a fair test. Next time I should come up with a better method of choosing my samples, i.e.; Systematic random sampling. I could probably get the total number of students in school and pick the tenth person each time until I get my desired sample number. This would be a more practicable solution and fair test as well.

CONCLUSIONS

BMI is only one of the factors that influence blood pressure as I have said before and so to answer my research question I would say that blood pressure before and after exercise is influenced by Body Mass Index (BMI) to some extent. BMI is not a true reflection of your percentage of body fat and therefore one can have a higher BMI but only due to muscle and not fat. This is the case in Lance Armstrong. In this case this becomes an error in my results because I would think that the higher the BMI the higher the blood pressure. My results suggest then that my second hypothesis is wrong and I have rejected it because as when I look at my scatter diagrams I see that as BMI increases, so does blood pressure. Also from the Pearson's correlation co-efficient I see that there is a good positive correlation between BMI and blood pressure. Lastly BMI cannot be relied on for someone to know whether they are healthy or not as BMI does not give true percentage of body fat. BMI on the other hand is useful for people to know whether they need to loose weight or add it and basically to just keep track of their eating habits.

?

how + why?

Bear who in mind that correlation does not mean a causal relationship.

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adequate / relevant.

APPENDIX

RAW DATA

Results Table showing the sample of individuals with their corresponding heights and weights

Individual no.	Height (m) ±0.1 cm	Weight (kg) ±0. 05 kg
1	1.56	45.56
2	1.60	55.45
3	1.80	67.78
4	1.83	75.54
5	1.56	46.77
6	1.78	66.13
7	1.66	56.65
8	1.67	53.28
9	1.75	53.46
10	1.65	52.52
11	1.57	55.89
12	1.76	55.76
13	1.66	48.32
14	1.56	48.87
15	1.72	56.98
16	1.63	54.67
17	1.71	57.87
	1.66	76.89
19	1.65	62.12
20	1.65	47.98
21	1.79	65.45
22	1.83	48.63
23	1.58	41.75
	1.56	78.64
25	1.55	55.73
26	1.55	58.96
27	1.76	67.42
28	1.66	54.54
29	1.65	54.87
30	1.75	74.85