EXTENDED ESSAY

BIOLOGY

INVESTIGATING THE EFFECT OF THE WEIGHT OF THE LOAD ON THE HEIGHT DIFFERENCE OCCURRED ON SPINE

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ABSTRACT

My extended essay evaluates the effect of the heavy objects that we carry in our daily life on our spinal health. Spine is prone to degenerate when it exposes to external forces. I researched these effects on human health.

My aim is to observe the harmful effects of heavy objects that occurs as a result of a physical force on our spine. I chose to use fresh cadaveric sheep spines, 0.5 kg, 1kg,2kg, 5kg,10 kg loads and fluoroscopy device.

Therefore; my research paper examines the question: How does the weight of load, which is released from 30 cm height , affect the height of the fresh cadaveric sheep spine by compressing, that is calculated by measuring and observing the height difference and amount of damage in the spine with a fluoroscopy device, with stable temperature and pressure of the medium, stable height where loads are released and time of process?

My hypothesis states that increase in weight of load is going to decrease the height of the fresh cadaveric sheep spine.

Firstly, I measured the initial heights of the spines. Then, I released these objects from a 30 cm height. After, I measured the final heights and processed the obtained datas. I calculate percentage height difference 1.91 in setup 1 with 0.5 kg load, 2.57 in setup 2 with 1.0 kg load, 2.64 in setup 3 with 2.0 kg load, 21.1 in setup4 with 5.0 kg load and 34.3 in setup 5 with 10.0 kg load.

I realised that if the weight of the object increases, the height difference occurred on models also increases. Therefore, the hypothesis corrected.

As I considered my results, I deduced that the more we carry heavy objects in our daily life, the more we are under risk of damages and curvatures.

CONTENTS PAGE

INRODUCTION

The first time I recognized the topic of my extended essay when I was in my father's mother country Antalya for our festive holiday. We were always very excited to visit our relatives and also regale them. My father is a neurosurgeon. Therefore, beside our relatives also the patience of the town came our home in order to get examined, to show their MRI, to tell him their problems and to ask for a solution. One day an old man who has a different appearance than the other patiences came into our house. He had a hunchback; his head was almost touching his knees. I was a little bit afraid because I could not make sense of this situation. It seemed really fantastic to me. When we asked my father what is his problem, he explained us that, he was a porter when he was young. My father mentioned that, his back was leaned because of the heavy objects that created deformation on his spine.

Interested, I wanted to research this topic for my extended essay. I began searching and found out that according to the result of the research 70% of the people, including children, are under risk of spine problems that comes from our daily life activities. Numerous actions danger our spine health. For example, we are carrying heavy bags all day long for school and work. Effects of this physical force can be more damaging for young people and lead to observe permanent consequences. Although a great proportion of the societies are not fully aware of the importance of this situation, further results can be life threatening.

The spine is a flexible column. It has lots of function for all vertebrates. It plays an important role both in skeleton and nervous systems. Firstly, it maintains stability in position as wells as provides body strength. Secondly, it contains spinal cord that helps transmission of signs in nervous system from brain to other part of the body and controls reflex movements. Spine lies down from our head to our legs. It is like a bridge that carries 2/3 of our weight. The human vertebral column usually consists of 33 vertebra; the upper 24 are articulating vertebra, separated by intervertebral discs and the lower nine are fused, five fused in the sacrum and four in the coccyx. It provides the spinal canal, which houses and protects the spinal cord. [1]

[1] http://en.wikipedia.org/wiki/Vertebral_column

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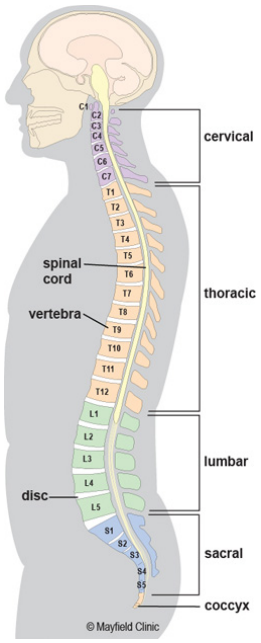

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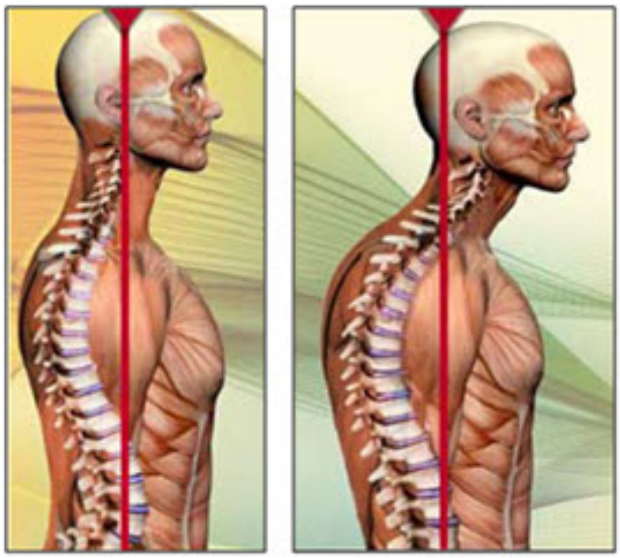

Spine has an interconnected structure which provide strength in order to not to bend. Although it is a robust support for our body, in some situations it can bend or get damaged. When a great pressure applied on a vertebrae, the minimalization of can be observed easily. size. Moreover, this minimalization cause to destroy disks and may occur some spinal curvature, the further affects may proceed to some break downs in this support system. Therefore, we need to be aware of the consequences and try to prevent the causes. First of all, we should be aware of our body strength and should not carry object that are too heavy for our individual body strength. In addition, we can also protect our spine health by additional factors. We should also sit properly, rest our backbone and exercise according to our age and weight daily.

There has been lots of studies that prospect the effect of ponderous objects on human skeleton and nervous system. These studies point out that ; spinal cord injuries occur when

[2]http://www.mayfieldclinic.com/Images/PE-AnatSpine_Figure2.jpg

[3]http://cdn.builtlean.com/wp-content/uploads/2011/11/posture-problems-3.jpg

blunt physical force damages the vertebrae, ligaments, or disks of the spinal column, causing bruising, crushing, or tearing of spinal cord tissue.[4]

After I considered my searchings, I had knowledge of the functions and structure of spine; also causes and possible risks for human health. I decided to do an experiment in which I can observe and show the phenomena effectively and also understand the outcomes by associating with the causes. In order to make efficient observations I thought I need to work with vertebra. However, one of the greatest limitations was that it is not appropriate to work with alive vertabrated organisms. Working with livestock can cause disturbance in their lives and the experiment that should be done can have harmful affects for their spinal health. As a consequence, I decided to work on a model which can reflect the results accurately and help in reaching the appropriate conclusion. I prefer small cattle rather than bovine animal in order to control the models easily and observe the deformation that will occur effectively. As a result, I chose to work on a fresh cadaveric sheep spine because I thought this model has all the properties that I, mentioned, need to conclude my experiment with accurate estimations.

While forming my experiment I considered all other factors that cause deformation on spine, but I decided to work on the effect of heavy objects that we carry in order to answer accurately my questions about the appearance of the porter man. I thought that I would need loads with different weights which I can use to animate the effect of ponderous objects to our spinal health. Therefore, I chose metal loads that we use in analog scale device. I use 0.5 kg, 1.0 kg, 2.0 kg, 5.0 kg, 10.0 kg loads in my experiment because I aimed to observe and compare the effects of lighter and heavier objects in a wider scale with detailed measurements.

I needed a measuring device in which I can get analyse the results in a concise way. Therefore, instead of using a 30 cm ruler as a height measuring device, I preferred digital C-armed fluoroscopy device that I can find in an x-ray unit easily. I chose this device because I thought using a digital device can let me to obtain more accurate results by providing images. Moreover, the obtained results would have small uncertainty values which can be beneficial to interpret the results effectively. After I chose all my materials, I built up my research question according for my paper which is;

[4] http://www.merckmanuals.com/professional/injuries_poisoning/spinal_trauma/spinal_trauma.html

How does the weight of load, which is released from 30 cm height , affect the height of the fresh cadaveric sheep spine by compressing, that is calculated by measuring the height difference and amount of damage in the spine with a fluoroscopy device, with stable temperature and pressure of the medium, stable height where loads are released and time of process?

HYPOTHESIS

There is an experiment of Journal of American Physical Therapy Association that supports; increased curvature and other damages in the thoracic spine is associated with higher spinal loads attributable to gravity and muscle force.[5] In addition, National Institutes of health also remarked that direct damage can occur if the spinal cord is pulled, pressed sideways, or compressed.[6] Evidences additionally suggests that these damages have also further affects like limiting daily life actions. For a similar reasons, these damages cause some physical changes like decrease in height of a person in early ages.

It can therefore hypothesised that; increase in weight of load, which is released from 30 cm height , is going to decrease the height of the fresh cadaveric sheep spine by compressing, that is calculated by measuring the height difference and amount of damage in the spine with a fluoroscopy device, with stable temperature and pressure of the medium, stable height where loads are released and time of process.

METHOD DEVELOPMENT

I constituted an appropriate method in order to support or reject verily the proposed hypothesis and answer the given research question brought about different problems with it. Firstly and the most important issue for me while planning this experiment is the policy about not to study on living vertabrated organisms. It was going to be a problem for me as I would need models that can help me observe, obtain accurate results and articulate analyses. After further research, I found out that I can make models from soft and hard materials such as foam and woods in order to give the texture of spine. However, I thought this models which

[5] http://ptjournal.apta.org/content/87/5/595.full

[6] http://www.nlm.nih.gov/medlineplus/ency/article/001066.htm

are going to be handmade is not a great choice because it is really hard to create the same structure with different materials. Therefore, I tried to find another solution. Firstly, I thought I can work with cadaveric models. Then, I decided to use small cattle, sheep, spine as their size is smaller and easy to control in an experiment. The problem was solved by deciding to use fresh cadaveric sheep spine for my investigation.

A further problem was that measuring the effects of loads was hard because there is a small weight difference between some loads that I selected such as 0.5 kg and 1.0 kg. This situation was a weakness of my experiment. I searched some measurement devices that can solve this problem. I mostly came across with rulers, tape measure, calipers which is a device used to measure the distance between two opposite sides of an object.[7] However, my father helped me and gave me an advice to do my experiment in the hospitals fluoroscopy unit where I can find a fluoroscopy device which is a device that would give me digital results with small uncertainty values. Therefore, I chose fluoroscopy device as a measurement device because I thought I would obtain accurate results.

Now it became important to make sure that all variables were being controlled. Temperature of the medium is important for this investigation. According to prevent some chemical reactions between the medium and model the temperature of the medium should not be optimum for any reactions that can occur.Therefore, the temperature should be stabilised in low values in order to prevent any reactions. When I consider all, I realised the fluoroscopy unit of the hospital is a great choice as I could find the fluoroscopy device easily and the controlled variables stabilised in appropriate values for my experiment: temperature stabilised at 18°C which is a low temperature that can prevent any reactions. As a result, by the help of my father I found a fluoroscopy unit where I can work effectively.

In addition, I acknowledged after few trials that it was necessary for models to be released from same height, so in order to stabilise the height that the objects released I measure 30 cm above the model and released the objects from that point.

On the other hand, in order to sustain the experiment verily, it needed strength. Therefore, I decided to do 3 trials for each set ups. Because of the experiment's strength results obtained from these trials would display more precise values. Moreover, the trials will facilitate the analysis of this experiment.

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[7] https://en.wikipedia.org/wiki/Calipers

MATERIALS

5 plastic tray

15 fresh cadaveric sheep spine

0.5 kg load

1 kg load

2kg load

5kg load

10 kg load

30cm ruler

Digital C-arm fluoroscopy device

Thermometer

Special air conditioning

Chronometer

METHOD

5 plastic trays are taken and located in fluoroscopy unit in the hospital where temperature and pressure is stabilised. Then, 5 different setups prepared. Models placed at the middle of trays. Initial heights of the models are measured with fluoroscopy device and recorded. 30 cm height above the model measured with 30 cm ruler and the 0.5 kg load is released through the first model. Then 1.0 kg load is released through the second model. 2.0 kg load is released through third model, 5.0 kg load is released through fourth model and 10.0 kg load is released through the fifth model. After, the final heights of the models are measured and recorded. This whole procedure is repeated 2 times more to diminish possible errors. Accessed datas are processed and interpreted by calculating the percentage height difference and the results are analysed with correlation test.

RESULTS

TABLE1: Includes masses of each load that released through 30 cm above the surface of the models with their time of free fall; initial and final heights of the models; temperature , pressure of the medium for 3 each trial of each load.

MASS OF LOAD (KG) (± 0.5)	TRIAL NUMBER	INITIAL HEIGHT (mm) (± 0.1)	FINAL HEIGHT (mm) (± 0.1)	TEMPERATURE (C)(± 0.5)	PRESSURE (mmHg) (±0.05)	HEIGHT LOADS RELEASED (cm)(± 0.5)	TIME FREE FALL ENDED (sn) (± 0.5)	MATERIAL OF PLATES
0.5	1	30.0	29.7	18.0	693.00	30.0	18.0	plastic
	2	29.7	29.2	18.0	693.00	30.0	23.0	plastic
	3	29.2	28.3	18.0	693.00	30.0	18.0	plastic
1.0	1	35.0	33.7	18.0	693.00	30.0	14.0	plastic
	2	35.2	34.4	18.0	693.00	30.0	15.0	plastic
	3	34.7	34.2	18.0	693.00	30.0	15.0	plastic
2.0	1	32.1	31.3	18.0	693.00	30.0	18.0	plastic
	2	31.2	30.3	18.0	693.00	30.0	18.0	plastic
	3	31.3	30.5	18.0	693.00	30.0	20.0	plastic
5.0	1	30.0	22.0	18.0	693.00	30.0	22.0	plastic
	2	34.1	28.3	18.0	693.00	30.0	21.0	plastic
	3	32.3	25.7	18.0	693.00	30.0	20.0	plastic
10.0	1	36.6	22.5	18.0	693.00	30.0	23.0	plastic
	2	36.5	25.0	18.0	693.00	30.0	25.0	plastic
	3	34.8	23.4	18.0	693.00	30.0	20.0	plastic

DATA ANALYSIS

Percentage height difference occurred under 0.5 kg load.

MEAN

of initial heights in each trial

(trial1+trial2+trial3)/3

=(88.9)/3

=29.63

MEAN

of final heights in each trial

(trial1+trial2+trial3)/3

=(87.2)/3

=29.06

HEIGHT DIFFERENCE

Mean of final heights - Mean of initial height

= 0.57

STANDART DEVIATION of height differences

[8]

$$SD=\sqrt{\frac{\sum(x-\bar{x})^2}{n}} = 0.31$$

STANDART ERROR

= standart deviation/ √3

=0.18

PERCENTAGE HEIGHT DIFFERENCE

100x Height Difference/ Mean of initial heights

= 56.6/29.63

=1.91

[8] http://www.thoughtyoumayask.com/picsbtqq/standard-deviation-formula-for-sample/8

TABLE2: shows mean of initial heights, final heights and height differences; standard deviation, standard error of 3 trails of each load with percentage height difference occurred after process.

MASS OF LOADS (kg)	MEAN OF INITIAL HEIGHTS	MEAN OF FINAL HEIGHTS	HEIGHT DIFFERENCE	STANDARD DEVIATION	STANDARD ERROR	PERCENTAGE HEIGHT DIFFERENCE OCCURED(%)
0.5	29.6	29.1	0.57	0.31	0.18	1.91
1.0	35.0	34.1	0.90	0.36	0.21	2.57
2.0	31.5	30.7	0.83	0.06	0.03	2.64
5.0	32.1	25.3	6.80	1.11	0.64	21.1
10.0	36.0	23.6	12.3	1.53	0.88	34.3

DATA ANALYSIS

Statistical Analysis: Correlation test was done to see the relationship between the masses of the released objects and the observed affects that the objects created by height difference.

Let X be the masses of objects as the independent variable.

Let Y be the height differences occurred as the dependent variable.

TABLE3: Shows the masses of objects (X), height differences (Y), product of mass and height difference (XY), square of mass (X^2), square of height difference (Y^2)

X	Y	XY	X^2	Y^2
0.5	**0.57**	**0.28**	**0.25**	**0.32**
1.0	**0.90**	**0.90**	**1.0**	**0.81**
2.0	**0.83**	**1.66**	**4.0**	**0.69**
5.0	**6.80**	**34.0**	**25.0**	**46.2**
10.0	**12.3**	**123.0**	**100.0**	**151.0**

∑X= 18.5

∑Y= 21.4

∑XY= 159.8

∑X² = 130.2

∑Y² = 199.3

correlation coefficient (r) [9]

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,][\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

=0.98

As a result the Pearson r, the correlation coefficient

r = 0.98 which can be considered a large effect as the more the r value gets closer to 1 the more the correlation is high.

Therefore, we can interpret that there is significant positive correlation between the masses of released object and occurred height differences.

p = 0.012

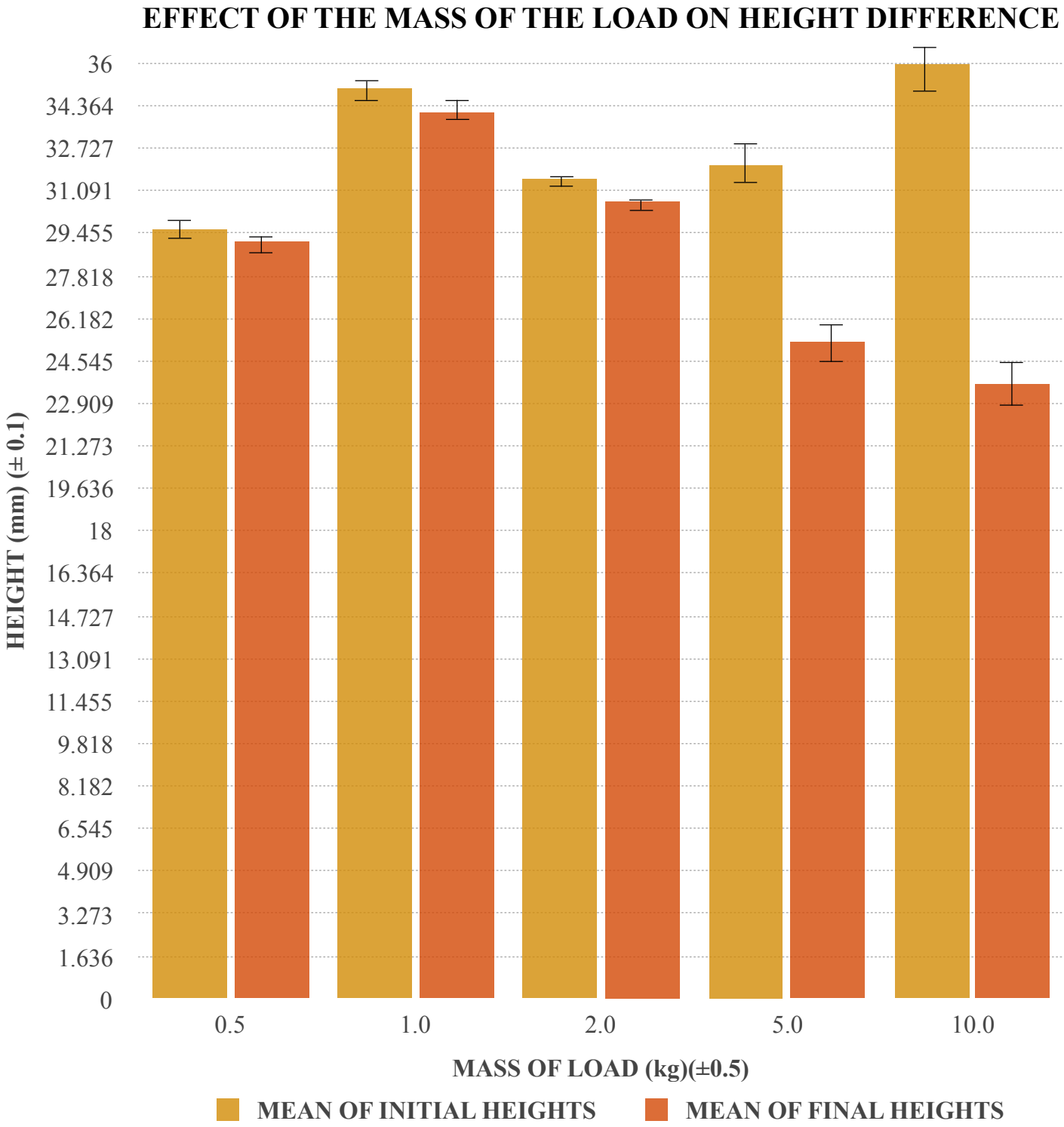
ALPHA p= 0.05

As my p value is less than 0.05,

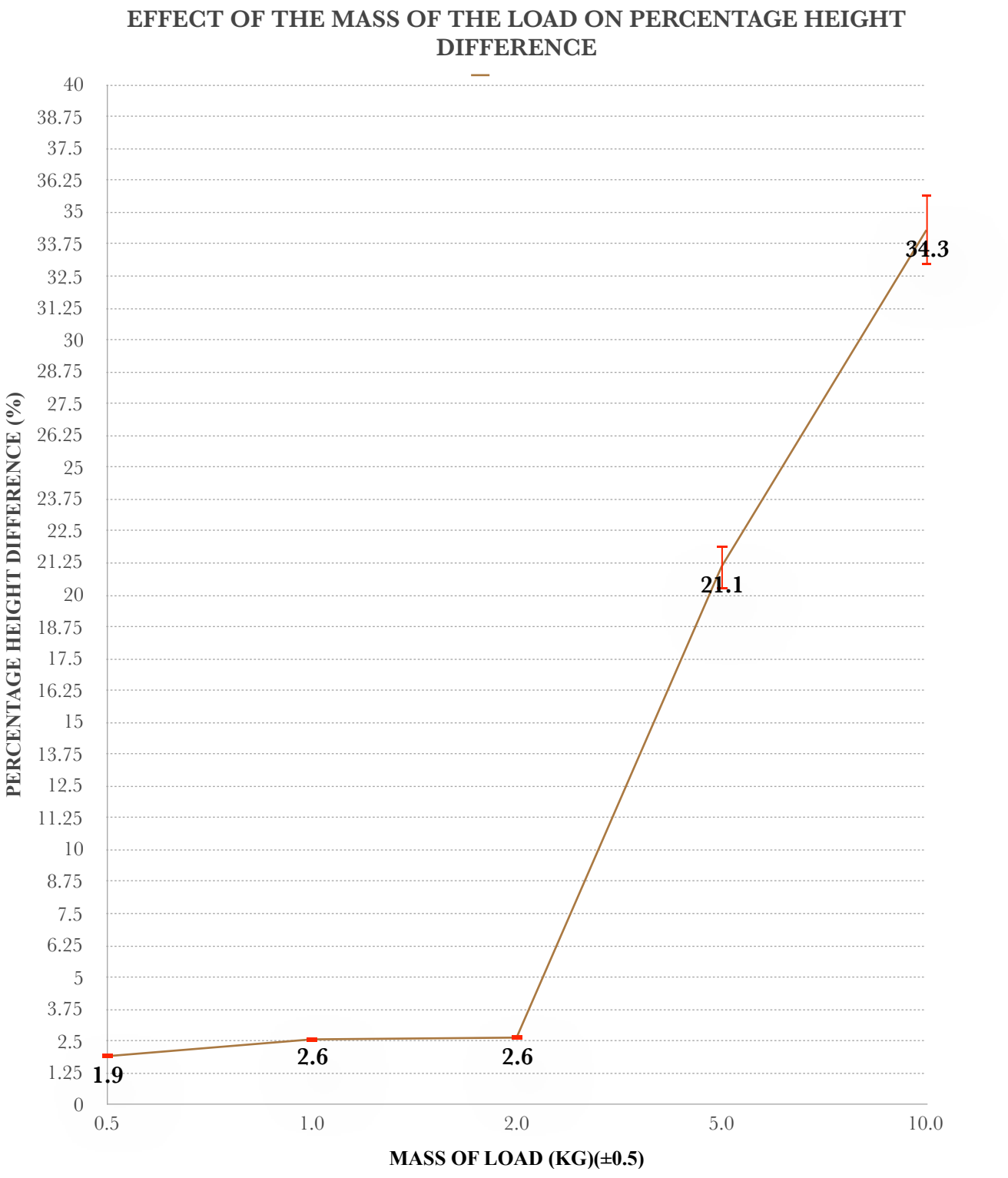
p< 0.05, the hypothesis can be assumed correct.

[9]http://www.statisticshowto.com/what-is-the-correlation-coefficient-formula/

GRAPH 1: shows mean of the initial height, mean of the final for each mass of load and the relation between them and error bars which are drawn by using standard error.



GRAPH2: shows how the mean of height differences differentiate with the effect of the masses of the loads and error bars which are drawn by using standard error.



ASSESMENT CRITERIA: EVALUATION&CONCLUSION

EVALUATION

Nervous system, is one of the most vital part of the body of all living organisms, consists of two parts that are the central nervous system, includes brain and spinal cord, and peripheral nervous system, includes nerves.

The spine is the structure that protects spinal cord. The spinal cord which is a part of central nervous system is a bundle of nervous tissue enclosed in the vertebral column. [10] It is firstly the centre of reflex actions and supplies communication between the brain and the spinal nerves. Therefore; spine plays an important role in protecting the structure of spinal cord. On the other hand, spine consists of three natural curves, cervical spine, thoracic spine, lumber spine, that helps to sustain an "S" shape. As a result of all these structural qualities spine is an important feature that both protects spinal cord and gives the shape of our body. Although spine has essential impact on our body, it sometimes come across with undesirable situations because of our life styles and unconsciousness about the importance of the consequences.

As it shown in the research of the World Health Organisation, every year, around the world, between 250000 and 500000 people suffer a spinal injury. [11] This research shows that most of the people are not aware of the harmful consequences of their actions. Mostly this injuries are the results of heavy loads that we are carrying during day. Traffic crashes, falls and violence are the other main reasons of this situation. All the causes that are considered shows us that disturbances occurred on spine cause deformation and injuries.

Besides, the injury occurs on spine has some economical and social consequences as it has physical. People who have spinal damages become dependent on other people and need help to sustain their lives. This situation leads to physiological problems that prevents improvements in general health. Also, when we consider this situation in a general perspective we can observe that people with spinal injuries can be excluded from society. In young people this can be seen as communication problems with peers and in adults it can be seen as obstacles in economic participation and unemployment.

In order to prevent further consequences, some preventions can be applied. Firstly, awareness should be raised for people who are not capable of understanding the general

[10] McGraw-Hill international edition Biology 11th edition page.702

[11] http://www.who.int/mediacentre/factsheets/fs384/en/

picture. In order to prevent traffic accidents improvements in roads and vehicles are effective when it is also supported by the people's behaviors in traffic. Further limitation in use of harmful materials like alcohol is also effective way to prevent the accidents and spinal injuries.

All in all, spine that protects spinal cord is one of the most essential feature for our body. Therefore, we need to understand its importance and consider the harmful situations with their eventuated outcomes that also have social and economic impacts on a persons life.

The experiment is suitable to answer the research question; however, it contains some weaknesses. Firstly, when I was preparing the set ups I used plastic trays that created little gliding situation when the loads were released. When cadaveric sheep spines glide through the plates, I sometimes could not observe the height difference accurately, as the gliding process created some difficulties in obtaining the correct final heights that can after affect the overall results. Therefore, using trays that are made from different material like foam can be an effective solution for this greasiness. Foam is a useful material as it is not harmful for environment as it can be recycled and reused.

Secondly, in my first trial I released loads on spines which are not separated from their fresh meats. The soft texture of the fresh meat protected the spine and I could not obtain observable height differences and damages. However, a different technique can be applied in order to create observable results. Cadaveric sheep spines can be separated from their fresh meat by a cooking style which is boiling. When the process of boiling applied to each cadaveric spine, they can easily be separated from their fresh meat; as a result both initial and final heights of the spines can be calculated accurately.

When I analyse the results by calculating the percentage height difference occurred in each mass. I realised that the percentage height difference occurred when I released 1.0 kg is greater than the percentage height difference occurred when I released 2.0 kg. Although the hypothesis and the results states that when the mass of load that is released increases, minimalization in height and damages on spine also increases, because the possibility of getting harmed increases as the spine is exposed to greater masses.

When I consider this situation I also realised that the times passed after I released the masses are different in some trails. This shows that the time could not be stabilised and the detected releasing point which is 30 cm high from the surface of the set ups is not standard.

As a result of not detecting a certain point to release objects, I obtained some erroneous values that cause a further miscalculations in percentage height difference. In order to prevent this situation, I think using a different material such as 30 cm pipe can be useful. The pipes can be made from papers according to the cross sectional area of the loads in order to pass through the objects easily. Therefore , pipe that has cross sectional areas of 16.6 cm2 can be appropriate for releasing 0.5 kg, 1.0 kg , 2.0 kg, 5.0 kg and 10.0 kg objects from a standardised height of 30 cm.

On the other hand, some errors occurred because of the limitations that are related with the medium. Because the x-ray unit in hospital is colder than room conditions, the humidity of the medium is lower than the appropriate level that cause little fluctuations in some trials. Therefore, using a humidifier which is a device that increases humidity (moisture) in a single room or an entire building [12] can be a great way to control and stabilise humidity in this medium.

To sum up, the experiment is appropriate to answer the research question because of its strength that comes from 3 trials; however, results that are obtained may not be accurate because of some weaknesses that cause some errors.

[12] http://en.wikipedia.org/wiki/Humidifier

CONCLUSION

This experiment aims to observe the effects of the different masses of the loads on spine by calculating percentage height difference occurred on 5 different models and also interpret the consequences on our daily life actions and on our body health.

The results support the hypothesis that when the mass of the load that free falls increases, percentage height difference occurred is also increases. The mean of percentage height difference occurred was calculated from the results of the experiment and graphs was drawn in order to make a comparison.

Firstly, 5 different set ups prepared in stable temperature, pressure of the medium. Plastic plates are cleaned in order to prevent any possible chemical reactions that can be occurred. Then, spines are placed each of the 5 plastic plates. Initial heights of each of the spines measured with a C- armed digital fluoroscopy device. The data obtained from an image that appeared in a computer. Initial height of the first set up found 30.0 mm; initial height of the second set up found 35.0 mm; initial height of the third set up found 32.1 mm; initial height of the four set up found 30.0 mm; initial height of the fifth set up found 36.6 mm. With a 30 cm ruler the height where the loads are going to be released calculated. For the first set up 0.5 kg load is released from 30 cm height to the top of the model; after the final height is also measured with an analog fluoroscopy device and recorded as 29.7 mm. This process applied all the other 4 set ups in first trails. For the second set up final height recorded as 33.7 mm; for the third trail final height recorded as 31.3; for the forth trial final height recorded as 22.0 mm; for the fifth set up final height recorded as 22.5 mm. This process repeated three times and results are recorded (see Table 1) in order to obtain more accurate values and to make suitable interpretations.

In order to analyse the collected datas mean of all three trials' initial and final heights calculated for each 5 load. For 0.5 kg mean of initial heights is 29.6 mm and mean of final heights is 29.1 mm; for 1.0 kg mean of initial heights is 35.0 and mean of final heights is 34.1 mm; for 2.0 kg mean of initial height is 31.5 mm and mean of final height is 30.7 mm; for 5.0 kg mean of initial heights is 32.1 mm and mean of final heights is 25.3 mm; for 10.0 kg mean of initial heights is 36.0 mm and mean of final heights is 23.6 mm.

These datas that I collected led me to calculate percentage height differences occurred after process. When I subtracted the mean of final heights from mean of initial heights I

obtained the mean of height differences (see Table 2) when I calculated these values with percentage distribution I obtained percentage height differences for each mass value. I observed that the percentage height difference occurred in 0.5 kg is 1.91%, in 1.0 kg is 2.57%, in 2.0 kg is 2.64%, in 5.0 kg is 21.1% and in 10.0 kg is 34.3%.

All in all, when I increased the mass of loads I observed that the height difference between initial and final height also increase. The deformation that I observed is greatest when I released a 10.0 kg load and smallest when I released 0.5 kg.

After I obtained all the results, I aimed to see the relationship between the masses of the released objects and obtained height differences. I needed to choose a method for statistical analysis. As a result of my research findings I realised the Pearson correlation test is the right method for analysing my results because my aim was to quantify association between two variables of the experiment which were masses of the loads for independent variable and occurred height different as a dependent variable. The Pearson r, correlation coefficient, value which is shown with "r" found to be 0.98. We can say that the masses of the objects that are released on spines have large effects on the height difference occurred on each spine as the correlation coefficient also supports this estimation. The r value shows us that there is a positive correlation between two variables: the masses of the released objects and the height difference. Using the relation between the Pearson r and the number of samples (N), I calculated the p value which is "the probability that you would have found the current result if the correlation coefficient were in fact zero." [13] It is stated that if this value is smaller than the alpha value , p= 0.05, it can be assumed that the results are statistically significant. As the result of the calculations the P-value found to be equal to 0.012; therefore, it can be interpreted that the results of the experiment is statistically significant and appropriate to answer the research question.

To sum up, the collected data shows us that if our support system is exposed to heavy objects, the possibility of minimalization in height and damaging of disks and some spinal curvature increases, the further affects may proceed to some break downs in support system; as a result, the hypothesis, which is earlier constituted by the literal support of the experiments of Journal of American Physical Therapy Association and National Institutes of Health, corrected.

[13] https://www.medcalc.org/manual/correlation.php

Therefore, it is stated that; increase in weight of load, which is released from 30 cm height , decreases the height of the fresh cadaveric sheep spine by compressing, that is calculated by measuring and observing the height difference and amount of damage in the spine with a fluoroscopy device, with stable temperature, pressure of the medium, stable height of release and time of process.

The results obtained from the experiment can be improved and can be directed to use in other research papers' questions. These results can also be used in identifying the resistance of other bones in our body for any other trauma.

APPENDIX 1

Apparatus:

- **Digital C arm Fluoroscopy device: Fluoroscopy is an imaging technique that uses X-rays to obtain real-time moving images of the interior of an object. [14]**

- **0.5 kg, 1kg, 2kg, 5kg, 10 kg loads**

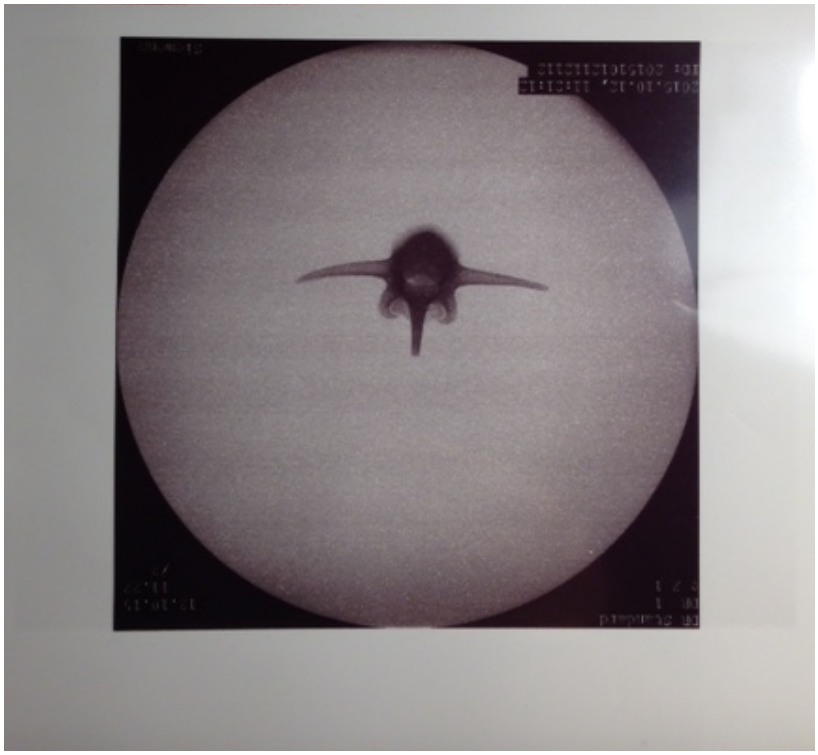
[14] https://en.wikipedia.org/wiki/Fluoroscopy

- **Fresh cadaveric sheep spine**

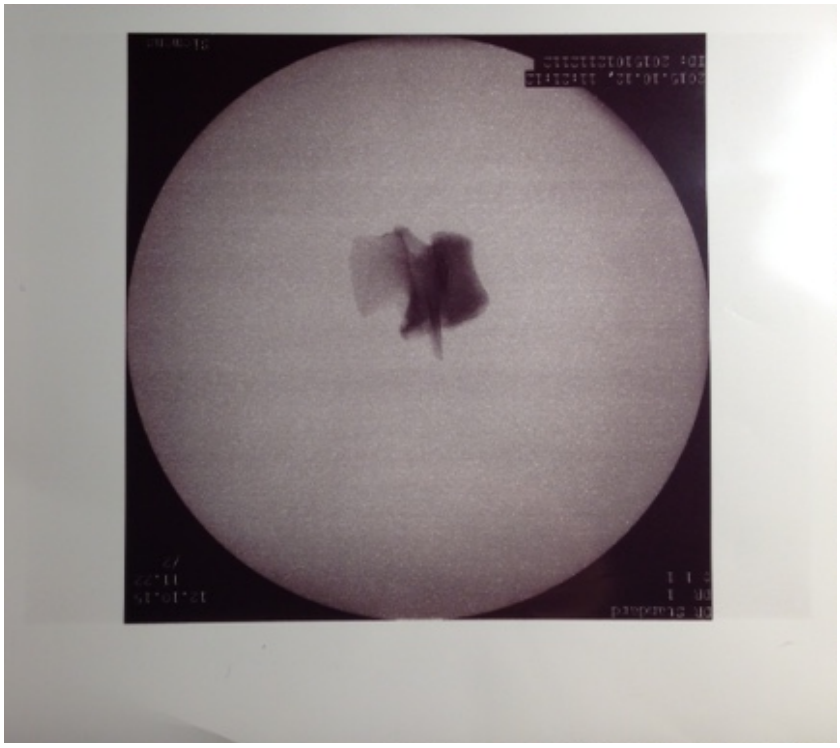
APPENDIX 2

Examples of the images

BEFORE: The spine is undisturbed.



AFTER : The shape of the spine is degenerated.



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