OPTIMAL DESIGN OF A COMPETITION BICYCLE FOR COMFORT RIDING (FOCUS ON BICYCLE SEAT FOR FEMALE)

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Report submitted in partial fulfilment of the requirements
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ABSTRACT

This thesis discuss on the comfort riding for female bicycle riders. Comfort when riding a bicycle can be identified through a number of key elements such as seats, handles, paddle and bicycle frame design. This study began by collecting all the relevant information to identify the height between bicycle seat and bicycle frame with height of rider, the suitable design of bicycle seat for female riders and the period of rider. The information is collected through a survey conducted on 30 female students with different height and weight. Experiment was conducted to gather the data required for this thesis. Three type of bicycle seat will be used in this experiment to identify the ergonomic design for female riders. Three level of height between bicycle seat and bicycle frame will be set to identify the suitable height for comfort riding which is 0 cm to 5 cm, 5 cm to 10 cm and 10 cm to 15 cm. To identify the most comfort period during riding, duration for riding will be set on 3 stages, 0 minutes to 5 minutes, 5 minutes to 10 minutes and 10 minutes to 15 minutes. It can be concluded that seat for female rider must be large compare to seat for male rider to support female pelvic muscles and also to avoid any injury on pelvic area. Height of seat must be adjusted to certain level to avoid pain on knees. If the height of bicycle seat too low, it will effect to knees because position of knees too bent.

ABSTRAK

Tesis ini membincangkan tentang keselesaan semasa menunggang basikal untuk penunggang perempuan. Keselesaan ketika menunggang basikal dapat dikenal pasti melalui beberapa elemen penting seperti tempat duduk basikal, pemegang basikal, pengayuh basikal dan reka bentuk bingkai basikal. Kajian ini bermula dengan mengumpul semua maklumat yang berkaitan untuk mengenal pasti ketinggian antara tempat duduk dengan bingkai basikal yang sesuai mengikut ketinggian penunggang, jenis reka bentuk tempat duduk yang sesuai bagi penunggang perempuan dan tempoh penunggangan yang dianggap selesa. Maklumat-maklumat yang diperlukan diperolehi melalui soal selidik yang dijalankan ke atas 30 orang mahasiswa perempuan dengan ketinggian dan berat yang berlainan. Ekperimen dijalankan untuk mengumpul data yang diperlukan untuk tesis ini. Tiga jenis tempat duduk basikal telah digunakan untuk mengenal pasti reka bentuk yang paling egronomik untuk keselesaan penunggang perempuan. Tiga jenis ketinggian antara tempat duduk basikal dengan bingkai basikal telah ditetapkan untuk mengenalpasti ketinggian yang paling selesa untuk penunggang perempuan iaitu 0 cm hingga 5 cm, 5 cm hingga 10 cm dan 10 cm hingga 15 cm. Untuk mengenalpasti tempoh menunggang yang paling selesa, tiga tempoh masa telah ditetapkan iaitu 0 minit hingga 5 minit, 5 minit hingga 10 minit dan 10 minit hingga 15 minit. Kesimpulannya, tempat duduk basikal untuk penunggang perempuan perlulah mempunyai permukaan yang luas untuk menyokong otot pada bahagian pelvik perempuan dan untuk mengelakkan sebarang kecederaan di kawasan pelvik. Ketinggian tempat duduk perlu dilaraskan ke satu ketinggian yang tertentu untuk mengelakkan kesakitan pada bahagian lutut. Tempat duduk basikal yang terlalu rendah akan memberi kesan di bahagian lutut kerana kedudukan lutut yang terlalu bengkok.

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LIST OF ABBREVIATION

mm	Millimetre
cm	Centimetre
kg	Kilogram

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

A bicycle or bike is a vehicle composed of two wheels held in a frame one behind the other, propelled by pedals and steered with handlebars attached to the front wheel. Karl von Drais of Paris invented the first bicycle in 1817. The Draisienne was a steerable bicycle. It was almost entirely made of wood, had no pedals, and was propelled down the street by riders who would push their feet against the ground. The record speed was 15 km/h. **[1]**

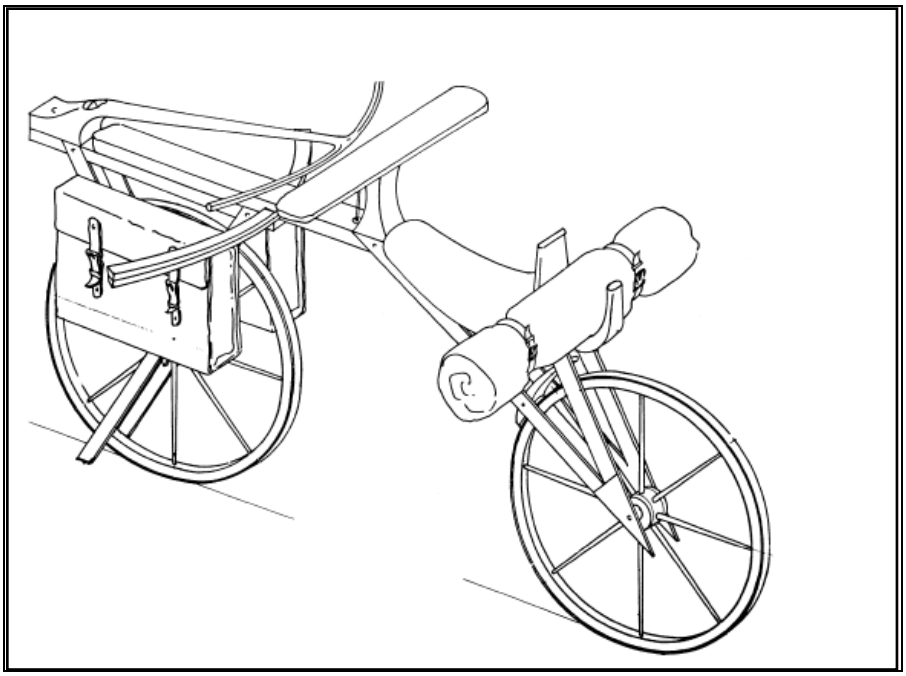


Figure 1.1: The Draisienne **[1]**

Today there are so many variations of bicycle and it would be hard to list and describe them all. Basically, type of bicycle depends on surrounding. Trailer bike, Kids' tricycle, and many are designed for children. For road bike are good for multiple pavement uses including fitness riding, commuting, long-distance rides, touring and racing. Mountain Bikes is designed for mountain area and is designed to be strong, with shock-absorbing features and better braking systems, mountain bikes can handle dirt trails and the rocks, roots, bumps and ruts that come with them and also they feature lower gears than most road bikes in order to better handle steeper terrain.

Bicycle for competition is different from normal bicycle that we are used daily. For long distance rider, comfort is important to make constant speed. There are many element in bicycle should be consider for comfort riding. Some cyclists believe that

foam is the most important of a comfortable ride because its function is to provide a cushion barrier between cyclist and a hard plastic or carbon saddle base.

Riding a bike for long distances will cause pain in the hand. The padding on handlebars bicycle is one of the easiest and most effective ways of make bike a more comfortable ride. Some tapes contain a gel-like material integrated into the fabric to make it even more forgiving. Tires are most important part in vehicle using wheels. Type and sizes of tires is important to make riding comfort for rider. All this element is depends on surrounding and area for competitions.

Creativity is very important for design process. A design process is usually complex. Ergonomic design for bicycle seat is important to ensure cyclist in comfort and safe. Ergonomics are implemented in every form of design. It is paramount importance that ergonomic factor are taken into consideration while designing product. Ergonomics design means irrespective of the type of product and its function. The principles of ergonomic design are considered in five levels are determined below **[2]**:-

1. An equipment / machinery must be safe while contact with human beings.
2. An equipment / machinery must not produce harmful effects in human beings over longer periods.
3. An equipment / machinery must be physically comfortable that is, it should not require excessive efforts, both physical and mental or visual.
4. An equipment / machinery should provide mental satisfaction or give a feeling of pleasure to the human being using the same. This must also include the cost price of equipment against the function of the same.
5. Determining the degree of modernity of an equipment / machinery ergonomic considerations must constitute an essential factor of the social profitability of the equipment / machinery. Even at the stage of establishing the design assumptions of an equipment / machinery it is necessary to introduce both ergonomic requirement and limitations

1.2 PROBLEM STATEMENT

Ergonomics design for bicycle seat must be consider to give comfortable for rider and to avoid injury during cycling. The bicycle seat must be design according to gender. The width and shape of bicycle seat depend on the distance between the seat bones and the shape of the pelvic. Women have a wider and differently shaped pelvic than men. The uncomfortable seat will cause pain in the female pelvic muscles. Most of rider will face pain in the knees, it is because height between bicycle seat and bicycle frame is not suitable with rider height. If bicycle seat too low, it will cause the knees positions of rider is too bent and uncomfortable. Height of bicycle seat should be adjusted to certain level to get comfortable riding.

1.3 OBJECTIVE

i. To study bicycle seat for comfort riding for female
ii. Ergonomic analysis for riding comfort

1.4 SCOPE OF STUDY

The scope of this study is:

i. Riding comfort: To investigate the elements that should be consider in bicycle seat for female comfort riding. Elements such as design of bicycle seat, height between bicycle seat and bicycle frame and duration during riding is important to ensure rider will riding in comfort condition.

ii. Ergonomic Experiment: To collect a data and to analysis the details about comfort elements. Height between bicycle seat and bicycle frame will set in three difference level. The data will be analysis to know the suitable height for this element. In this experiment, three difference design of bicycle seat will be test to get feedback from respondents to identify the most comfortable design for female rider. Data from the experiment will be analysis to choose the most ergonomic design among three different design of bicycle seat.

1.5 RESEARCH QUESTION

In this study, there are some questions that will be explored in this study as:

i. Comfort effect on the performance of cyclists in a race
ii. Ergonomic design for comfort cyclists in a race for female rider
iii. The relationship between the height of the bicycle seat with rider height

1.6 EXPECTED RESULTS

Expected results are result to be received at the end of this study. In this project, the expected results for this project are a size of bicycle seat is large. It is use to reduce the pressure resulting from the riders body. In addition, women's seat riders must have a spring under the seat to balance weight and function as cushions to reduce the piles experienced. Bicycle seat cannot be too low or too high from bicycle frame.

1.7 CLOSURE

This chapter highlighted on basic information regarding comfort riding for female bicycle rider. In the next chapter an extensive literature review will be discussed about comfort elements, bicycle seat, and female rider.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

For millions of people worldwide bicycle riding is a popular activity, enjoyed as a means of transportation, exercise and sport. Bicycles are the most common and widely used human powered vehicle around the world. Cycling is nowadays considered not only an efficient and healthy means of transportation but also a popular recreational and sport activity. The expansion of cycling over the last 50 years led to various bicycle designs, like sport or road bicycles, mountain bicycles, BMX bicycles, standard utility bicycles and more recently the hybrid bicycle.

The term ‘comfort’ might be used to describe a feeling of contentment, a sense of cosines or a state of physical and mental well-being. In engineering term, comfort is generally presumed to be a definable human condition or attribute, with each new innovation bringing society closer to the achievement of ideal indoor conditions**. [3]** Comfort is a concept of rather subjective nature but it can generally be defined as the absence of pain and any other similar nuisance and is usually associated in the relevant literature with the design and adjustment**. [4]** Based on the two statements taken from

the journals, comfort is a point where a person will not feel the pain when performing the same activities in a long period of time.

The design of bicycles involves the definition of frames of different size and dimensions as well as the definition of the corresponding adjustment ranges for the seat and the handlebar. To successfully ride a bicycle in a seated position, many elements should be considered. A minimized frontal area and shape should be presented by the combination of the bicycle and the bicycle rider. The position of the bicycle rider must be comfortable so that the rider can produce requisite high level of effort and performance for long distance. Racing type bicycle handlebar is generally constructed of rigid, tubular metal that transfers the vibration from the bicycle directly to rider hands.

2.2 COMFORT ELEMENT

There are many element should be consider to ensure rider comfort during ridding bicycle based on research, the cyclist makes contact with the bicycle at three locations the handlebar, the saddle and the pedals. It is believed that most discomfort is felt near the handlebar and the saddle when riding over a rough surface. **[5]** Frontal areas and rider positions are greatly affected by the position, shape and arrangement of the bicycle handlebars. **[6]** Handlebar grips located in a relatively raised position will encourage a rider to assume a relatively upright riding position. A large frontal area is presented to be comfortable and the relatively large ensuing wind resistance minimizes top speed through the rider may be producing a large amount of pedaling effort.

The quality of a racing wheel is related to the combination of several performance parameters with the level of comfort during long cycling tracks. Comfort riding is related to the radial behavior of the wheel assembly, intended as combination of tire and rim. Radial properties of wheels are believed to be dependent on tire pressure and construction, rim profile and materials, spoke design and disposition, hub shape and

materials. Despite the common opinion among cyclists that the wheel radial properties affect the rider's back comfort. **[7]**

There are many elements need to be consider in order to get comfort riding for long distance rider or competition rider. In this project, only saddle based element will be analysis and discuss. A poorly designed seat will not distribute body weight or reduce pressure effectively over the perineum and thus increase the risk of seat discomfort or injury, which seems to be a common occurrence among cyclists. **[8]**

2.3 BICYCLE SEAT

Saddle or bicycle seat is substantially flat and thus does not provide adequate posterior support for the buttock muscles of cyclists who wish to assume an aero-dynamically efficient position with the upper body tilted over forward. **[9]** Saddle base should be designed to supply a flat base for periods of intense effort that cause to slide forward on the saddle, especially sitting for long distance.

The 21% of sport cyclists reported genital numbness after a bicycle race and 13% reported impotence[5] while other research reported a 61% incidence of genital numbness among cyclists and a 19% incidence in erectile dysfunction among cyclists riding more than 400 km (249 miles) per week[6]**. [10]** Ergonomic saddle designs universally embraced cyclists. Some scientific literature suggests that saddles designed with cut-out regions and without a narrow nose may adversely affect the position and weight distribution of the cyclist on the bicycle

Perineal pain during bicycling is often related to the cyclist position on the bicycle. Perineal pain is a more frequent complaint among women as opposed to men cyclists and it thought to be the most common non-traumatic pain syndrome experienced by women cyclist although not all specific to women, support this contention and have indicated than 35-81% of cyclist complains of pain in the perineum and buttock region

after long distance rides. **[11]** To reduce the incidence of low back pain, a forward pelvic tilt is favorable as it decreases lumbar flexion and tensile stress to the longitudinal ligaments of the lumbar spine. If female cyclists are able to achieve a forward pelvic and trunk tilt without perineal pain, their comfort level during bicyclist may increase and their incidence of low-pack pain may be decrease

Saddle based available in two types, too soft or too hard. In cases where the saddle consists only of a hard seat material, the rider gains the advantages of adequate support at the expense of comfort especially when be seated for long period of time. A hard support surface may undesirably restrict the blood flow through the blood vessels within the soft tissues of the rider. For saddle consists of only a soft cushion material, the rider will experience a more comfortable seat but rider may find himself without the sufficient firmness that is necessary to adequately support rider weight. The rider may sink into saddle so as come to rest against the rigid base plate or frame over which the saddle material is laid. **[12]** Bicycle saddle needed to capable of providing the rider with soft and comfortable cushion surface on one hand as well as a firm surface on the other hand by which to support the rider's weight above the rigid base plate especially when rider will be seated for a long period of time.

The width of a saddle must be considered to ensure comfort element for rider. Bicycle seat for riders receive a high pressure. Based on the results of the study and producing the map pressure for rider seat between the seat and the subject's pelvis and groin that stated the pressure zones showing the largest contact area appeared to repetitively map out the shape of the pubic tubercles and anterior portion of the ischium. **[13]** Based on the results of this study, the surface area is an important bicycle seat for riders. Other than that, this surface area is dependent on the size of the rider if the rider has a large size the pressure to be exerted on the surface of the seat is larger.

2.4 BICYCLE SEAT FOR WOMEN

A bicycle saddle for female, comprising a saddle body that defines a support surface on which a female can be supported, the support being profiled to conform anatomically to the shape of a female's buttock and genital regions. **[14].** Body of a female reproductive system is equipped with. This system is important and can be affected if a woman has undergone extreme activities such as sports, hiking and so on. Riding a bicycle can also have an impact on the system if the security features are not emphasized. Height distance between a bicycle seat and bicycle frames shall be in accordance with the height of a woman rider. This is because, if the height used inappropriately it can cause intense pressure and may interfere with the reproductive system. A women's pelvic structure is different from a man's in yet another way. Saddle does not provide the required combination of support to the pelvic zone and comfort to the pubic zone required by female cyclist. Saddle also does not provide adequate ventilation. Most of saddle was not specifically designed to support a women pelvic area and pubic area or to ventilate either of such areas during use of the saddle. **[15]**

2.5 CLOSURE

This chapter highlighted on literature review regarding comfort riding for female bicycle rider. In the next chapter, a methodology for this project will be discussed about the theory of bicycle and also the principles of ergonomic. Experimental set up and procedure also will be discussed on the next chapter.

CHAPTER 3

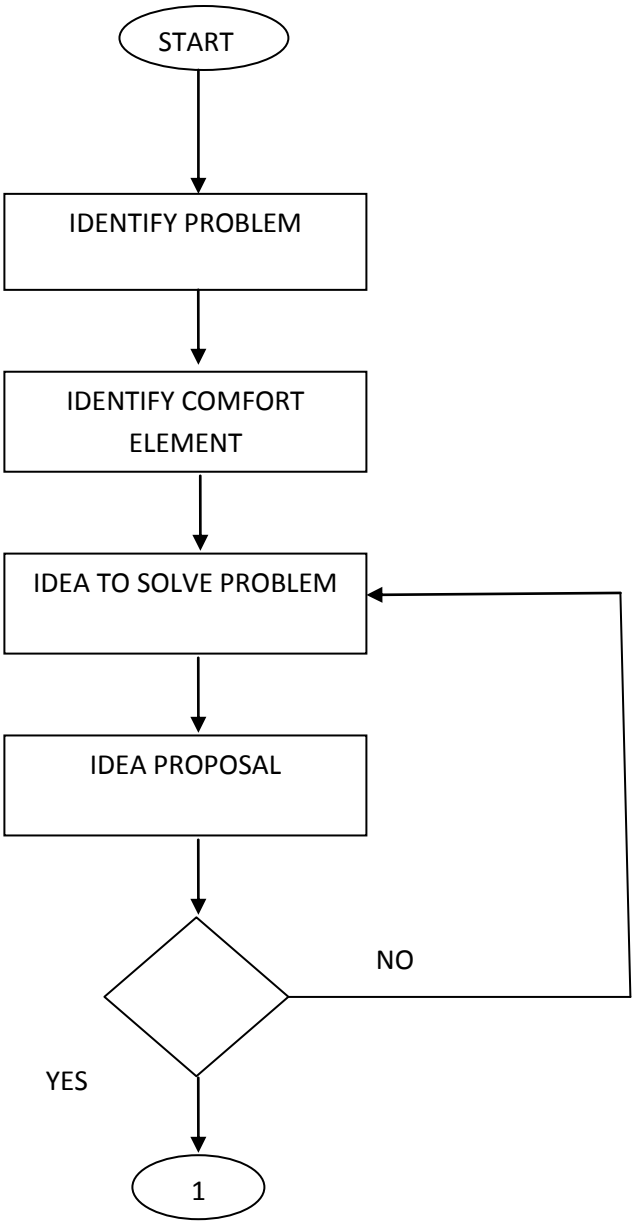
METHODOLOGY

3.1 INTRODUCTION

This chapter will describe the tools and equipment used to analysis comfort element for rider. Research methodology is a set of procedures or methods used to conduct research. There are two types of research methodologies. These two types of methodologies are qualitative methodologies and quantitative methodologies. Qualitative research involves the use of qualitative data such as interviews, direct observations, survey and analysis of documents and material. This chapter also covered about the process or procedure to collecting data using experiment and questionnaire for analysis design bicycle seat for female.

The works begin with finding the information about the project. This is where the research problems are identified. In this project, need to identify comfort element for rider especially on bicycle seat. It has been the problems that need to be solved. The works continues with the literature reviews on saddle seat design for women rider. This is important for the researcher to understand the fundamental concept and operations carried out.

FLOW CHART


START
IDENTIFY PROBLEM
IDENTIFY COMFORT ELEMENT
IDEA TO SOLVE PROBLEM
IDEA PROPOSAL
NO
YES
1

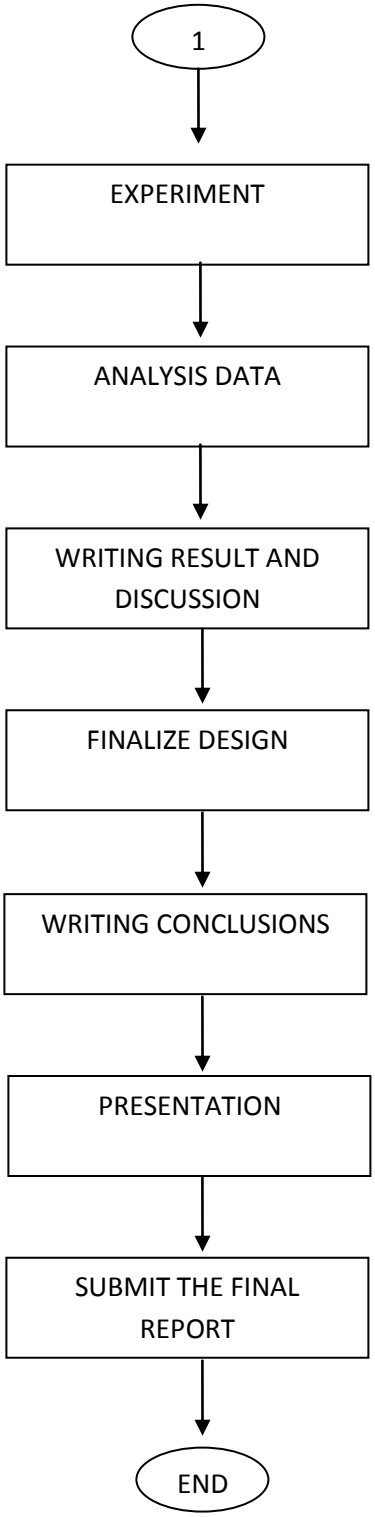


Figure 3.1: Flow chart

3.2 THEORY

The bicycle has its own identity and it is eco-friendly also economical to help the rider to keep fit and healthy. A design process is usually complex and creativity is very important for design process. Ergonomic design for bicycle seat is important to ensure cyclist in comfort and safe. Ergonomics are implemented in every form of design. It is paramount importance that ergonomic factor are taken into consideration while designing product. Ergonomics design means irrespective of the type of product and its function. The principles of ergonomic design are considered in five levels are determined below **[2]**:-

1. An equipment / machinery must be safe while contact with human beings.
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5. The determining the degree of modernity of an equipment / machinery ergonomic considerations must constitute an essential factor of the social profitability of the equipment / machinery. Even at the stage of establishing the design assumptions of an equipment / machinery it is necessary to introduce both ergonomic requirement and limitations.

A number of aspects that deal with comfort, taking the parts of the body which actually make physical contact with the bicycle such as saddle, handlebars, pedals as a starting point. It should be noted that these three parts of the body are of crucial importance in the adjustment of the bicycle, rather than the size of the frame. Many cyclists and bicycle dealers are fixed on the size of the frame only. The frame geometry

is only important when adjusting the bicycle, in order to get the three contact parts of the body in the right interrelated proportion. This aspect is irrespective of the fact that the frame geometry can have consequences for the cycling properties of the bicycle.

A saddle should fit comfortably. The width and shape of the seat depend on the distance between the seat-bones and the shape of the pelvis. Normally women have a wider and differently shaped pelvis than men. The larger the distance between the seat-bones and the rounder the pelvis, the wider the seat should be. The width of the saddle also depends on the position of the upper body on the bicycle. As far as is known, no practical measuring method has been developed yet which takes into account both width and shape of the saddle, as well as the position of the upper body on the bicycle.

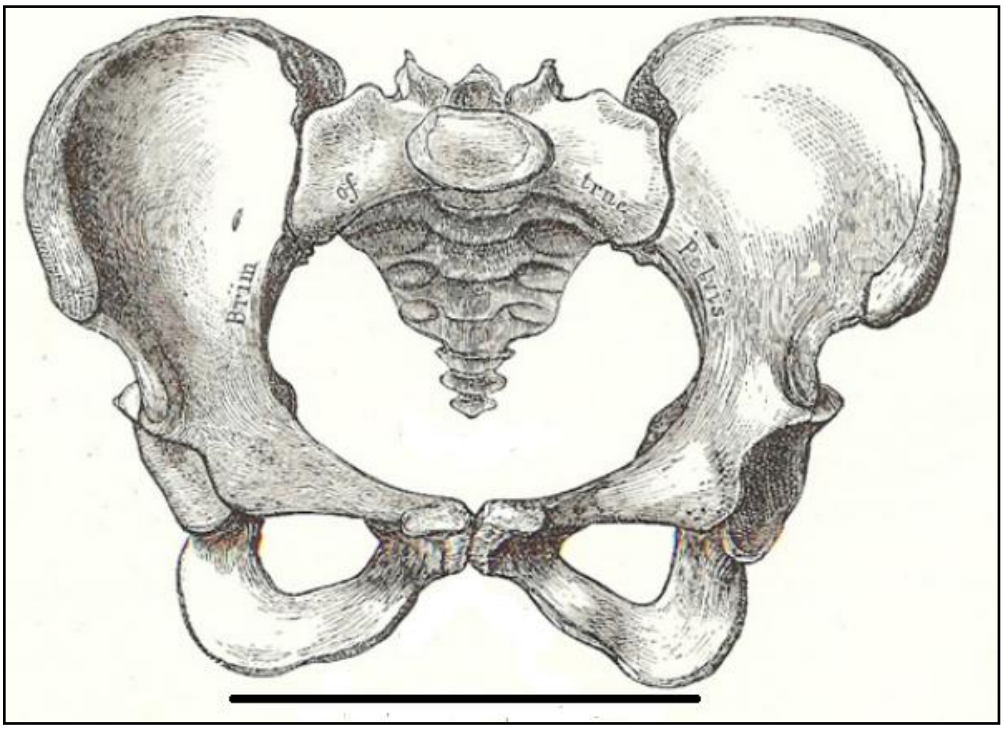

Figure 3.2: Women pelvis **[16]**

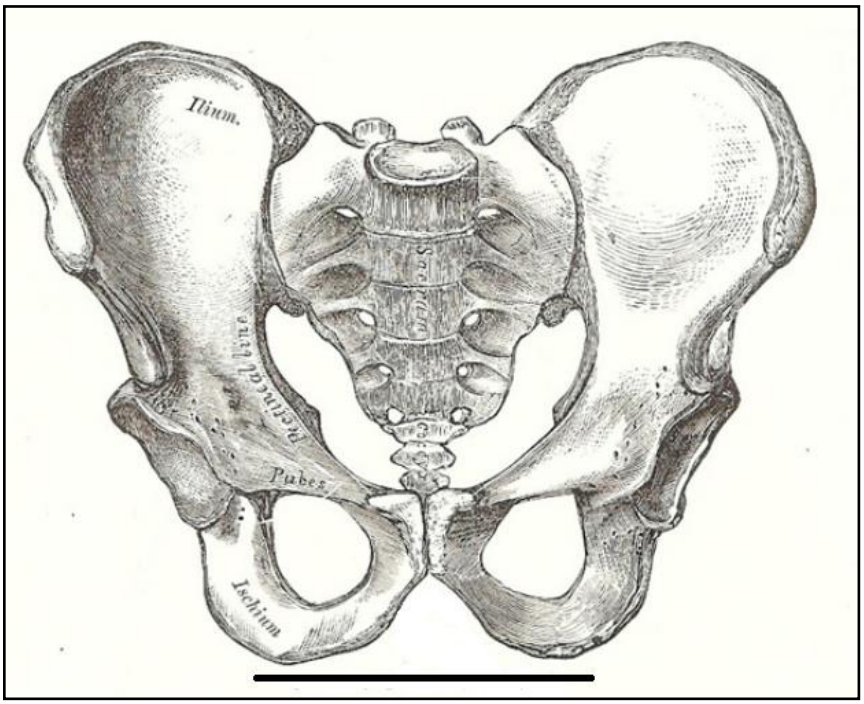

Figure 3.3: Man pelvis **[16]**

In case of a saddle pointing upwards, the cyclist runs the risk of numbing certain parts of his body. As a consequence, the cyclist will be inclined to tilt his pelvis backwards which results in more pressure on the lower back. If the saddle is pointed downwards, the cyclist will tend to slide forward. This is very uncomfortable not only because the narrower front part of the saddle gives too little support, but also because the arms, wrists and hands are subjected to too much pressure as a result of the cyclist trying to maintain a normal position on the saddle. The height of the saddle plays an important role in experiencing the bicycle as comfortable. If the saddle is placed too high, the cyclist runs the risk of over stretching his muscles and if the saddle is placed too low, the pressure on his quadriceps might become disproportionately high.

The adjustment of the saddle serves to enable the muscles to work optimally in the longitudinal reach. As there is only one optimal longitudinal reach, there is only one

optimal saddle height. Most of the methods used at present to determine the correct saddle height are far from optimal. Below is the method to measure height bicycle seat **[17]**:

1. Heel-method. The heel of the shoe is placed on the pedal and the saddle is adjusted at such a height that the leg is stretched while the pelvis is still in horizontal position.
2. The 109% method. The saddle base was positioned at 109% of your inseam length when measuring from pedal axle to the top of the seat height.
3. The LeMond method. , this formula calculates 88.3% of your inseam length and uses it to measure the distance from the centre of the bottom bracket to the top of the seat height.

3.3 RESEARCH METHODS

There are various methods in collecting information. It can be carried out by searching the related topic literatures, white papers, technical papers, marketing reports, conferences proceedings, product data sheets, product brochures, web pages, project focus groups, conducting interviews with experienced personnel, distributing questionnaire, or even communicate to people. The research methods used for this dissertation purpose are the review of literatures and books from the Internet and data gathering by distributing questionnaires.

3.3.1 QUESTIONNAIRE

A questionnaire is defined as a form that people fill out used to obtain demographic and views and interests of those questioned. Questionnaire is used in this

research to elicit information and to get feedback from consumers. Questionnaire encompassed of a series of questions for the purpose of gathering data or information from potentially a large number of respondents. These are the steps taken to design a questionnaire for this dissertation purpose:

1. Objectives of the survey are defined
2. Determined the sampling group
3. Designed the questionnaire by creating the questions
4. Administered the questionnaire
5. Results interpretations

Questions are designed to gather either qualitative or quantitative data. Qualitative questions are designed with more care and required well administration and interpretation, generally it requires more thoughts from the participant, whereas quantitative questions are more exact if compared to qualitative questions. In this project, 30 person's respondents will be used to collect data about comfort riding focus on female rider. All respondents used to answer this questionnaire are among women. Questionnaire as in Appendix 1.

3.3.2. THE EXPERIMENTAL METHOD

The experimental method formally surfaced in educational psychology around the turn of the century, with the classic studies by Thorndike and Woodworth on transfer. The experimental method is usually taken to be the most scientific of all methods, the 'method of choice'. The experiment is sometimes described as the cornerstone of psychology. This is partly due to the central role experiments play in many of the physical sciences and also to psychology's historical view of itself as a

science. A considerable amount of psychological research uses the experimental method. An experiment is a study of cause and effect. It differs from non-experimental methods in that it involves the deliberate manipulation of one variable, while trying to keep all other variables constant. To study about bicycle comfort riding especially on bicycle seat, experiments are conducted on female students based on the following details:

1. Weight of respondent
2. Height of respondent
3. Height between bicycle seat and bicycle frame
4. Time during experiment
5. Design of bicycle seat

Three bicycle saddles were chosen to represent three types of saddle designs. An evaluation of every ergonomic bicycle saddle design available on the consumer market would be a daunting if not impossible task. The goal in this investigation was to select a manageable number of saddles that were representative of ergonomic saddles. All respondents will fill in a form that will provided while on the bicycle to find out the level of comfort depends on the time and height of a bicycle seat bicycle frames. 30 respondents that will be participate to collecting data. Refer to appendix for experiment form.

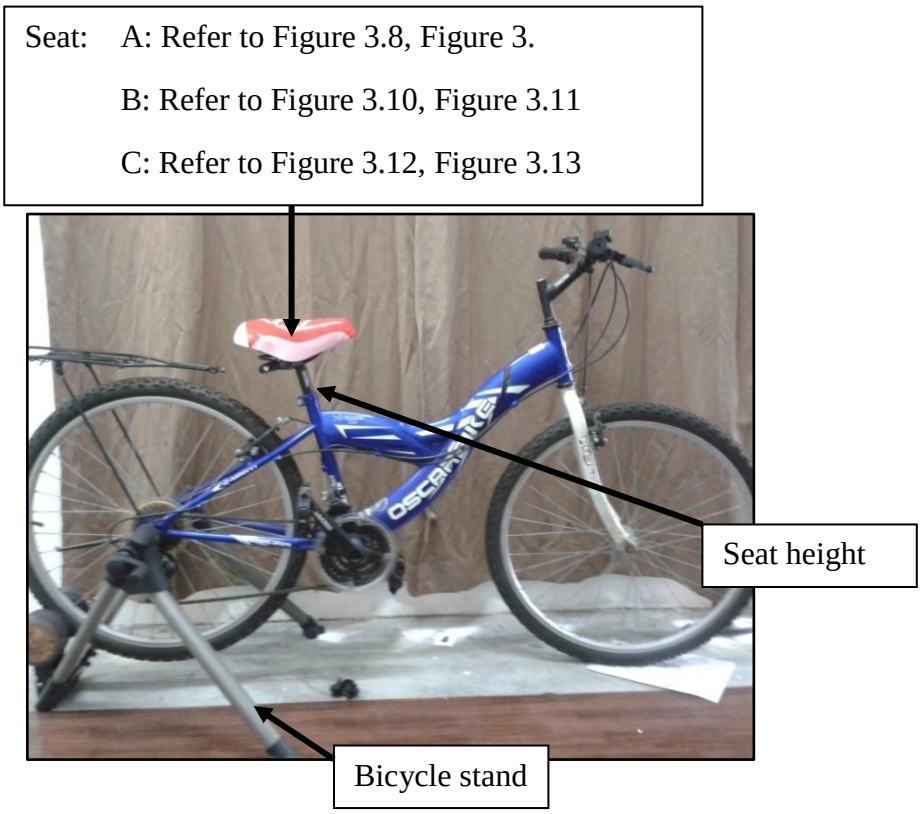

Figure 3.4: Experiments set up

Figure 3.5: Experiments set up back rear

Figure 3.6: Bicycle training stand

Figure 3.7: Height between seat and frame

Figure 3.8: Top view Seat A

Figure 3.9: Side view Seat A

Figure 3.10: Top view Seat B

Figure 3.11: Side view Seat B

Figure 3.12: Top view Seat C

Figure 3.13: Side view Seat C

3.4 CLOSURE

This chapter highlighted on methodology for this project will be discussed about the theory of bicycle and also the principles of ergonomic and also experimental set up and procedure. In the next chapter, result and discussion will be discussed.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will briefly discuss on the analysis data collection from experiment, result and discussion regarding on the project. The data finding collected throughout the project will be discussed.

4.2 THE EXPERIMENTAL RESULT

Three bicycle saddles were chosen to represent three types of saddle designs. An evaluation of every ergonomic bicycle saddle design available on the consumer market would be a daunting if not impossible task. The goal in this investigation was to select a manageable number of saddles that were representative of ergonomic saddles. All respondents will fill in a form that will provided while on the bicycle to find out the level of comfort depends on the time and height of a bicycle seat bicycle frames. Thirty respondents that will be participate to collecting data. Refer to appendix for experiment form.

4.3 WEIGHT OF RESPONDENTS

Based on experiment, below are data has been collected:

Weight	30 kg-40 kg	40 kg -50 kg	50 kg -60 kg	60 kg -70 kg
Person	1	16	10	3

Table 4.1: Weight of respondents

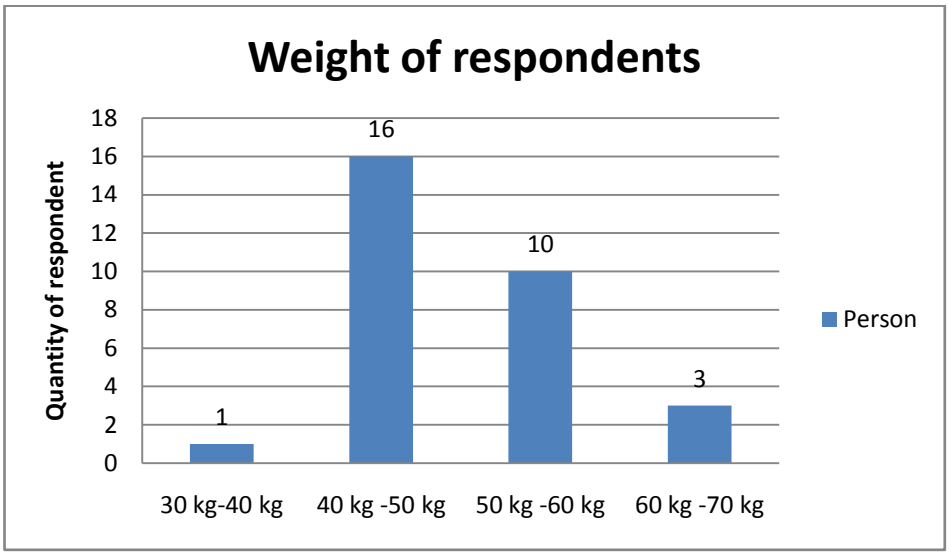

Figure 4.1: Weight of respondents

4.4 HEIGHT OF RESPONDENTS

Based on experiment, below are data has been collected:

Height	150 cm -155 cm	155 cm-160 cm	160 cm-165 cm	165 cm-170 cm
Person	2	10	13	5

Table 4.2: Height of respondents

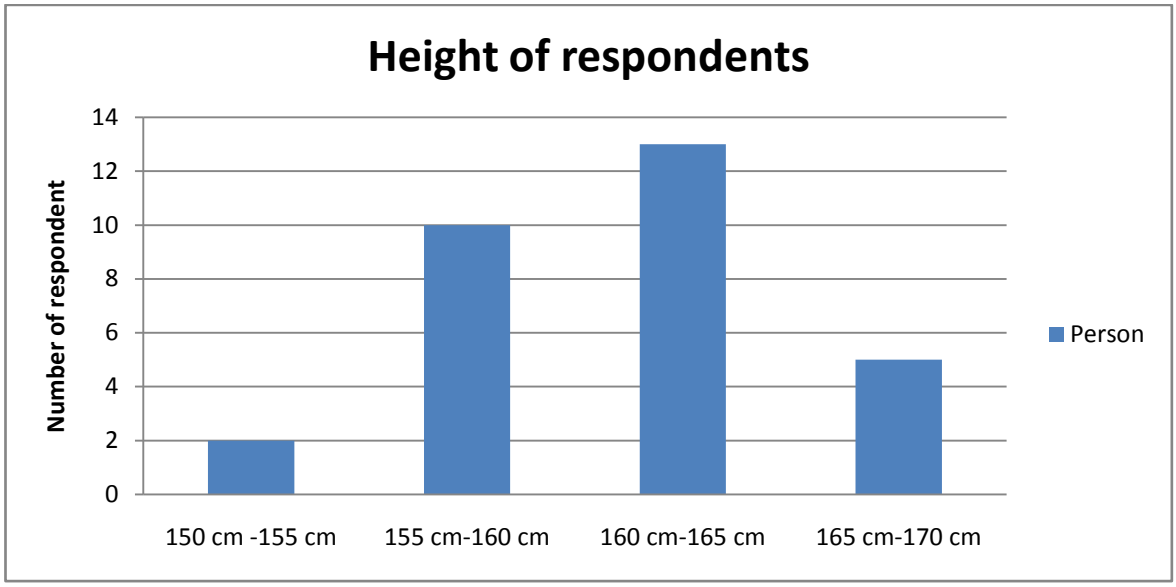

Figure 4.2: Height of respondents

4.5 DATA FOR SEAT A

4.5.1 Height between seat and frame is 0 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	2			
B	27	3			
C	28	2			
D	30				
E	29	1			
F	29	1			
G	30				
H	30				

Table 4.3: Height 0 cm, Time 0 minutes to 5 minutes (Seat A)

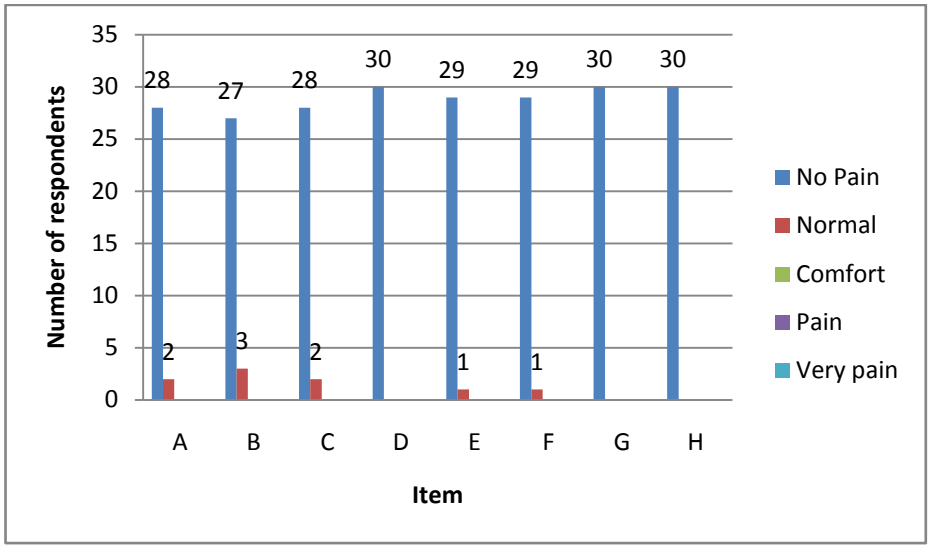

Figure 4.3: Height: 0 cm, Time: 0 minutes to 5 minutes (Seat A)

4.5.2 Height between seat and frame is 0 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	27	3			
B	27	3			
C	26	4			
D	25	3	1	1	
E	27	3			
F	25	1		4	
G	23	3		4	
H	22	5		3	

Table 4.4: Height 0 cm, Time 5 minutes to 10 minutes (Seat A)

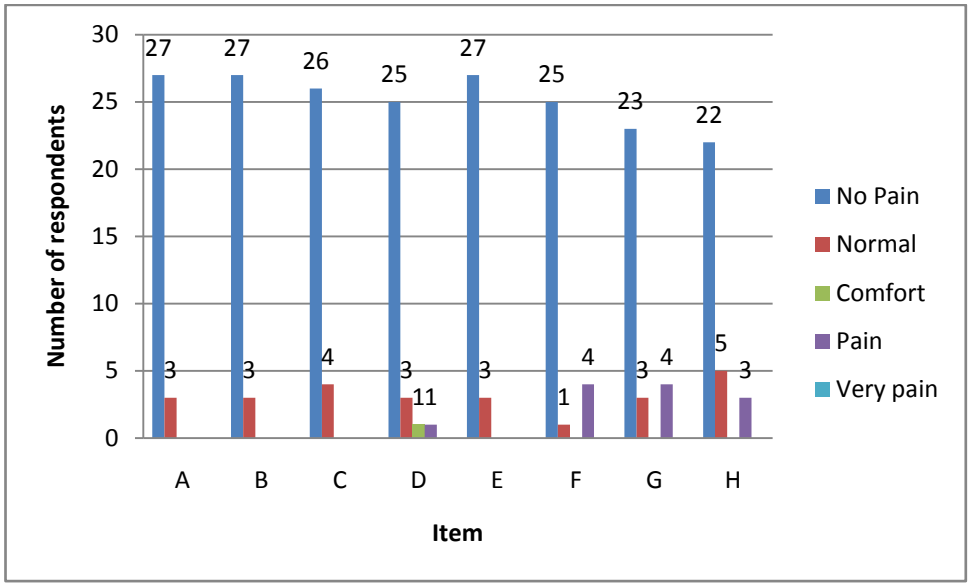

Figure 4.4: Height 0 cm, Time 5 minutes to 10 minutes (Seat A)

4.5.3 Height between seat and frame is 0 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	4			
B	27	3			
C	25	5			
D	25		1	4	
E	27	3			
F	25	1		4	
G	23	2		5	
H	22	5		3	

Table 4.5: Height 0 cm, Time 10 minutes to 15 minutes (Seat A)

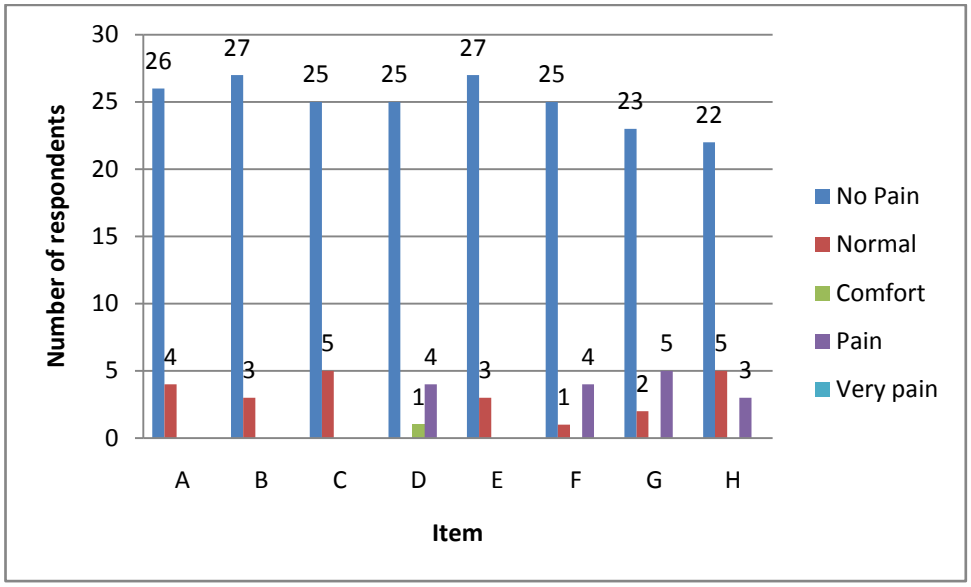

Figure 4.5: Height 0 cm, Time 10 minutes to 15 minutes (Seat A)

4.5.4 Height between seat and frame is 5 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	29	1			
C	28	1	1		
D	30				
E	29	1			
F	29	1			
G	27	3			
H	29	1			

Table 4.6: Height 5 cm, Time 0 minutes to 5 minutes (Seat A)

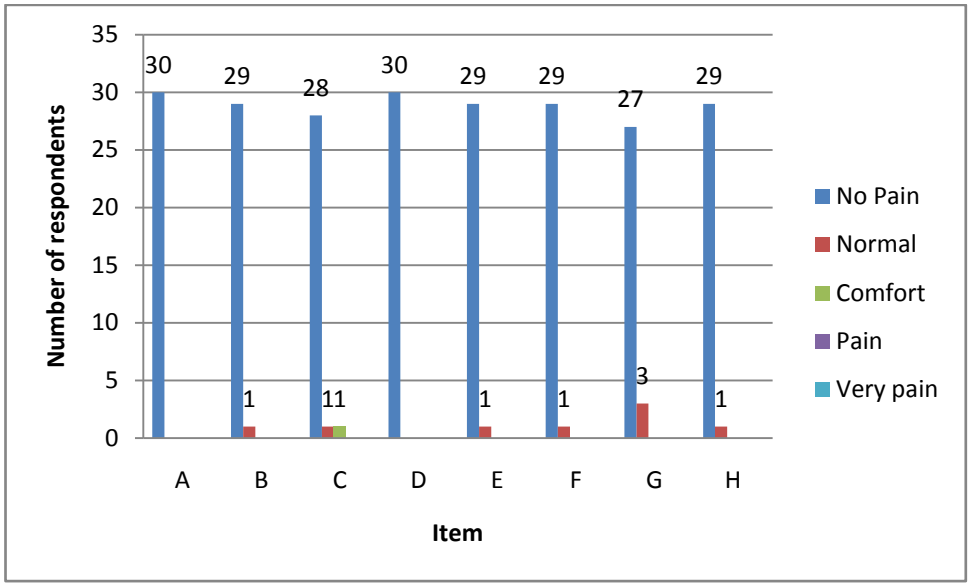

Figure 4.6: Height: 5 cm, Time: 0 minutes to 5 minutes (Seat A)

4.5.5 Height between seat and frame is 5 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	29	1			
B	28	1		1	
C	25	3		2	
D	29	1			
E	29	1			
F	26	1		3	
G	25	3		2	
H	29	1			

Table 4.7: Height 5 cm, Time 5 minutes to 10 minutes (Seat A)

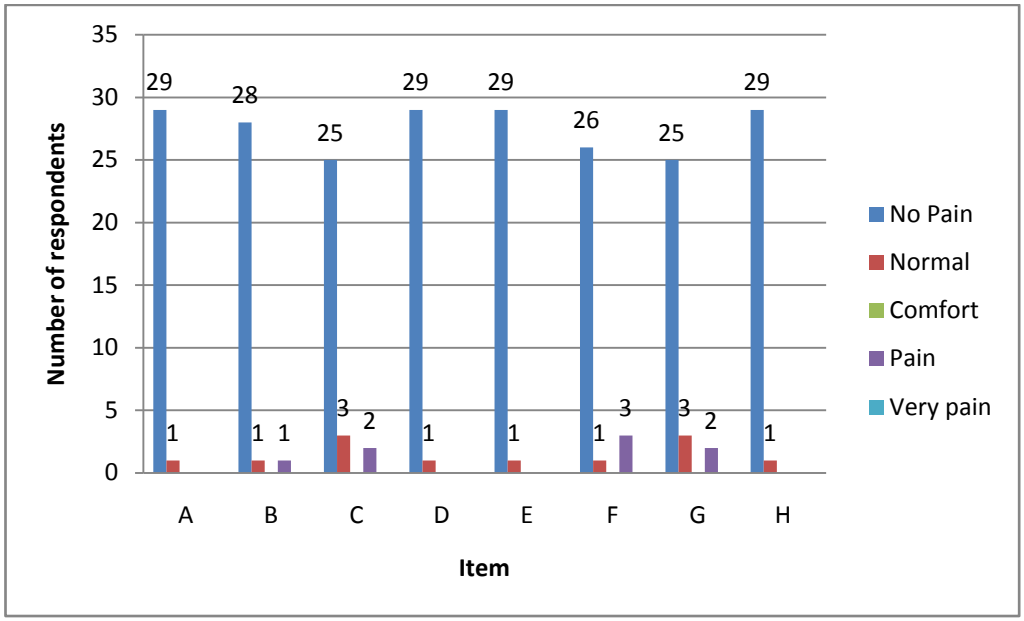

Figure 4.7: Height 5 cm, Time 5 minutes to 10 minutes (Seat A)

4.5.6 Height between seat and frame is 5 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	29	1			
B	28	1		1	
C	23	3		4	
D	28	2			
E	29	1			
F	25	1		4	
G	25	2		3	
H	29	1		1	

Table 4.8: Height 5 cm, Time 10 minutes to 15 minutes (Seat A)

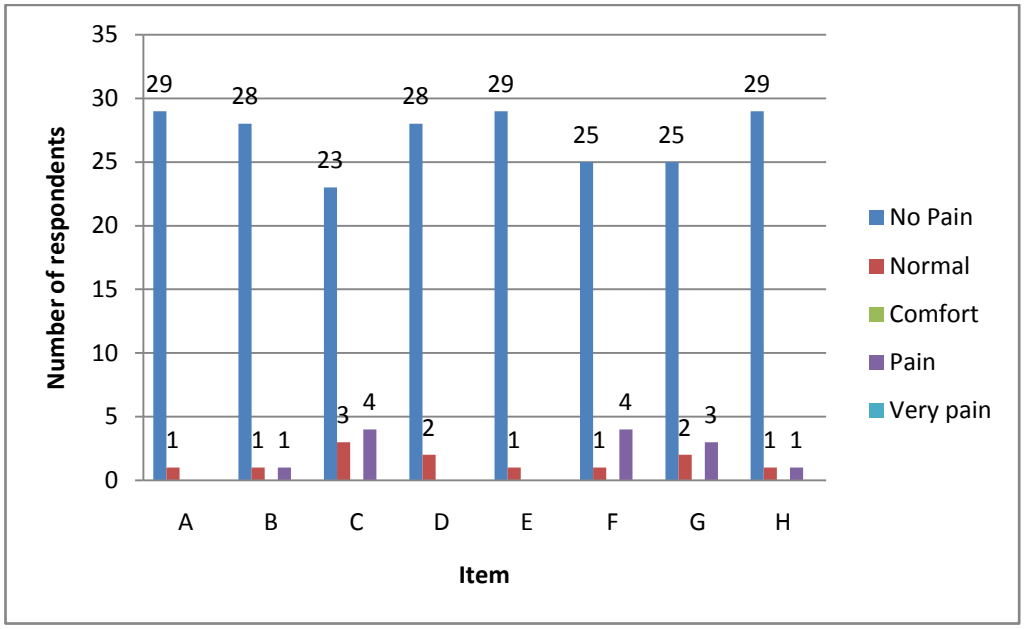

Figure 4.8: Height 5 cm, Time 10 minutes to 15 minutes (Seat A)

4.5.7 Height between seat and frame is 10 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	30				
C	28	2			
D	30				
E	29	1			
F	28	1		1	
G	30				
H	30				

Table 4.9: Height 10 cm, Time 0 minutes to 5 minutes (Seat A)

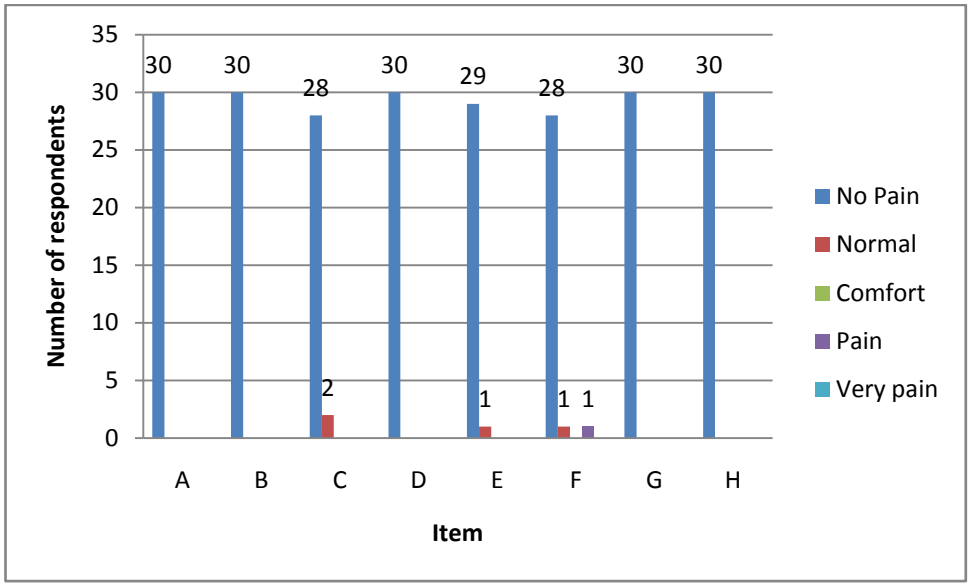

Figure 4.9: Height: 10 cm, Time: 0 minutes to 5 minutes (Seat A)

4.5.8 Height between seat and frame is 10 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	1		1	
B	25	3		2	
C	25	2		3	
D	27			3	
E	28	2			
F	27	3		2	
G	28	2			
H	28	2			

Table 4.10: Height 10 cm, Time 5 minutes to 10 minutes (Seat A)

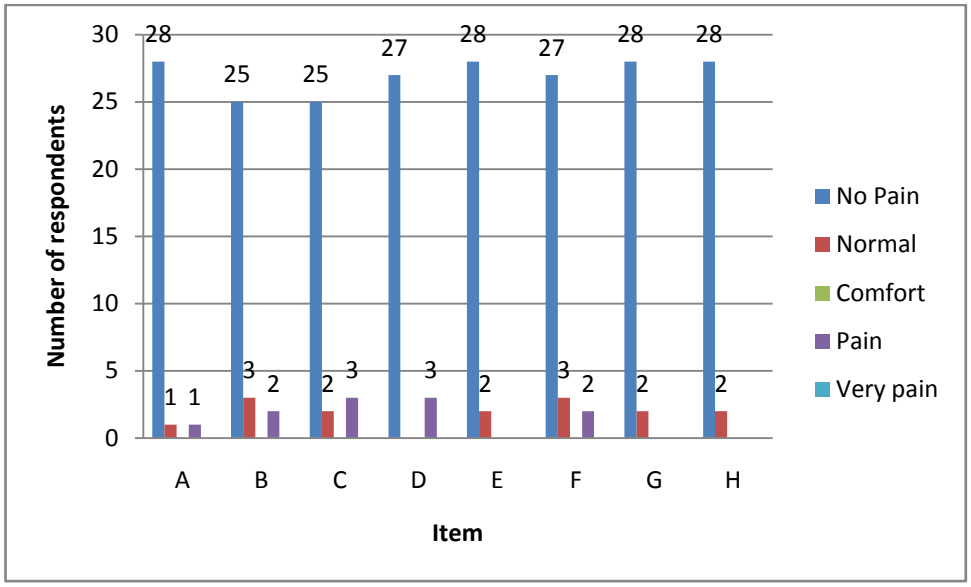

Figure 4.10: Height 10 cm, Time 5 minutes to 10 minutes (Seat A)

4.5.9 Height between seat and frame is 10 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	1		3	
B	25	2		3	
C	23	2		5	
D	25	1		4	
E	27	3			
F	25	1		4	
G	26	2		2	
H	27	2		1	

Table 4.11: Height 10 cm, Time 10 minutes to 15 minutes (Seat A)

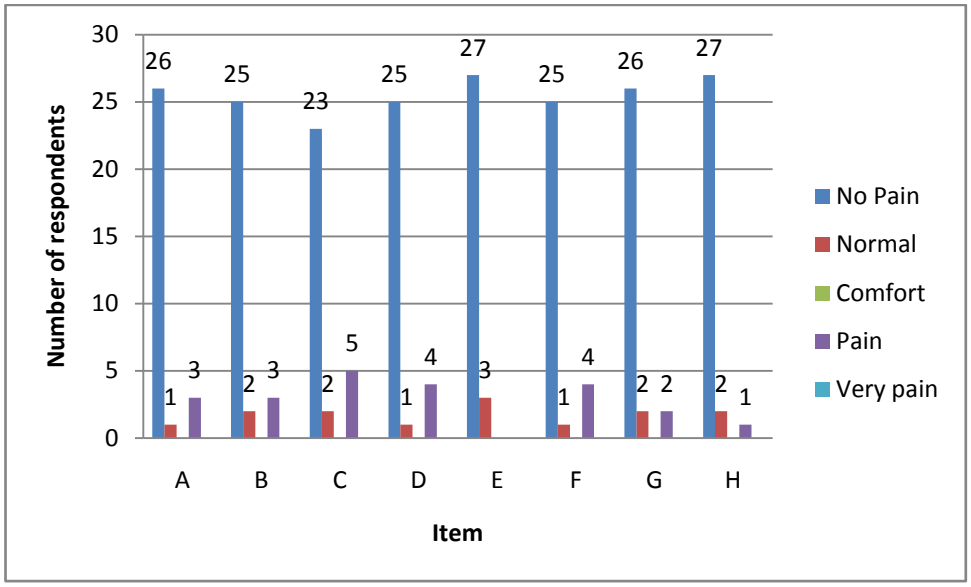

Figure 4.11: Height 10 cm, Time 10 minutes to 15 minutes (Seat A)

4.6 DATA FOR SEAT B

4.6.1 Height between seat and frame is 0 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	2			
B	27	3			
C		19		11	
D	30				
E	29	1			
F		15		11	4
G	30				
H	29	1			

Table 4.12: Height 0 cm, Time 0 minutes to 5 minutes (Seat B)

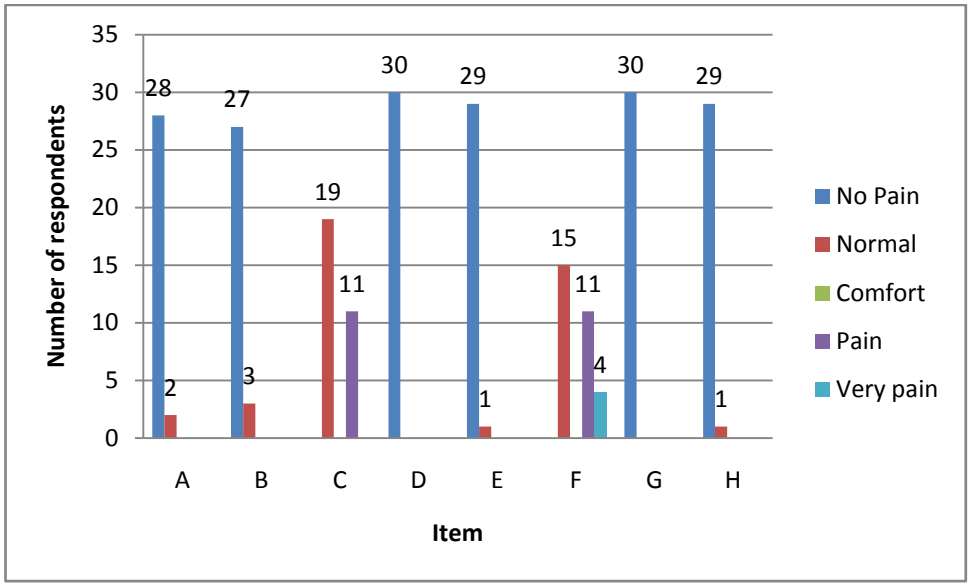

Figure 4.12: Height 0 cm, Time 0 minutes to 5 minutes (Seat B)

4.6.2 Height between seat and frame is 0 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	27	3			
B	28	2			
C		17		10	3
D	25	3	1	1	
E	27	3			
F		15		10	5
G	23	3		4	
H	22	5		3	

Table 4.13: Height 0 cm, Time 5 minutes to 10 minutes (Seat B)

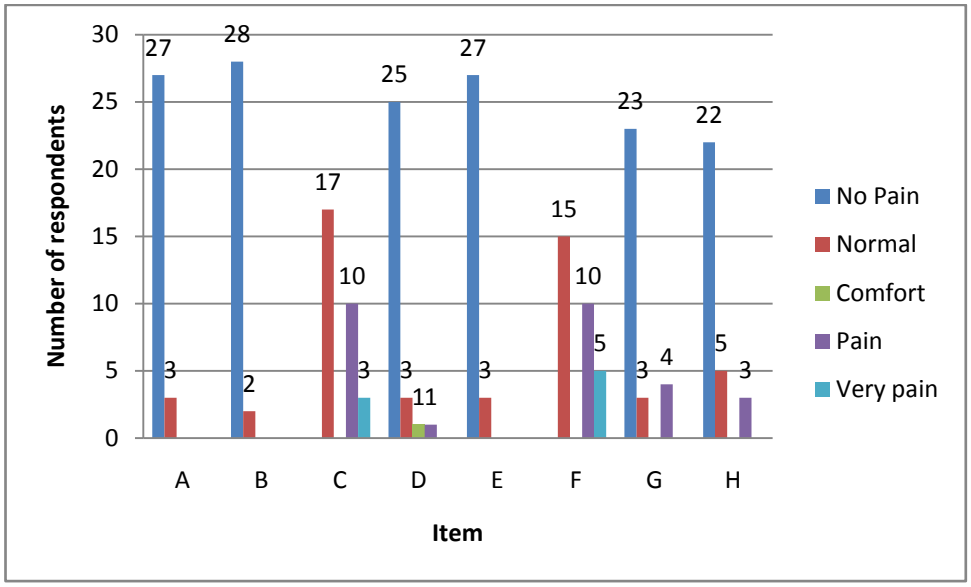

Figure 4.13: Height 0 cm, Time 5 minutes to 10 minutes (Seat B)

4.6.3 Height between seat and frame is 0 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	4			
B	27	3			
C		16		9	4
D	25		1	4	
E	27	3			
F		14		10	6
G	22	3	1	4	
H	22	4		4	

Table 4.14: Height 0 cm, Time 10 minutes to 15 minutes (Seat B)

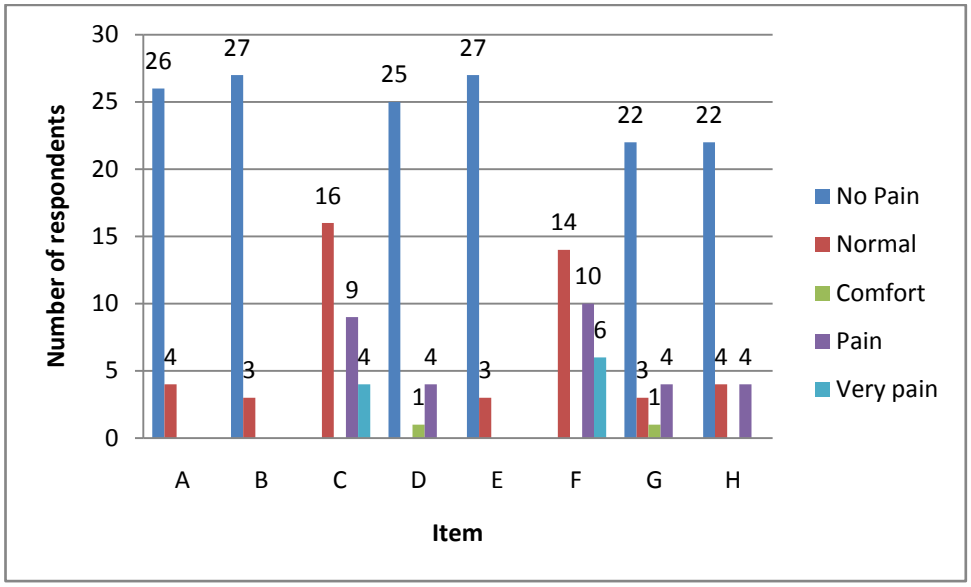

Figure 4.14: Height 0 cm, Time 10 minutes to 15 minutes (Seat B)

4.6.4 Height between seat and frame is 5 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	29	1			
C		19		11	
D	30				
E	29	1			
F		15		11	4
G	27	3			
H	28	2			

Table 4.15: Height 5 cm, Time 0 minutes to 5 minutes (Seat B)

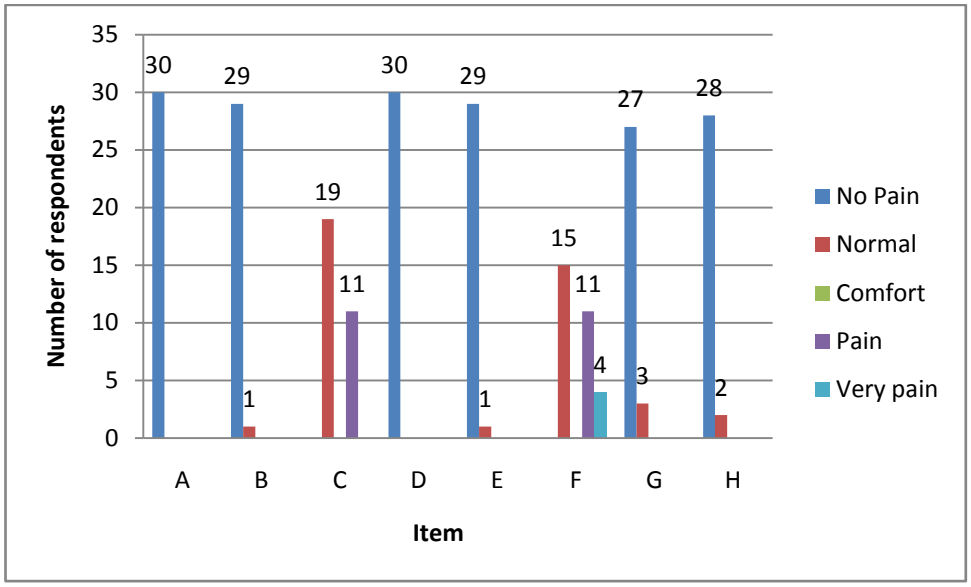

Figure 4.15: Height 5 cm, Time 0 minutes to 5 minutes (Seat B)

4.6.5 Height between seat and frame is 5 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	2			
B	29	1			
C		17		10	3
D	29	1			
E	29	1			
F		14		12	4
G	25	2		3	
H	29	1			

Table 4.16: Height 5 cm, Time 5 minutes to 10 minutes (Seat B)

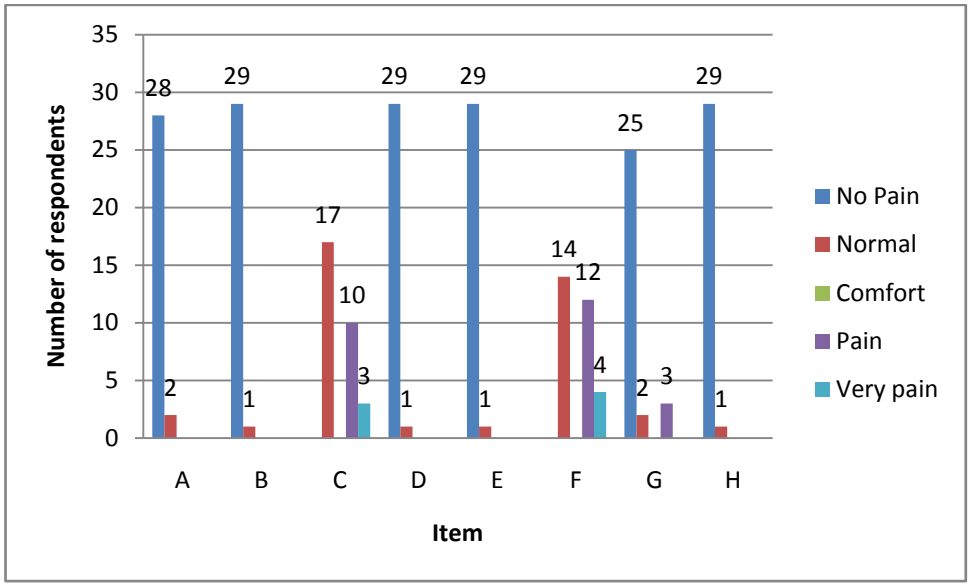

Figure 4.16: Height 5 cm, Time 5 minutes to 10 minutes (Seat B)

4.6.6 Height between seat and frame is 5 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	29	1			
B	28	1		1	
C		15		10	5
D	28	2			
E	29	1			
F		13		13	4
G	25	2		3	
H	29	1		1	

Table 4.17: Height 5 cm, Time 10 minutes to 15 minutes (Seat B)

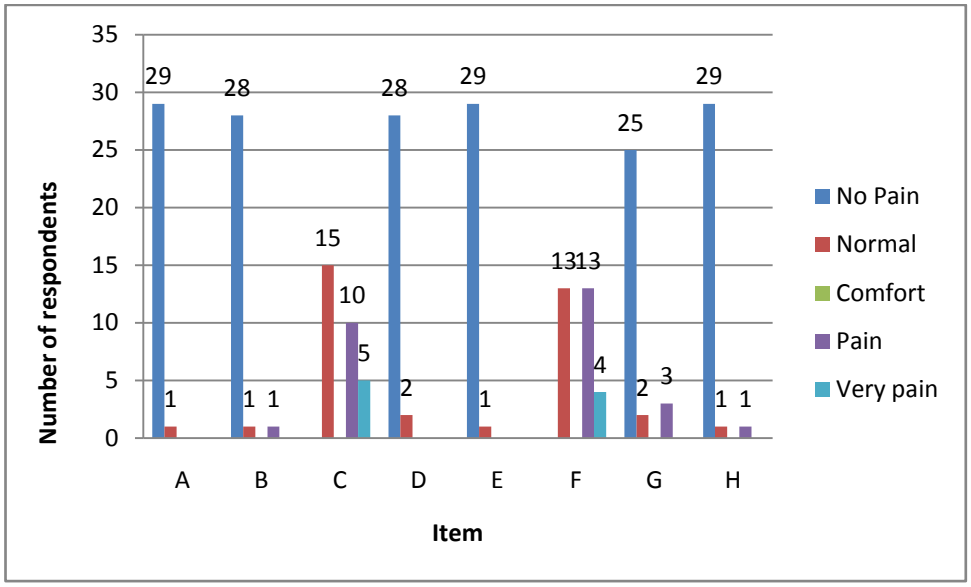

Figure 4.17: Height 5 cm, Time 10 minutes to 15 minutes (Seat B)

4.6.7 Height between seat and frame is 10 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	29	1			
C		18		11	
D	30				
E	29	1			
F		15		10	5
G	29	1			
H	30				

Table 4.18: Height 10 cm, Time 0 minutes to 5 minutes (Seat B)

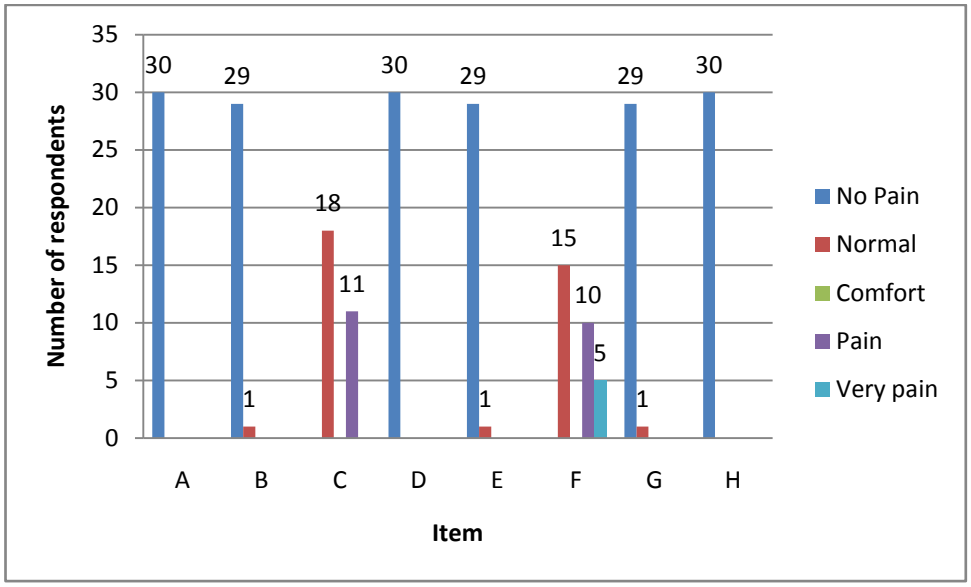

Figure 4.18: Height 10 cm, Time 0 minutes to 5 minutes (Seat B)

4.6.8 Height between seat and frame is 10 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	1		1	
B	26	2		2	
C		16		10	4
D	27			3	
E	28	2			
F		15		9	6
G	25	4		1	
H	27	3			

Table 4.19: Height 10 cm, Time 5 minutes to 10 minutes (Seat B)

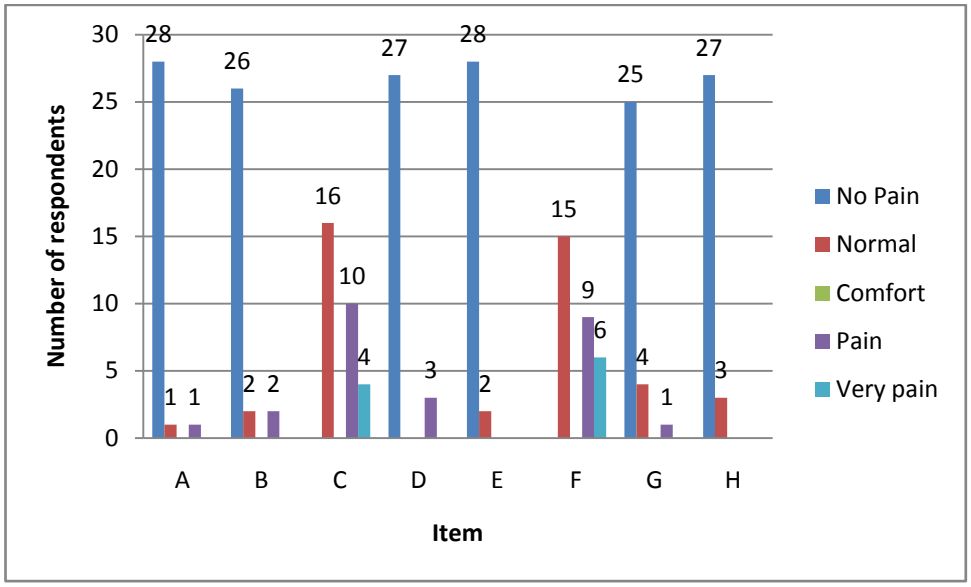

Figure 4.19: Height 10 cm, Time 5 minutes to 10 minutes (Seat B)

4.6.9 Height between seat and frame is 10 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	1		3	
B	25	2		3	
C		15		9	6
D	25	1		4	
E	27	3			
F		14		10	6
G	25	3		2	
H	27	2		1	

Table 4.20: Height 10 cm, Time 10 minutes to 15 minutes (Seat B)

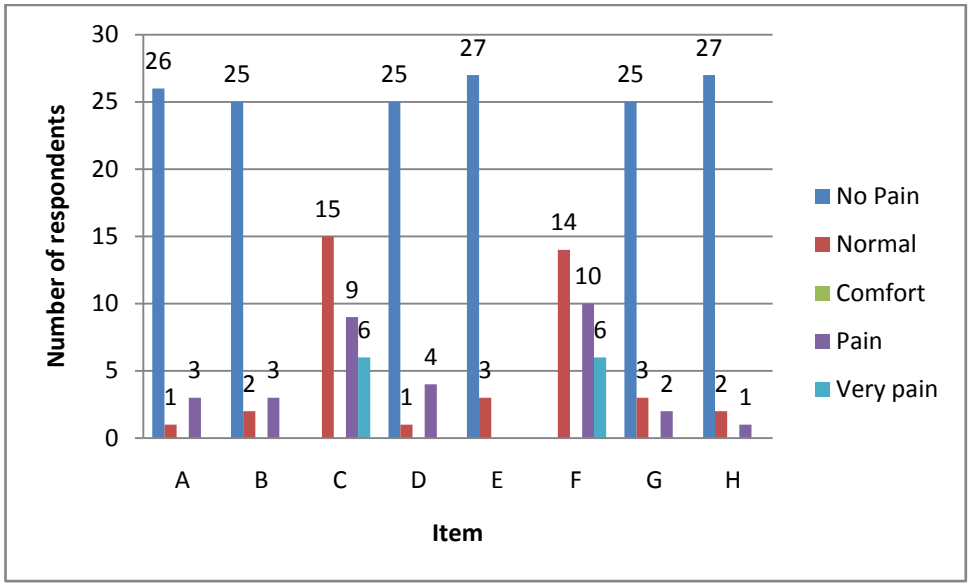

Figure 4.20: Height 10 cm, Time 10 minutes to 15 minutes (Seat B)

4.7 DATA FOR SEAT C

4.7.1 Height between seat and frame is 0 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	2			
B	27	3			
C			30		
D	30				
E	29	1			
F			30		
G	30				
H	29	1			

Table 4.21: Height 0 cm, Time 0 minutes to 5 minutes (Seat C)

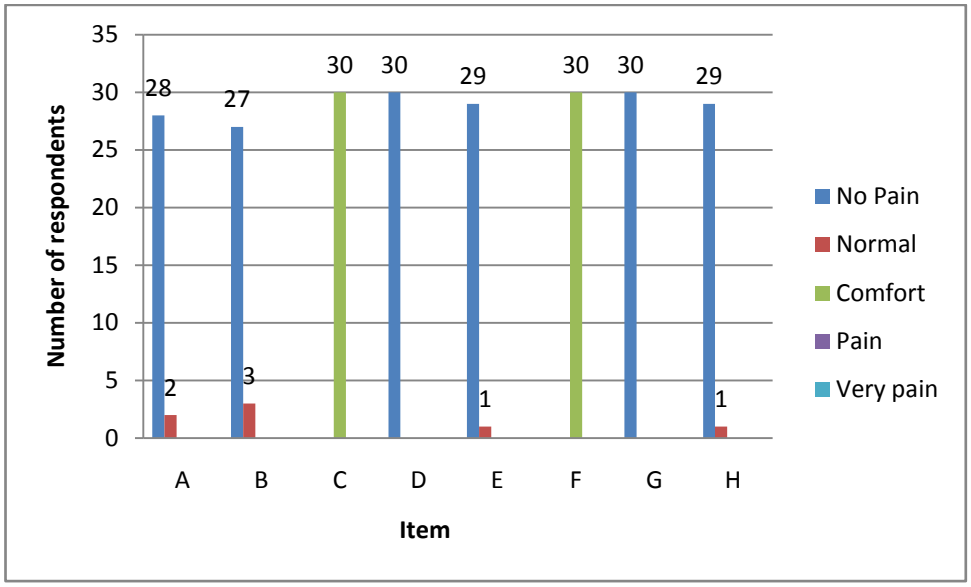

Figure 4.21: Height 0 cm, Time 0 minutes to 5 minutes (Seat C)

4.7.2 Height between seat and frame is 0 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	27	3			
B	27	3			
C		1	29		
D	25	3	1	1	
E	27	3			
F		1	29		
G	23	3		4	
H	22	5		3	

Table 4.22: Height 0 cm, Time 5 minutes to 10 minutes (Seat C)

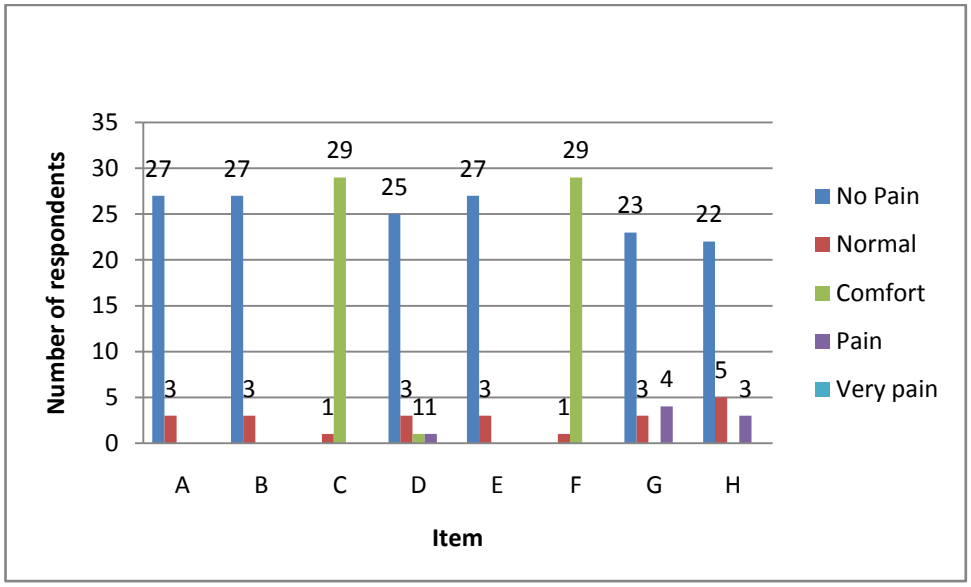

Figure 4.22: Height 0 cm, Time 5 minutes to 10 minutes (Seat C)

4.7.3 Height between seat and frame is 0 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	4			
B	27	3			
C		1	29		
D	25		1	4	
E	27	3			
F		1	29		
G	22	3	1	4	
H	22	4		4	

Table 4.23: Height 0 cm, Time 10 minutes to 15 minutes (Seat C)

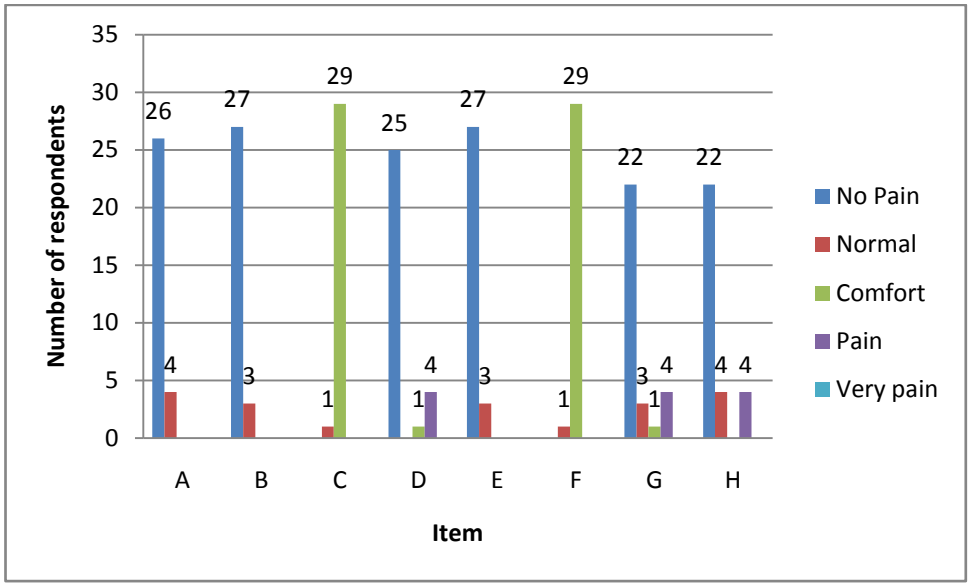

Figure 4.23: Height 0 cm, Time 10 minutes to 15 minutes (Seat C)

4.7.4 Height between seat and frame is 5 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	29	1			
C			30		
D	30				
E	29	1			
F			30		
G	27	3			
H	28	2			

Table 4.24: Height 5 cm, Time 0 minutes to 5 minutes (Seat C)

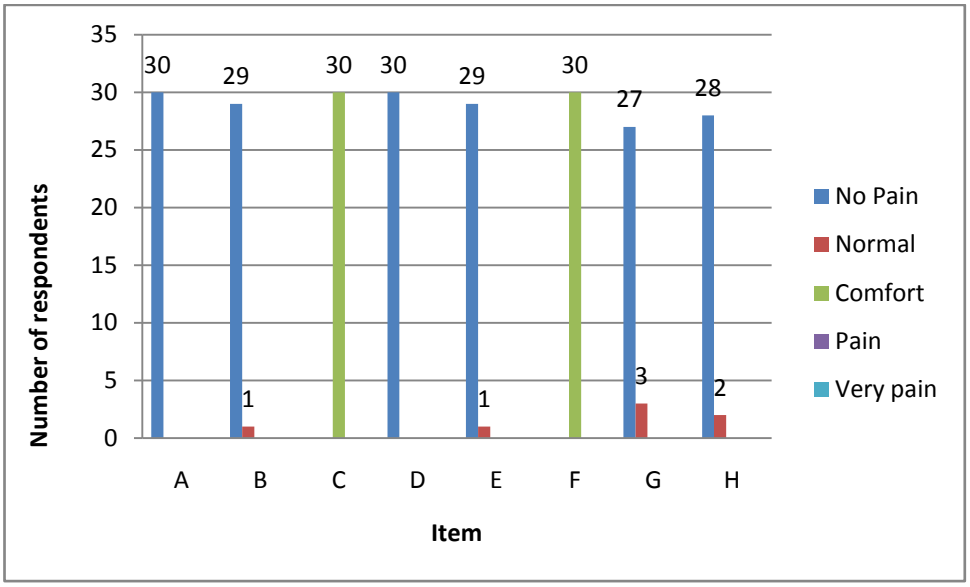

Figure 4.24: Height 5 cm, Time 0 minutes to 5 minutes (Seat C)

4.7.5 Height between seat and frame is 5 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	29	1			
B	28	1		1	
C		1	29		
D	29	1			
E	29	1			
F		1	29		
G	25	3		2	
H	29	1			

Table 4.25: Height 5 cm, Time 5 minutes to 10 minutes (Seat C)

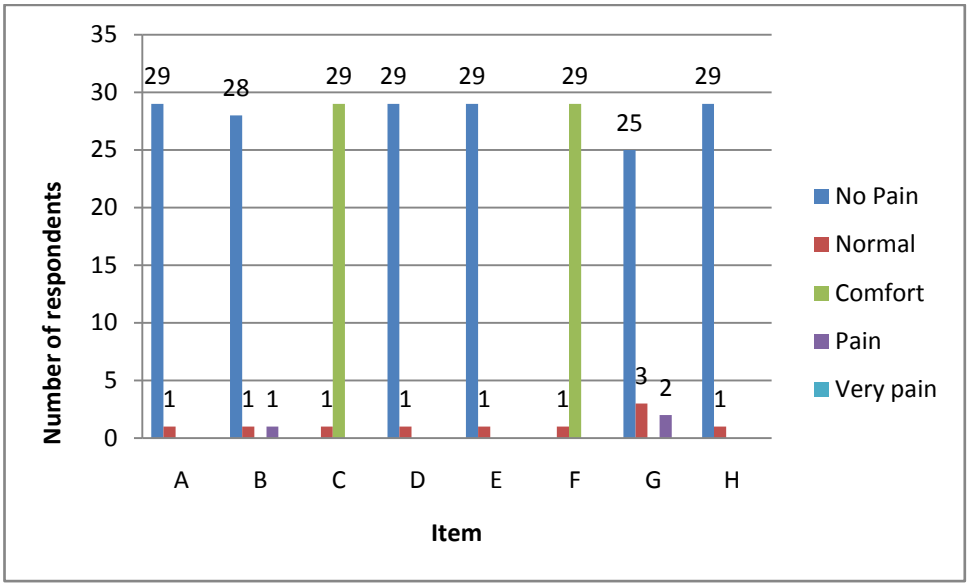

Figure 4.25: Height 5 cm, Time 5 minutes to 10 minutes (Seat C)

4.7.6 Height between seat and frame is 5 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	29	1			
B	28	1		1	
C		1	29		
D	28	2			
E	29	1			
F		2	28		
G	25	2		3	
H	29	1		1	

Table 4.26: Height 5 cm, Time 10 minutes to 15 minutes (Seat C)

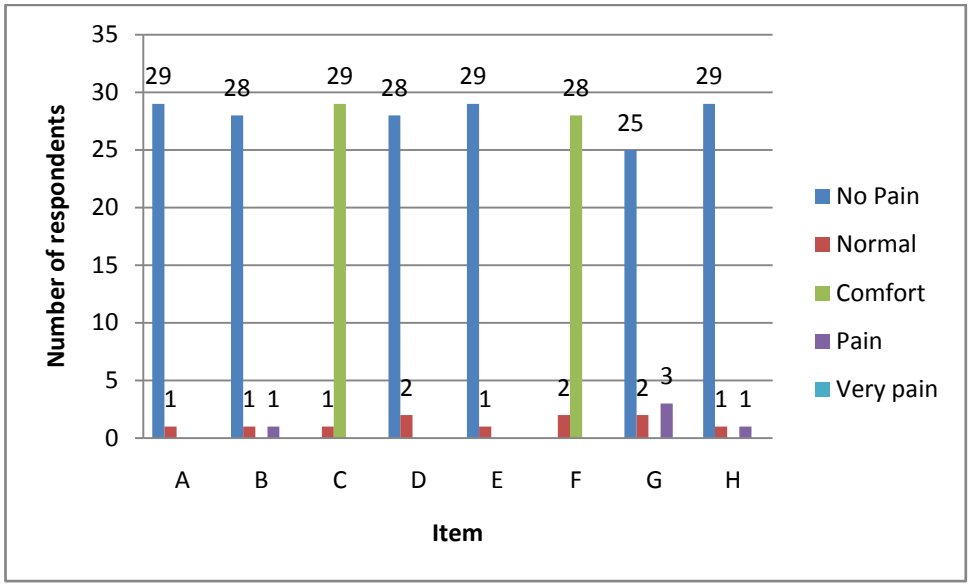

Figure 4.26: Height 5 cm, Time 10 minutes to 15 minutes (Seat C)

4.7.7 Height between seat and frame is 10 cm and time is 0 minutes to 5 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	30				
B	29	1			
C			30		
D	30				
E	29	1			
F			30		
G	29	1			
H	30				

Table 4.27: Height 10 cm, Time 0 minutes to 5 minutes (Seat C)

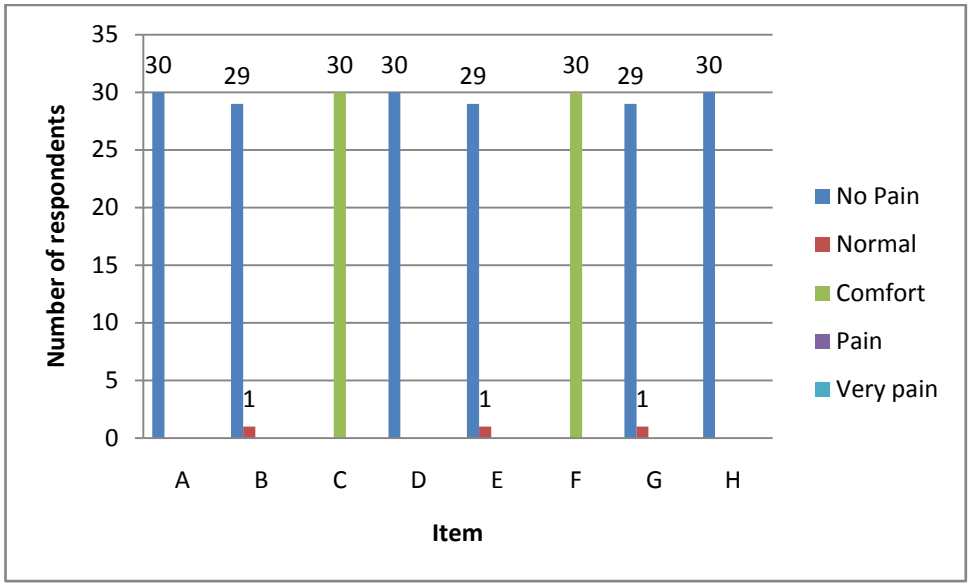

Figure 4.27: Height 10 cm, Time 0 minutes to 5 minutes (Seat C)

4.7.8 Height between seat and frame is 10 cm and time is 5 minutes to 10 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	28	1		1	
B	25	3		2	
C		2	28		
D	27			3	
E	28	2			
F		2	28		
G	28	2			
H	28	2			

Table 4.28: Height 10 cm, Time 5 minutes to 10 minutes (Seat C)

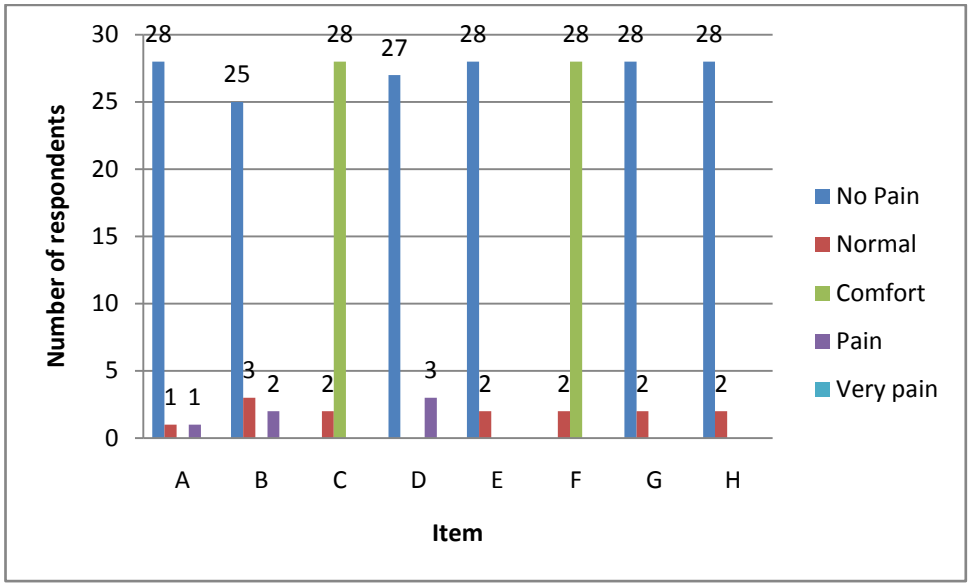

Figure 4.28: Height 10 cm, Time 5 minutes to 10 minutes (Seat C)

4.7.9 Height between seat and frame is 10 cm and time is 10 minutes to 15 minutes

Item	No Pain	Normal	Comfort	Pain	Very pain
A	26	1		3	
B	25	2		3	
C		2	28		
D	25	1		4	
E	27	3			
F		2	28		
G	25	3		2	
H	27	2		1	

Table 4.29: Height 10 cm, Time 10 minutes to 15 minutes (Seat C)

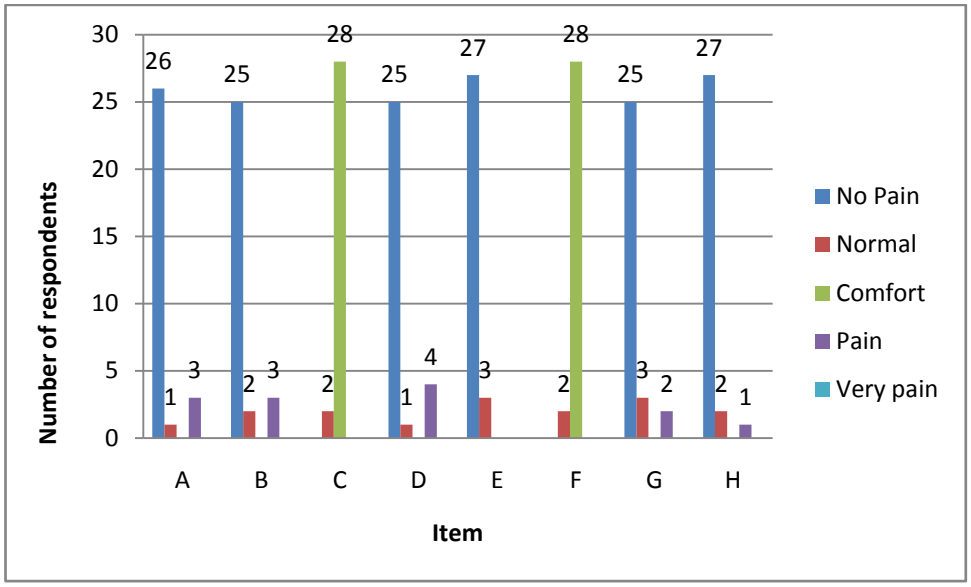

Figure 4.29: Height 10 cm, Time 10 minutes to 15 minutes (Seat C)

4.8 COMFORT TIME ZONE

Time	0 minutes to 5 minutes	5 minutes to 10 minutes	10 minutes to 15 minutes
Number of respondents	11	14	5

Table 4.30: Comfort time zone

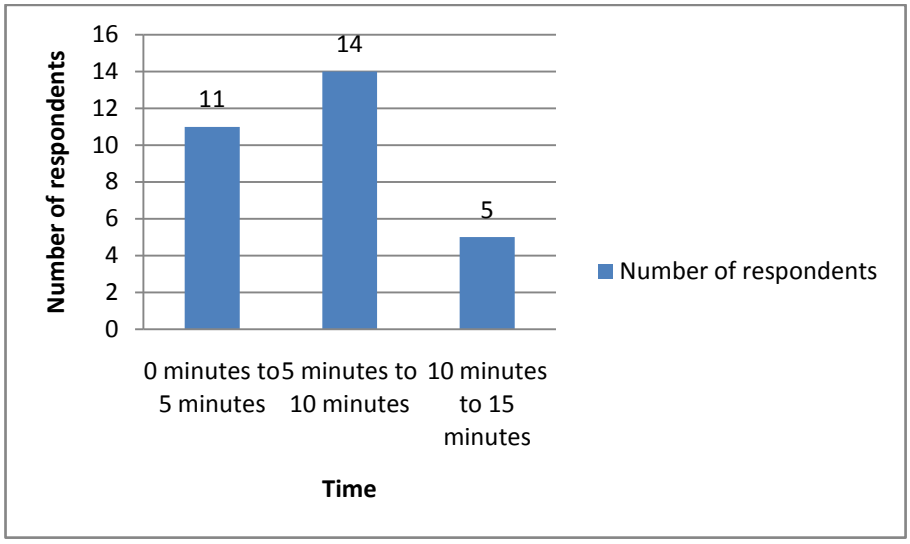

Figure 4.30: Comfort time zone

4.9 COMFORT DESIGN

Design	SEAT A	SEAT B	SEAT C
Number of respondents	8	3	19

Table 4.31: Comfort design

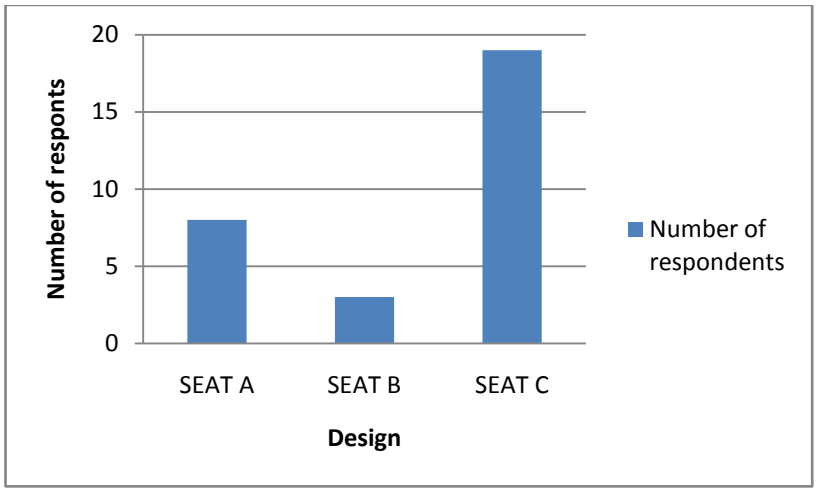

Figure 4.31: Comfort Design

4.10 COMFORT HEIGHT OF SEAT

Difference height	0 cm	5 cm	10 cm
Number of respondents	7	19	4

Table 4.32: Comfort height

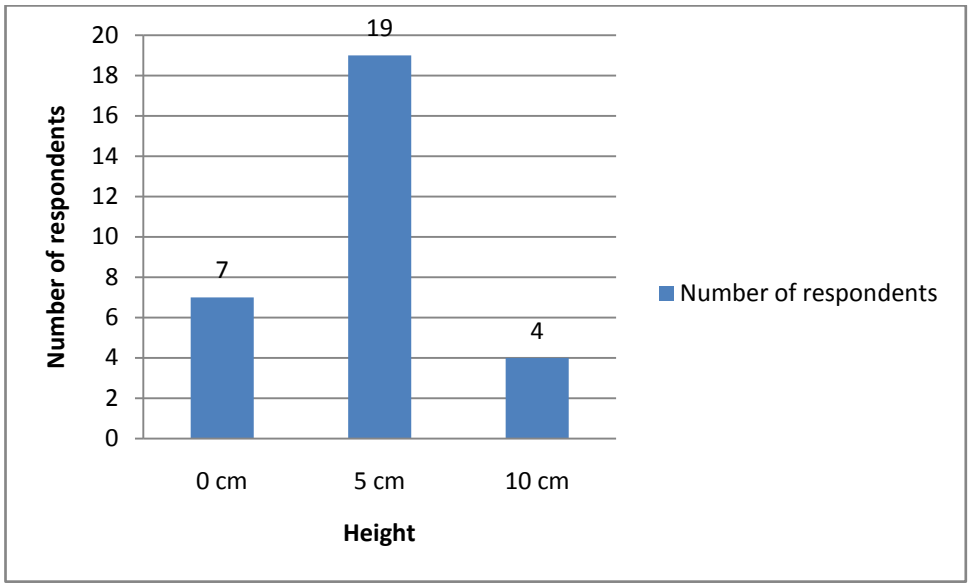

Figure 4.32: Comfort height

4.11 RESULTS & DISCUSSION

4.11.1. Height

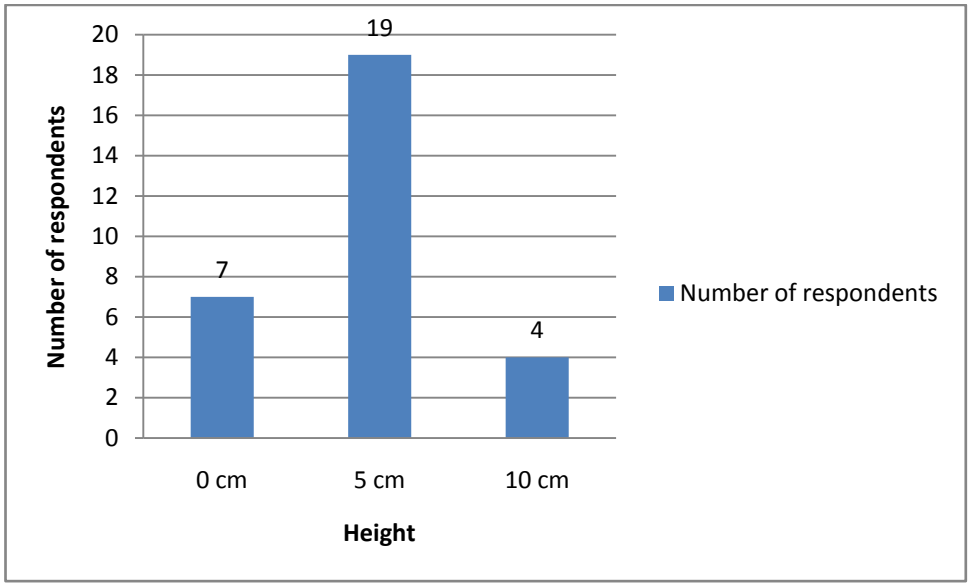

Figure 4.32: Comfort height

Based on Figure 4.32, there are three type of height which is 0 cm, 5 cm and 10 cm. Thirty respondents is require to seat on three difference level of seat to identify which level are they comfort during cycling. The 63.3% of respondents agree to state that 5 cm is the most comfort height for bicycle seat during cycling. The 23.3% of respondents state that 0cm is the comfort height for riding and only 13.3% of respondent's state that 10 cm is the comfort height for riding.

4.11.2 Weight

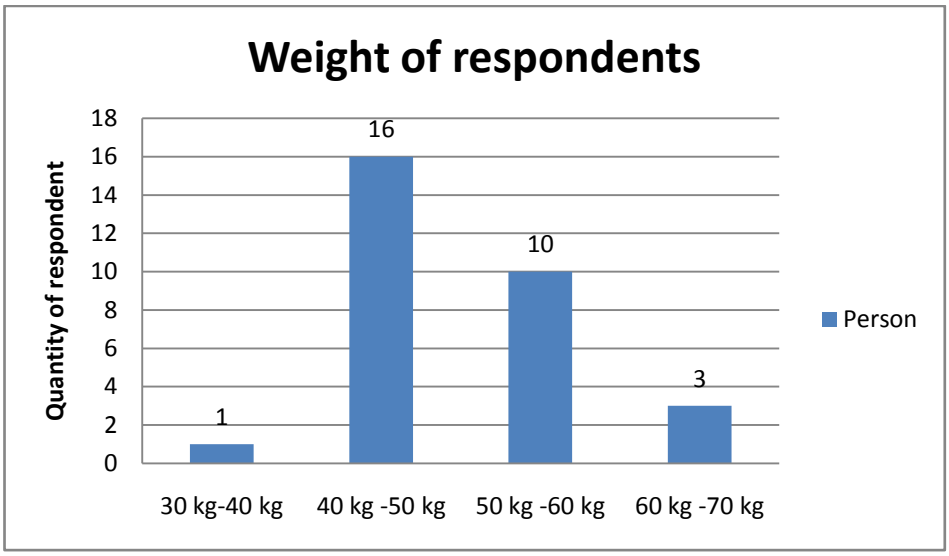

Figure 4.1: Weight of respondents

The Figure 4.1 shows that weight of respondents. There are four groups of respondents according to group of weight. First group is respondents with their weight 30 kg to 40 kg. Second group is respondents with their weight 40 kg to 50 kg. Third group is a respondent with their weight 50kg to 60kg and last group is respondents with their weight is 60kg to 70 kg. The 53.3% of respondents which is majority of respondents have average weight which is second group. These numbers are follows by 33.3% of respondents from third group. The 10% of respondents are from last group which is 60 kg to 70 kg and only minority number of respondents which is 3.3% of respondents with weight between 30 kg to 40 kg.

4.11.3 Seat Design

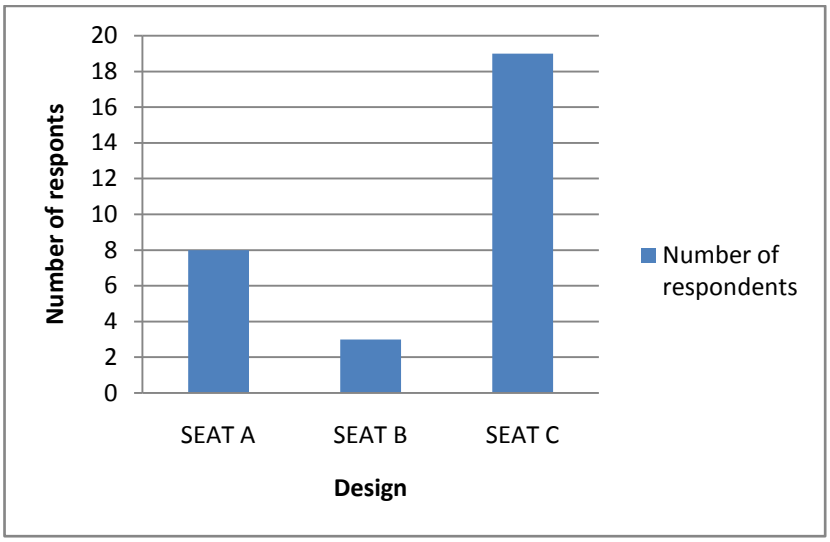

Figure 4.31: Comfort Design

The Figure 4.31 shows the number of respondents and design seat with percentages of comfort design. The 63.3% of respondents agree that most comfort design for female in this experiment is Seat C and follow by 26.6% of respondents for Seat A. The lowers percentages are Seat B which is only 10% of respondents.

4.11.4 Duration of cycling

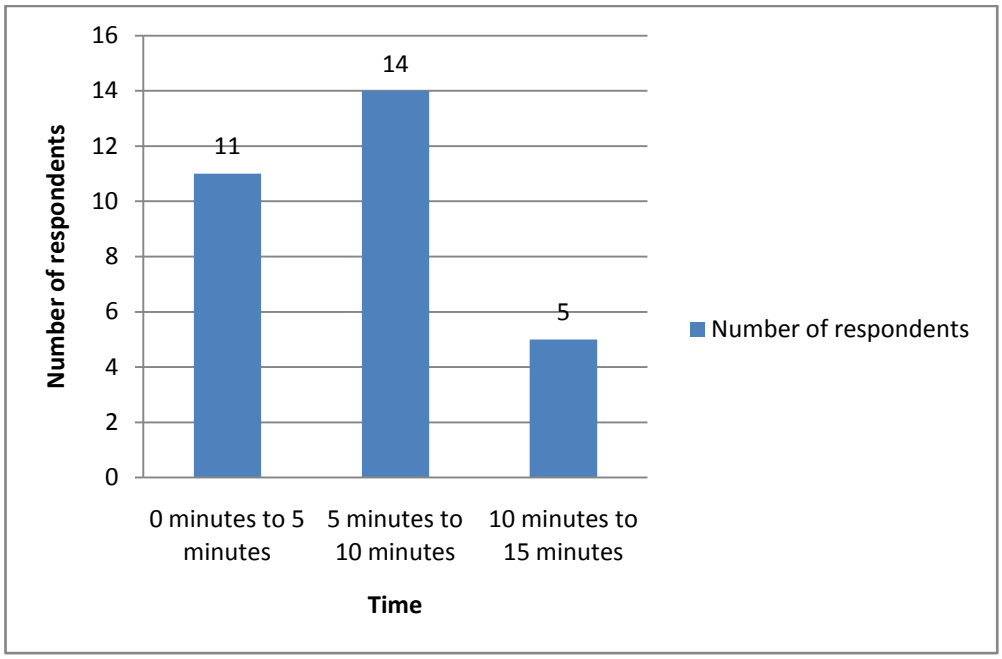

Figure 4.30: Comfort time zone

Based on Figure 4.30, there are three level of duration in this experiment. First level is 0 minutes to 5 minutes, second is 5 minutes to 10 minutes and last is 10 minutes to 15 minutes. The 46.6% of respondents state that the most comfort duration during cyclist is 5 minutes until 10 minutes which is 14 respondents. Only 16.6% which is 5 respondents state that 10 minutes to 15 minutes are comfort for them. Only 11 respondents state that 0 minutes until 5 minutes is the comfort time zone which is 36.7%.

4.12 CLOSURE

This chapter highlighted on result and discussion for comfort riding for female rider. In the next chapter conclusion and recommendation for future works will be discussed.

CHAPTER 5

CONCLUSION AND RECOMMENDATION FOR FUTURE WORKS

The project of comfort riding focus on bicycle seat for female had achieved its overall target. There are two main objectives stated in the early stage of the project.

The first objective is to study bicycle seat for female comfort riding. Bicycle seat is one of the most important elements that should be considered to ensure rider can ride bicycle in comfort. Design of bicycle seat is depend on gander because shape of women pelvic and men pelvic are differences. Women pelvic is more large than men pelvic. The width and shape of the bicycle seat is depending on the distance between the seat bones and the shape of pelvic. The larger the distance between the seat bones and the rounder the pelvic, the wider the bicycle seat should be. Ergonomics design for bicycle seat must be consider to give comfortable for rider and to avoid injury during cyclist. The uncomfortable seat will cause pain in the female pelvic muscles, numbness, and edema of pelvic floor structures. **[18]**

The second objective is to analysis riding comfort. Effect when bicycle seat is positioned too high, handlebars positioned will be lower than the bicycle seat. This positioned will increased perineum saddle pressures and decreased genital sensation in female cyclists. When the position on the bicycle is too low, it will cause the knees positions of rider is too bent and uncomfortable. Height of bicycle seat should be adjusted to certain level to get comfortable riding. Oxygen consumption at each seat height would vary significantly with changes in saddle height and thus indicate a most efficient seat height. The lower and higher seat heights were less efficient with the difference between the mean oxygen consumption at the 100 and 105 percent bicycle seat heights being significant. The most efficient seat heights are close to the value of 109% Method which designed as being optimum. **[19]** It is important to ensure height between bicycle seat and bicycle frame is suitable depends on height of rider.

As a conclusion, there are many elements should be consider to analyze either the seat are ergonomic and comfort for rider. The most important elements should be consider for choosing the best bicycle seat is safety and will avoid any injury.

5.1 RECOMMENDATION

Recommendations for this project:

i. To use sensor while conducting experiments to obtain data about the comfort of the rider. It is better if the sensor is used to get more accurate data and also can collect more data such as reading pulse rider, rider body temperature, areas that receive a lot of pressure when the rider and so on.

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7.0 APPENDICES

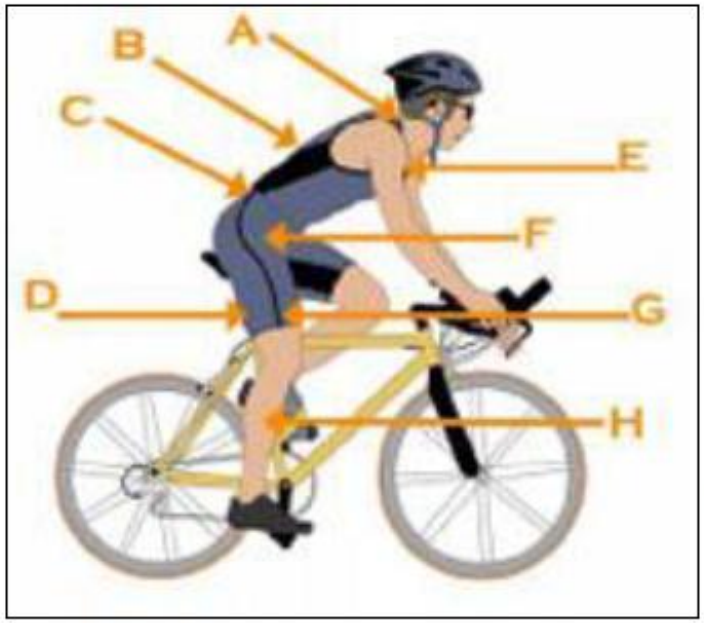
Please fill in your personal information and tick (√) on related

Name : _____

Age : _____

Weight			Height		
	30KG-40KG			150 cm – 155 cm	
	40KG-50KG			155 cm – 160 cm	
	50KG-60KG			160 cm – 165 cm	
	60KG-70KG			165 cm – 170 cm	

Seat Design :			Time :			Height between seat and frame		
	A			0 min- 5min			0 cm	
	B			5 min -10 min			5 cm	
	C			10 min – 15 min			10 cm	



ITEM	DESCRIPTION	1	2	3	4	5
A	Cervical spine extended					
B	Middle back/thoracic spine immobile					
C	Lower back in flexion					
D	Pedaling range of motion (hamstring)					
E	Leaning forward, gripping the bars					
F	Pedaling range of motion (hip flexors)					
G	Knee on a "fixed" track					
H	Shoes "clipped" in, the foot as a lever					

1: No pain, 2:Normal, 3: Comfort 4: Sick, 5: Very sick

Appendix 1