UNIVERSITI PUTRA MALAYSIA

ANALYSIS OF POSTURE AND ITS RELATIONSHIP WITH RIDING DISCOMFORT AMONG POLICE RIDERS: A CROSS-SECTIONAL STUDY

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BY

MUHAMMAD AIMAN BIN CHE ZAHARI

Thesis submitted in fulfilment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

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ABSTRACT

ANALYSIS OF POSTURE AND ITS RELATIONSHIP WITH RIDING DISCOMFORT AMONG POLICE RIDERS: A CROSS-SECTIONAL STUDY

MUHAMMAD AIMAN BIN CHE ZAHARI

Introduction: Royal Malaysia Police (RMP) is one of the uniformed forces in Malaysia to ensure public safety and security of the country. The motorcycle is one of the vehicles that have been widely used in several departments of RMP. Non-ideal posture (slump, short lordosis and long lordosis) during prolonged riding affects the risk of discomfort to the body parts which lead to the development of musculoskeletal disorders (MSD). However, there is a lack of studies conducted that focus on riding posture and its relationship with riding discomfort among police riders in Malaysia. The aim of this study is to determine the riding posture and its relationship with riding discomfort among police riders. **Methods:** Seventy one male CBX 750 police riders from Maktab Teknik Polis Diraja Malaysia participated in this study. A set of modified questionnaire was distributed to obtain respondent's personal data, job information, body part discomfort rating during riding and discomfort on motorcycle seat features. Discomfort rating on the body part and motorcycle seat features were subjectively rated on the Borg's Scale CR10. Monitoring of posture's riding angle was obtained using Truposture Smart Shirt. **Results:** Posture assessment showed the riding posture angles vary from ideal riding posture by the police riders. For the body discomfort symptoms experienced, the lower back (5.7 ± 3.1) has a highest mean of discomfort, followed by right side of body (5.2 ± 3.2), left side of the body (5.2 ± 3.2), tailbone (5.2 ± 2.2) and left upper pelvis (5.1 ± 2.3). Majority of the police riders felt discomfort (5.1 ± 1.9) on motorcycle seat features with seat features of no lumbar support (6.0 ± 2.5) recorded the high mean of discomfort. For the correlation between riding time and riding posture angles for 5 different sensors, sensor 5 showed a significant relationship with riding time ($r=0.638$). Last, in comparison of body parts discomfort symptoms between preferred riding posture among the police riders, lower back, right and left side of the body showed a statistical difference with preferred riding posture with ($z=19.586$, $p<0.001$), ($z=14.484$, $p=0.001$) and ($z=13.676, p=0.001$) respectively. **Conclusion:** Ideal riding posture cannot be maintained by the police riders since there are varies of riding posture angles from ideal posture angles. Lower back, left and right side of the body, right upper pelvis and tailbone are the most affected body part with discomfort. The police riders felt discomfort on motorcycle seat features and no lumbar support has the highest mean of discomfort on motorcycle seat features. Therefore, lumbar support should be proposed to be equipped on the motorcycle seat to reduce lower body parts discomfort and helps to maintain ideal posture during riding.

Keywords: posture, discomfort, police rider, musculoskeletal disorders

ABSTRAK

ANALISIS POSTUR DAN HUBUNGANNYA DENGAN KETIDAKSELESAAN SEMASA MENUNGGANG DALAM KALANGAN PENUNGGANG MOTOSIKAL POLIS: KAJIAN KERATAN RENTAS

MUHAMMAD AIMAN BIN CHE ZAHARI

Pengenalan: Polis Diraja Malaysia (PDRM) adalah salah satu pasukan berseragam di Malaysia untuk memastikan keselamatan awam dan negara. Motosikal adalah salah satu kenderaan yang banyak digunakan di beberapa jabatan PDRM. Postur yang tidak sesuai (bongkok, sangat tegak dan sedikit tegak) secara berterusan semasa menunggang motosikal boleh menyebabkan ketidakselesaan pada badan, seterusnya menyebabkan gangguan muskuloskeletal. Tujuan kajian ini adalah untuk menentukan postur menunggang dan hubungannya dengan ketidakselesaan badan dalam kalangan penunggang motosikal polis. **Metod**: Tujuh puluh satu penunggang lelaki untuk motosikal CBX 750 dari Maktab Teknik Polis Diraja Malaysia mengambil bahagian dalam kajian ini. Satu set soal selidik yang diubahsuai telah diedarkan untuk mendapatkan data peribadi, maklumat pekerjaan, ketidakselesaan bahagian badan semasa menunggang dan ketidakselesaan pada ciri-ciri tempat duduk motosikal. Penarafan ketidakselesaan pada bahagian badan dan ciri-ciri tempat duduk motosikal dinilai secara subjektif pada Skala Borg CR10. Pemantauan sudut postur semasa menunggang telah diperoleh menggunakan Baju Pintar Truposture. **Keputusan:** Penilaian postur menunjukkan sudut postur menunggang berbeza dari kedudukan postur yang ideal. Bagi simptom ketidakselesaan badan, bahagian bawah belakang (5.7 ± 3.1) mempunyai purata ketidakselesaan tertinggi, diikuti oleh sisi kanan badan (5.2 ± 3.2), sebelah kiri badan (5.2 ± 3.2), tulang ekor (5.2 ± 2.2) dan pelvis atas kiri (5.1 ± 2.3). Kebanyakan penunggang berasa tidak selesa (5.1 ± 1.9) pada ciri tempat duduk motosikal dengan ciri tempat duduk tanpa sokongan lumbar (6.0 ± 2.5) mencatatkan ketidakselesaan tertinggi. Untuk hubung kait antara masa dan sudut postur semasa menunggang untuk 5 sensor yang berbeza, sensor 5 menunjukkan hubungan yang signifikan dengan masa ($r = 0.638$). Perbandingan antara bahagian badan yang tidak selesa antara postur menunggang dalam kalangan penunggang, bahagian bawah belakang, kanan dan kiri badan menunjukkan perbezaan statistik dengan postur pilihan semasa menunggang dengan ($z = 19.586$, $p < 0.001$), ($z = 14.484$, $p = 0.001$) dan ($z = 13.676$, $p = 0.001$) masing-masing. **Kesimpulan:** Postur yang ideal tidak dapat dikekalkan oleh penunggang polis kerana terdapat perbezaan antara sudut postur menunggang dan sudut postur yang ideal. Bahagian bawah belakang, sebelah kiri dan kanan badan, bahagian kanan atas dan tulang adalah bahagian badan yang paling terjejas. Para penunggang merasa tidak selesa pada ciri-ciri kerusi motosikal dan tidak ada sokongan lumbar yang mempunyai ketidakselesaan tertinggi pada ciri-ciri kerusi motosikal. Oleh itu, sokongan lumbar pada tempat duduk motosikal dicadangkan untuk mengurangkan ketidakselesaan bahagian bawah badan dan membantu mengekalkan postur yang ideal ketika menunggang.

Kata Kunci: Postur, Ketidakselesaan, Penunggang Motosikal Polis, Gangguan Muskuloskeletal

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LIST OF ABBREVATIONS

RMP	Royal Malaysia Police
MSDs	Musculoskeletal Disorders
SOCSO	Social Security Organization
OSHA	Occupational Safety and Health Act 1994
SOP	Standard Operating Procedure
MOHA	Ministry of Home Affairs
BMI	Body Mass Index

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CHAPTER 1

INTRODUCTION

1.1 Background

The Royal Malaysia Police (RMP) is one of the uniformed forces in the country. They plays a very important role in ensuring the public safety and security of the country. They covered a wide range of responsibilities from traffic control until intelligence gathering (Hoong, Wafa & Eranza 2013). Some of the general responsibility of the police officer have been mentioned in the Police Act 1967. Under Section 3(3) of Police Act 1967, the police officer is subjected to the maintenance of law and order, the preservation of the peace and security of Malaysia, the prevention and detection of crime, the apprehension and prosecution of offenders and the collection of security intelligence. The annual report of the National Transformation Program 2017 stated that there is a reduction of 13% of index crime from 2016 to 2017. It shows that the Royal Malaysia Police performed very well in order to tackle the crimes in Malaysia.

Vehicles such as motorcycle has been widely used in the several departments of Royal Malaysia Police. A huge number of police officers have been assigned for patrol duty and escorting by using the motorcycle. The number of the police riders will be gradually increased as this initiative started to shows a great significant in term of crime reduction in the community. In Malaysia, the motorcycle is one of the transports that

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commonly used by the people as it is cheap compared to the car, easy to maintain and also convenient to use. The quantities of bikes enrolled yearly harmonize with the expansion in the nation's population (Ma'arof et al., 2015). Besides, it also helps to reach the destination faster when there is a high traffic congestion. CIEC (2018) stated that the total number of registered motorcycles in Malaysia was 13, 173, 030 based on the data from Department of Statistics.

However, the usage of motorcycle is considered as not ergonomic as motorcycle lack of human interaction with the machine which can lead to discomfort (Karmegam et. al, 2009*)*. The police riders also have a tendency to be exposed with musculoskeletal disorders (MSDs) as the unnatural posture for a longer period during riding the motorcycle is considered as an ergonomic hazard. The discomfort of body parts can be an early sign of MSDs have been started (Gillen, 1998; Karmegam et al*.*, 2013). A previous study conducted in Malaysia revealed that the daily duration of riding among traffic police officers was 5.64 hours and 34.3% of them are having low back pain (Athirah Diyana et al., 2016).

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Department of Occupational Safety and Health also have established a Guideline on Ergonomics Risk Assessment at Workplace 2017. It indicates that ergonomic hazards pose a significant hazard toward the employee and risk reduction measures have to be proposed in order to reduce the MSDs. The increasing number of MSDs problems from 2009 to 2017 lead to increasing number of the compensation claim by the employee from the Social Security Organisation (SOCSO). Section 15 of Occupational Safety and Health

Act (OSHA) 1994 also emphasized that it is duty of employer to provide a safe working conditions for their employees.

1.2 Problem Statement

Traffic police is a police officer who serve to enforce the rules related to traffic. Most of traffic police are using motorcycle to enable them to move from one place to another in a short time and ease to perform the duty including escorting and traffic control. In Malaysia, traffic police use several types of motorcycles in order to perform their duties. However, the types of motorcycle commonly used is CBX 750 as shown in Figure 1.1. A previous study among traffic police officers revealed that mean daily duration of riding are more than 5 hours daily (Athirah Diyana et al., 2016). Therefore, traffic police riders are exposed to a prolonged riding duration.

Figure 1.1: CBX 750 motorcycle with no back support

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The selection of riding posture is very important to be considered as non-ideal posture for riding may cause discomfort to the riders. Flat position is considered as ideal posture for standard riding where lower back and pelvis are in upright position. Ideal riding posture is important to avoid discomfort on body parts. Discomfort is an indicator of many types of MSDs (Gillen, 1998). Non-ideal riding posture including slump, short lordosis and long lordosis are viewed as possibly harmful and are considered as of the major risk factors contributed to several MSDs among the riders including low back pain.

Karmegam et al. (2009) stated that motorcycle riding provides unnatural workstation as there are lacks of adjustment to fulfill the riders need. The riders need to hold their body in an ideal posture riding. Currently, CBX 750 Motorcycle (Figure 1.1) does not have back support equipped on motorcycle seat. So, does traffic police riders able to maintain an ideal posture for riding as taught by the motorcycle instructor during motorcycle training course? They spend approximately more than 5 hours of riding a motorcycle and prolong riding duration may lead to discomfort which could lead to severe MSDs problems in the future. Therefore, riding posture among police riders should be assessed as it also may contribute to discomfort.

According to Mansfield et al. (2014), seat shape, user suitability , seat material, duration of sitting in same position, vibration and changes of posture are among the factors that influence seat comfort. Griffin et al. (1982) also explained that seated posture with the vibration during long duration journey especially causing higher discomfort level

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among driver. Therefore, the police riders may have the possibility to be exposed to another risk factors of work related musculoskeletal disorders.

There is still lack of study conducted to analyse the motorcyclist's riding discomfort especially among police officers in Malaysia who are using motorcycle to perform their duties on daily basis. Previous study in Malaysia (Karmegam et al., 2013) was conducted among polytechnic students of Sultan Azlan Shah, Perak, Malaysia. The motorcyclist's riding discomfort may be vary between police riders and the other populations as the police riders may be having a longer duration and higher frequency of riding due to their job responsibilities. Through this study, it will determine whether the police riders are having discomfort or not due to riding process.

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1.3 Study Justification

The police riders have a wide range of responsibilities to be fulfilled in order to ensure the safety of the public and the country. They also are exposed to various hazards including physical, chemical, biological, psychosocial and not only ergonomics hazards during the riding process. However, this study will focus only on ergonomic hazards. The overexposure to ergonomic hazards such as uncomfortable posture may lead to the development of discomfort among police riders due to riding.

This study is important as it assesses whether the police riders can maintain their ideal posture during riding as non-ideal posture may pose a discomfort risk among the police riders. Besides, this study also determines the body part discomfort symptoms experienced among the police riders due to riding. The present of discomfort may reduce the productivity of police riders to perform their duties. This study also determines the current discomfort level on motorcycle seat features as there is no study yet available among police riders who are using a motorcycle. However, the posture and motorcycle seat features may not the only risk factors that contribute to the discomfort during the riding process.

This study needs to be conducted in order to develop and provide more data regarding riding posture and discomfort among police riders, especially who are riding the motorcycle to perform the duties. This study also will provide baseline data for the assessment of discomfort among police riders in the country. From the baseline data, it

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will helps the management to make a decision whether to control measure need to be immediately taken or not as the prolonged of discomfort may be signs of work-related musculoskeletal disorders.

1.4 Conceptual Framework

Conceptual framework of this study is shown in Figure 1.2. Police riders from RMP were enrolled in this study to determine the posture and its relationship with riding discomfort. Occupational hazards consist of physical hazard, biological hazard, chemical hazard, ergonomic hazard and psychosocial hazard. Police riders exposed to ergonomic hazard since the motorcycle is considered as unnatural working space. This study focused on ergonomic hazard since improper posture exposure is one of the risk factors that can contribute to discomfort during riding. Riding posture can be ideal and non-ideal. This study also to investigate whether the police riders able to maintain an ideal riding posture as taught by the instructor. Prolonged non-ideal riding posture can contribute to body parts discomfort which could lead to MSD in the future. This study also focused on discomfort on current motorcycle seat features.

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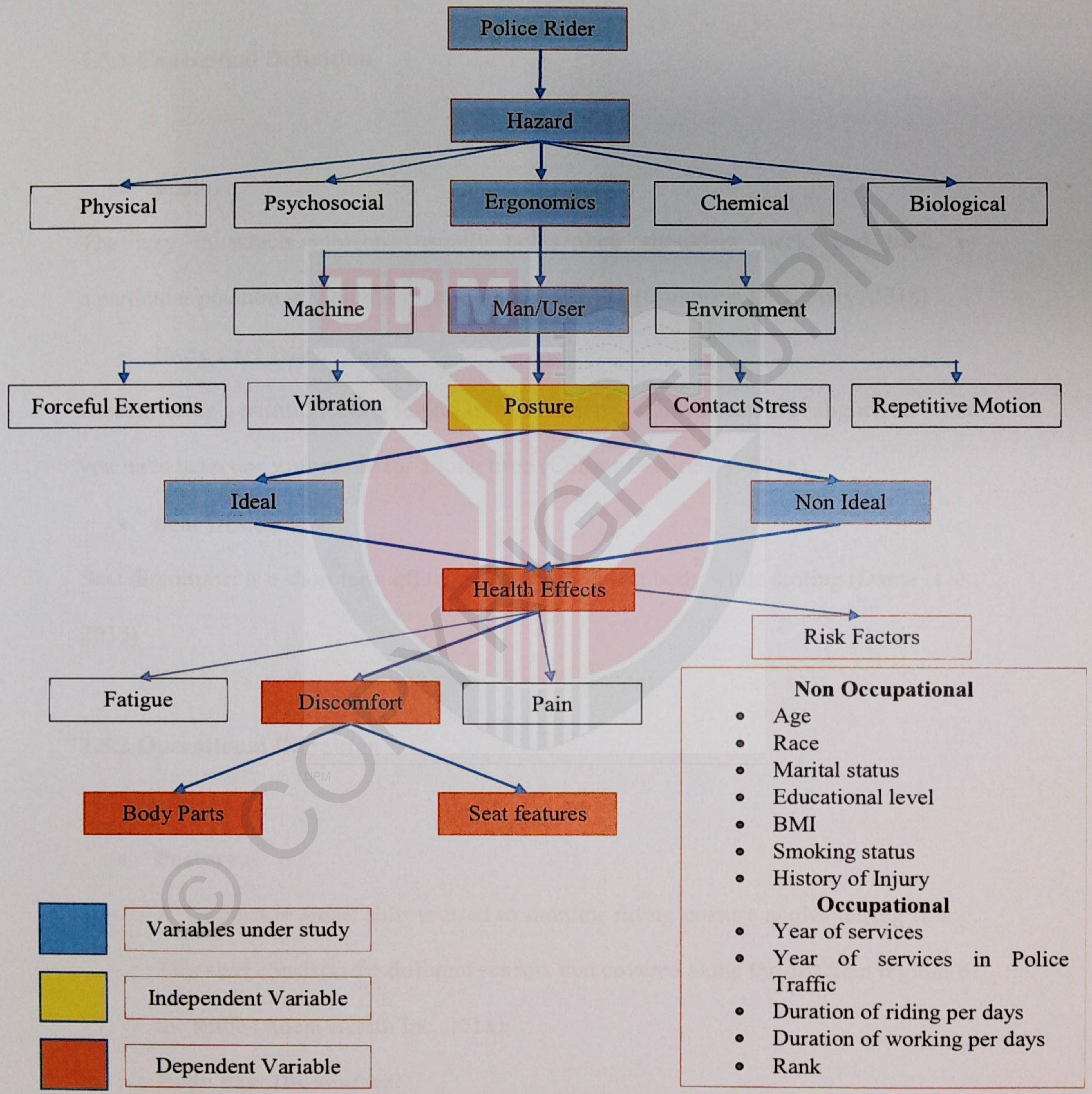

Figure 1.2: Conceptual framework

1.5 Definition of Terms

1.5.1 Conceptual Definition

- **Posture**

The way in which someone usually holds their shoulders, neck, and back, or a particular position in which someone stands, sits, etc (Cambride Dictionary, 2018)

- **Body Part Discomfort**

Discomfort is a painful feeling in part of body when you have been hurt slightly or when you have been uncomfortable for a long time (Collins Dictionary, 2018)

- **Seat Discomfort**

Seat discomfort is a short term effect of a seat on human body while seating (Dama et al., 2015).

1.5.2 Operational Definition

- **Posture**

  A Truposture smart shirt is used to monitor riding posture angles during riding. This shirt consists of 5 different sensors that covered along the different regions of the spine (Adela Health Inc, 2018).

- **Body Part Discomfort**

  A modified version of questionnaire for a body region discomfort from SAE paper 2005-01-2690 is used to indicate the rating of body part discomfort symptoms.

- **Seat Discomfort**

  The rating of seat features discomfort is determined by an adapted questionnaire from Deros, Daruis and Nor (2009).

1.6 Research Question

Some of the research questions in this study including:

1. What is preferred riding posture among traffic police riders?
2. Can police riders keep maintaining ideal posture during riding process?
3. Which part of the body experienced discomfort symptoms by the police riders due to riding process?
4. What kind of motorcycle seat features contribute to seat discomfort among police riders?
5. Is there a difference between preferred riding posture and body part discomfort symptoms experience by police riders?

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1.7 Objectives

1.7.1 General Objectives

1. To determine the posture and its relationship with riding discomfort among police riders.

1.7.2 Specific Objectives

1. To determine socio-demographic, occupational and lifestyle profile of police riders.
2. To determine the mean difference between riding posture angle and ideal posture angle for 5 different sensors.
3. To determine the mean rating of body part discomfort symptoms experienced by the police riders.
4. To determine the mean rating of discomfort on motorcycle seat features by the police riders.
5. To determine the relationship between riding time and riding posture angle for 5 different sensors.
6. To determine the significant difference of body part discomfort symptoms experienced between preferred riding positions by the police riders.

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1.8 Hypothesis

H_1: There is a significant correlation between riding duration and riding posture angle for 5 different sensors.

H_1: There is a significant difference of body part discomfort symptoms experienced between preferred riding positions by the police riders.

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CHAPTER 2

LITERATURE REVIEW

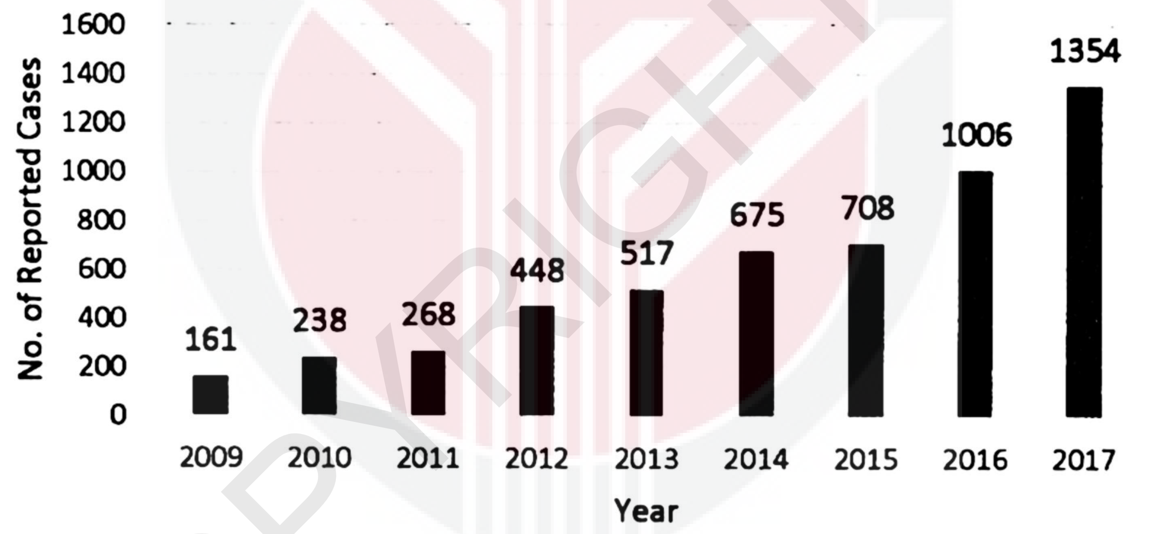
2.1 Ergonomics

According to International Ergonomics Association (2019), ergonomics is defined as a scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Besides, Occupational Safety and Health Administration (2000) stated that ergonomics as a science of fitting the job and product to the worker through designing rather than impose the worker's to fit the job. Ergonomic is one of the hazards that may arise at the workplace. Thus, it may affect the workers' well-being, productivity and efficiency if the action plans to minimize the risk of ergonomic hazards have not been taken.

Ergonomics is important in preventing in the development of MSDs among the workers. In developed countries, work-related disability and loss of productivity are mainly caused by MSDs (Rasotto et al., 2014). In Malaysia itself as a developing country, in 2015, SOCSO has reported that there were increasing trend of reported cases for musculoskeletal disorders with 161 cases in 2009 to 675 cases in 2017 as shown in Figure

2.1. Bhattacharya (2014) also stated that MSDs also contributes to indirect costs including fringe benefits losses, fringed benefit losses, wages losses, and training, hiring, disruption costs in order to return the worker back to pre-injury. The goals of ergonomics are to improve worker's productivity through better designation of workplace, instruments, products, system or combination of these elements (Bansal & Kaur, 2018). Therefore, ergonomics is very crucial to be take care of because it can contributes to direct costs and also indirect costs which may affect company's financial status and also workers' well-being.

Figure 2.1: Trend of Reported Musculoskeletal Disorders (MSDs) from 2009 – 2017



Guidelines on Ergonomics Risk Assessment at Workplace (2017) listed several ergonomics hazards that may cause harm to the workers including awkward posture, forceful and sustained exertions, repetitive motion, static and sustained posture, vibration, contact stress and environmental risk factors such as lighting, noise, heat and more.

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2.2 Anatomy of Musculoskeletal System

Musculoskeletal system is one of the important system for the human body. It has an important role to create natural movement by dealing with the physical environment (Aktharuzzaman et al., 2016). The functions of musculoskeletal system are to allow and facilitate movement. Besides, it also important to support and protect human's body and internal organs including brain, heart and lungs. The human musculoskeletal system comprises of several major substructure which are bones, muscles, ligaments and tendons

Human body consist of 206 bones. The bone system play other functions rather than only providing the support but also serve as body organ protection, helps in production of new blood cells and also functions as a bank for minerals (Reid, 2009). The bone have two types of tissue which are cortical bone and cancellous bone. Compact bone is almost hard and it is also located on outside layer of the bone. The cancellous bone is positioned inside the bone and where the bones are not hardly pressured as it is much more porous and fragile compared to corticol bone.

There are three types of muscle which are skeletal muscle, smooth muscle and cardiac muscle. Smooth muscle is involuntary muscle and not striated in shape. This muscle made up the layer of digestive, reproductive and urinary tracts. Cardiac muscle is striated and involuntarily muscle, contain only one nucleus and made up the layer of the heart. Different with the skeletal muscle as the skeletal muscle is also striate muscle but

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contain more nuclei. The skeletal muscle is also known as voluntary muscle. This is because the brain can consciously regulate the skeletal muscle.

Bone and muscle are connected by tendons, ligament and joints. Tendon, a connective tissue that joins the muscle to the bone and its function is to help the movement of the bone (Medline Plus, 2019) and also withstand the high tensile force during transferring forces from muscle to bone (Kirkendall & Garrett, 1997). Besides, ligament is a connective tissue that connects bone to bone. This connection ensure the structure maintain together and stable.

There are several sitting postures commonly used for riding including slump, flat position, long lordosis position and short lordosis position. However, the flat position is considered as an ideal sitting posture for riding (Karmegam et. al, 2009). It is important for the riders to maintain an ideal posture during riding because it can reduce the intradiscal pressure during sitting. Pressure on intradiscal for prolong duration is related to low back pain. If the riders do not practice an ideal riding posture, then it can lead to discomfort on body parts and at long term, it can lead to the development of MSD.

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2.3 Definition of Musculoskeletal Disorders

Musculoskeletal disorders (MSDs) is a conditions where the muscles, nerves, tendons and other supporting structures affected. It is caused by the use of one or more associated body tissues having to work exceeding their capabilities (IOSH, 2019). Musculoskeletal disorders also can be described as one types of disorders impacting lower limbs, upper limbs back and neck (Stock et al., 2005). There are another terms for MSDs include Repetitive Strain Injury Occupational Overuse Syndrome, Repetitive Stress Injury, Cumulative Trauma Disorders and others.

The development of MSDs is not only caused by a single risk factor but, combination of several risk factors including individual, social and occupational factors. Repetitive movement, poor posture and vibration are examples for occupational factors. However, duration, intensity and frequency of exposure to these risk factors determine the severity of the disorders. Pain, numbness, stiffness, muscle weakness and discomfort are among symptoms of MSDs (University of California, 2015).

Ergonomics is important to eliminate in the development of MSDs and injuries and also minimize the stress resulted from excessive use of muscles, repeated task and poor postures (CDC, 2018).

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2.4 Royal Malaysia Police (RMP)

Royal Malaysia Police is one of the important organizations in Malaysia. Royal Malaysia Police has a very huge responsibility to be fulfilled in order to ensure and preserve public safety. Royal Malaysia Police is under the administration of Ministry of Home Affairs (MOHA). One of MOHA functions is to ensure, maintain and improve public safety and order from any threats and also implement the enforcement of the laws in the country (MOHA, 2018). The Royal Malaysia Police covered a wide range of responsibilities from traffic control until intelligence gathering (Siew Hoong, Syed Azizi Wafa & Datu Razali, 2013). All general duties of the police officers have been stated in Police Act 1967 under section 20 (3) including the following:

a) apprehending all persons whom he is by law authorized to apprehend
b) processing security intelligence
c) conducting prosecutions
d) giving assistance in the carrying out of any law relating to revenue, excise, sanitation, quarantine, immigration and registration
e) giving assistance in the preservation of order in the ports, harbours and airports of Malaysia, and in enforcing maritime and port regulations
f) executing summonses, subpoenas, warrants, commitments and other process lawfully issued by any competent authority
g) exhibiting information
h) protecting unclaimed and lost property and finding the owners thereof
i) seizing stray animals and placing them in a public pound

j) giving assistance in the protection of life and property

k) protecting public property from loss or injury

l) attending the criminal courts and, if specially ordered, the civil courts, and keeping order therein escorting and guarding prisoners and other persons in the custody of the police

(Police Act 1967)

There are 113, 336 of police officers and it shows that there are a variety of responsibilities among the police officers through a large number of officers (RMP Website, 2016). About 10 main departments under the Royal Malaysia Police comprise Management Department, Special Branch, Criminal Investigation Division, Narcotics Criminal Investigation Division, Internal Security and Public Order Department, Commercial Crime Investigation Department, Traffic Enforcement and Investigation Department, Strategic Resources and Technology Department, Crime Prevention and Community Safety Department and also Integrity and Standard Compliance Department. It shows that the Royal Malaysia Police have a broad aspects and responsibilities aspect to be covered through its different departments.

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2.4.1 Traffic Enforcement and Investigation Department

Traffic Enforcement and Investigation Department is one of the latest main departments in the RMP which was established on 25th March 2016 (RMP Website, 2016) to replace Traffic Branch Department. The general duties of police officers on roads have been clearly stated under section 21 of the Police Act 1967 including the following:

a) to regulate, control and divert any traffic;
b) to keep order on public roads, streets, thoroughfares and landing places, and at other places of public resort and places to which the public have access
c) to prevent obstruction on the occasions of assemblies on public roads and streets, and in any case, when any road, street, thoroughfare, landing place or ferry may be thronged or liable to be obstructed

(Police Act 1967)

This department has a huge responsibilities to be played in order to be a leading agency for enforcing the rules related to the traffic. Besides, the main operation of Traffic Enforcement and Investigation Department not only focuses on enforcement and investigation of accident cases, but also include traffic control and manage and enforce the summons. Reduction of road accident is one of main target of this department as Malaysia is known as one of top countries with high number of accidents. Therefore, this target can be achieved through education the community to obey the rules. (JPST, 2019)

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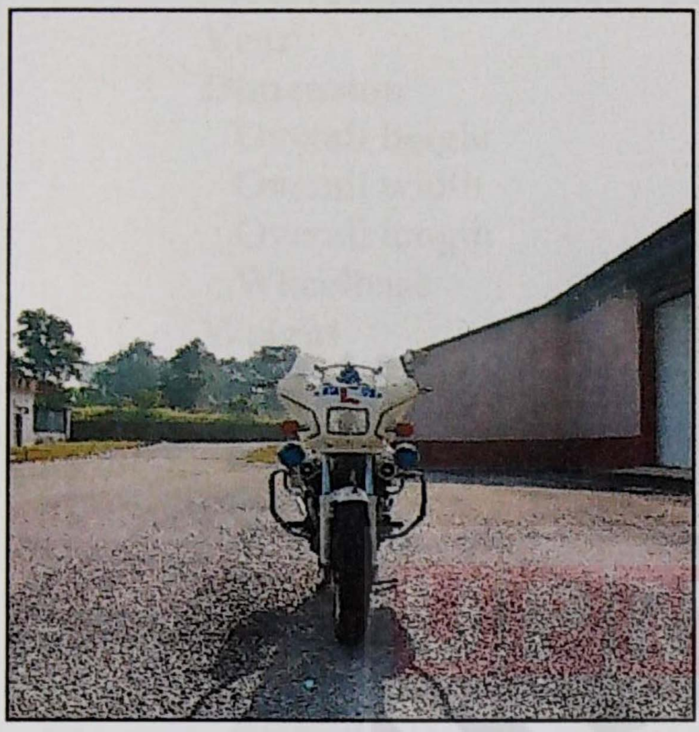
The work task of the traffic police officers divided into 3 types which are routine task, service operation and integrated operation. The example of task for each type includes as following in Table 2.1:

Routine task	Point duty include road traffic control and safety.
	Escorting VVIP
	Patrol and Summons
Service Operation	*Ops Lumba Haram*
	Ops Laju
	Ops Halangan
Integrated Operation	*Ops Motosikal*
	Ops Bersepadu

Table 2.1: Examples of work task for traffic police officers

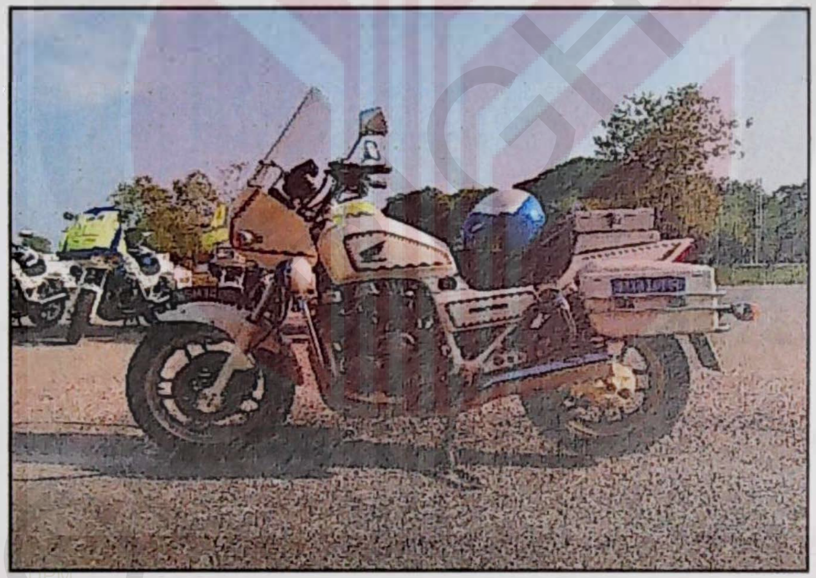
2.4.2 The Traffic Police Motorcycle

In Malaysia, traffic polices use several types of motorcycles in order to perform their duties. Honda CBX 7502P1, Honda VFR 800, Honda ST 1300, Kawasaki Ninja 300, Kawasaki KLX 250 and Kawasaki Z250 are among the type of motorcycles used by police traffic and most of them are the high-powered motorcycle. For this study, the subjects used a Honda type CBX 750 (Figure 2.2). This type of motorcycle has benefits over other models because this motorcycle only uses by police departments in several countries (Athirah Diyana et al., 2016). The specifications of the motorcycle are shown in Table 2.2:



a)

b)



c)

Figure 2.2: Honda CBX 750P21 Motorcycle

a) Front View
b) Rear View
c) Side View

Motorcycle body part	Specification
Year	2008
Dimension	
Overall height	1495mm
Overall width	880mm
Overall length	2290mm
Wheelbase	1515mm
Weight	
Dry weight	252 kg (555lbs)
Tyre size	
Front	110/90-1861H
Rear	130/90-1667H
Engine	
Bore and stroke	67.0 x 53 mm
Total stroke volume	747cc
Maximal power	9500rpm
Maximal torque	8500rpm

Table 2.2: Specifications of CBX 750 motorcycle

2.4.3 Riding Posture for CBX 750 Motorcycle

First of all, Police riders must undergo training at Maktab Teknik PDRM before they can use this motorcycle. A certified instructor will train the police riders on proper riding techniques as based on their Standard Operating Procedure (SOP) and training module. One of the scopes of training covered for riding course is ideal riding posture for the motorcycle used. According to the instructor, the ideal posture for CBX 750 motorcycle is sitting in an upright position, elbows are slightly bent, and lower arms are parallel to the ground. Besides, both right and left thighs must grasp the fuel tank of the motorcycle. The ideal riding posture for CBX 750 as in Figure 2.3. Since a motorcycle is a limited workstation for the police riders. Posture is one of the important aspects that need to be considered during performing the task and duty as posture also can contribute to discomfort and MSDs problems in the future. There are several factors during working that should be considered including repetitive movements, sustained postures, incorrect work positions, and prolonged sitting in incorrect fixed positions (Wu et al., 2012; Loghmani et al., 2013). Previous study also observed that prolonged static posture is a clear risk of MSD development in the neck, lower and upper back (Pille et. al, 2016) from and static posture can lead to prolonged static loading of the body which may cause MSD (Casciolli et al., 2011; Li et al., 2017)

Figure 2.3: Ideal posture for CBX 750 showed by the instructor

2.5 Prevalence of Musculoskeletal Disorders Problems among Police Officer

There are several studies that have been conducted among police officer regarding the prevalence of MSDs. Braga et al., (2018) conducted a study among military police officers of the Ostensive Motorcycle Patrol group. They found that the most affected body part due to pain and discomfort was lower back (50%), knee (43%) and upper back (36%). They concluded that additional load, weapon, uniform, riding activity contributed to pain complaint despite of sitting for long hours. Mohd Hafizi et al., (2011) also revealed that the prevalence of shoulder pain among the traffic enforcement officers in Malaysia was high by 77.5 %. Lastly, a previous study of MSDs among traffic police riders found that the prevalence of MSDs for 12 month was 88.6%. However, this high prevalence of MSDs is not caused by single risk factor but combination of several risk factors including vibration exposure, static posture and sit for a long time increase the possibility to MSDs development (Athirah Diyana et al., 2016)

2.6 Discomfort of Riding

There are a number of studies that have been conducted related fatigue and discomfort among motorcycling activity. Discomfort is associated with tiredness, numbness and pain feelings (Helander & Zhang, 1997). However, according to Gillen (1998), body discomfort is the first indicator for many types of musculoskeletal disorders. Discomfort and comfort level are commonly measured by using subjective rating scales. The respondents will be asked to evaluate their pain intensity and discomfort by using body map (Tan et al., 2008; Karmegam et al., 2009)

Motorcycle riding provides unnatural workstation as there are lacks of adjustment to fulfil the riders need (Karmegam et al., 2009). According to Porter and Gyi (2002), regularity of exposure to driving which leads to the development of musculoskeletal symptoms among the drivers and the study also found that the discomfort frequency also increased along with the total distance of driving. It shows that the frequency and duration of driving influenced the level of discomfort. Besides, a study by Balasubramanian and Jaannath (2014) concluded that the longer duration of riding cause more fatigue among

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motorcycle riders. Besides, erector spinae and latissimus dorsi medial are among posture muscles that show fatigue development due to motorcycling activity.

Biomechanical factors also linked with the development of bodily discomfort. For examples, muscular contractions, postures, joint angles, stresses and distribution of pressure while sitting (Ospina Mateus & Quintana Jimenez, 2019). Riding activity for a prolonged time can lead to musculoskeletal disorders problem. A previous study by Ramasamy, Adalarasu and Patel (2017) showed that shoulder and back parts have high number of incidence for driving related musculoskeletal disorders. Static position of sitting also influence the level of discomfort during riding. The action of sitting for an extended time with the same position and limited space lead to discomfort and fatigue (Motorcycle Council of New South Wales, 2005).

A study conducted in India by Velagapudi and Ray (2011) revealed that more than 95% of the motorcycle users are having discomfort in some or the other body and low back region has highest reporting for discomfort by 87%. Besides, a previous study in Malaysia among motorcyclists also found that prevalence of low back was high prevalence compared to other body regions. However, prevalence of low back pain was more significant among occupational motorcyclist compared to non-occupational motorcyclist. (Mohd Hafizi et al, 2011).

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2.7 Selected Contributing Factors to Discomfort

2.7.1 Ergonomic Factor

2.7.1.1 Posture

Posture can be explained by joints, position and movement of the human body. A good working posture is very important to be practised by every individual to avoid serious health effects. Posture also plays a role in determining the work-related musculoskeletal disorders. Occupational Safety and Health Administration (2000) stated that force, repetition, awkward postures, static postures, quick motion, compression or contact stress, vibration and cold temperatures exposure are among risk factors that contribute to work-related musculoskeletal disorders.

Awkward position can be described as positions of the body that drift significantly from neutral posture during carrying out work activities. Keester & Sommerich (2017) showed that the risk of developing musculoskeletal problems increased due to prolonged awkward posture among tattoo artist. Besides, a research by Gangopadhyay et al., (2010) found that core making workers that practiced awkward posture are having musculoskeletal pain especially at low back part.

The riders of motorcycle are more exposed to awkward or uncomfortable posture hazard compared to other vehicles. Besides, the ergonomic aspects of motorcycle are

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usually negligible during its designation. This hazard exposure is one the major contributor to postural fatigue among the motorcycle riders. However, there are other contributors to postural fatigue during riding such as damaged roads, motorcycle vibration, poor weather and rider attitude. (Arunachalam *et al.,* 2018).

In term of ideal posture for standard riding, upright position of lower back and pelvis was prefered (Athirah Diyana et al., 2016) or also the flat position (Karmegam et al., 2013). There are also other riding postures but it considered as non-ideal posture for riding include slump, short lordosis and long lordosis (Tan et. al, 2008). A rider cannot maintain riding posture and it always changes during the process. However, Arunachalam et al., (2018) emphasized that rider's posture can be influenced by many factors including human factors, motorcycle's characteristics and environmental elements.

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2.7.1.2 Basic Riding Posture

According to Innova Pain Clinic Website (2010), there are three basic of motorcycle riding postures which are detailed out as follow:

Standard Riding Posture (Figure 2.4).

- It is considered a neutral posture. The rider's back is in a straight position and the neck in a more neutral posture. The shoulders and elbows are held easily on the holds without exceeding or over-expanding the elbows. Elbow are flexed, and lower arms are parallel to the ground.

Figure 2.4: Standard riding posture

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Sport Riding Posture (Figure 2.5)

- During this position, the body is lean forward, the feet are usually behind the knees and the head is extended. The lower arms should be parallel to the ground and the wrists should be near to neutral practice.

Figure 2.5: Sport riding posture

Cruise Riding Posture (Figure 2.6)

- For this posture, the legs are held near to the fuel tank while relaxing the hip and pelvis. The feet are regularly forward with respect to the knee. This posture also has slightly higher grips and controls. The rider usually in leaned back position.

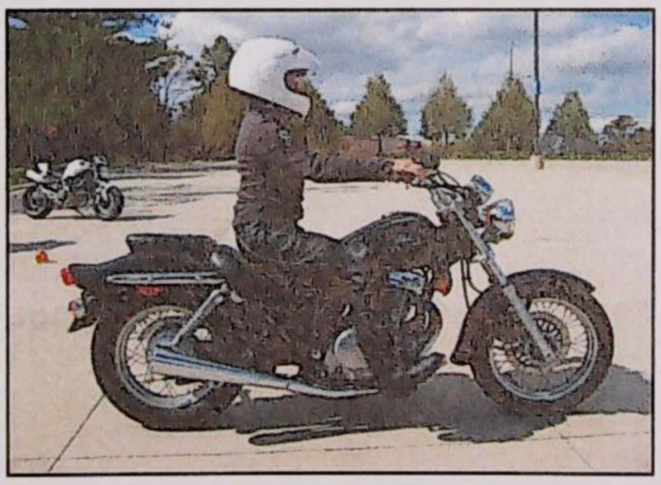

Figure 2.6: Cruise riding posture

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2.7.2 Other Contributing Factors to Discomfort

Other than ergonomic factor such as awkward posture, there are several contributing factors to development of discomfort among the riders include biological factors, vehicle factors and environmental factors.

Age is among biological factors that can contribute to discomfort. A previous study by Amrutkar and Rajhans (2011) concluded that recovering of body to its healthy state decreased when the age increased after suffered an injury. Besides, the feeling of discomfort increased as age and years of riding increased. Ramasamy, Adalarasu and Patel (2017) found that riders with high age are more prone to musculoskeletal disorders. Besides, gender and Body Mass Index (BMI) also can contribute to discomfort. Karmegam et al., (2009) found that there was significant difference of body part discomfort symptoms among female and male riders. It showed that the discomfort symptoms varies among gender. In term of BMI, a review study by Alias et al., (2016) reveled that most of female riders experienced higher discomfort symptoms compared to male under certain factors including BMI, riding duration and riding experience.

For vehicle factors, motorcycle design's frameworks also play a role in contributing to discomfort among riders. For example, angle, height, seat, foot pegs location, handles and rider's anthropometry as it decides the riding posture (Alias et al., 2016). The designation of the seat in term of its firmness also plays a role to avoid pain and discomfort (Hanel, Dartman and Shishoo, 1997). A previous study by Karmegam et al., (2009) also mentioned that motorcycle provide unnatural workstation as there were lacks of adjustment to fulfill the rider needs. Similar with a study among truck drivers by Tan et al., (2008) the rider also keep adjusting their posture as it will avoid the mechanical load and *ischemia* of the tissue which will cause discomfort on body parts because of lacking of mechanical features that will support the back posture and also limited space of adjustment.

There are several environmental factors that contribute to discomfort to riders. The road surface states including slippery surfaces, road repaired patches, bumpy surface and road marking can lead to discomfort among riders (Tan et al., 2008).

2.9 Truposture Smart Shirt and Its App

Truposture smart shirt (Figure 2.8) is a device that has been developed to encourage the good back posture practice, thus aids in minimising lower back pain problems in the community (Adela Health inc, 2015). Truposture smart shirt consists of 5 nano-sensors technology that attached undershirt. These 5 sensors cover along the thoracic vertebrae, lumbar region and also pelvic (Table 2.3) and each sensor also corresponds to the different regions on the spine (Figure 2.7).

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Table 2.3: Representation of sensors

Sensor	Region on spine
1	T1
2	T8
3	L1
4	L3
5	Pelvis

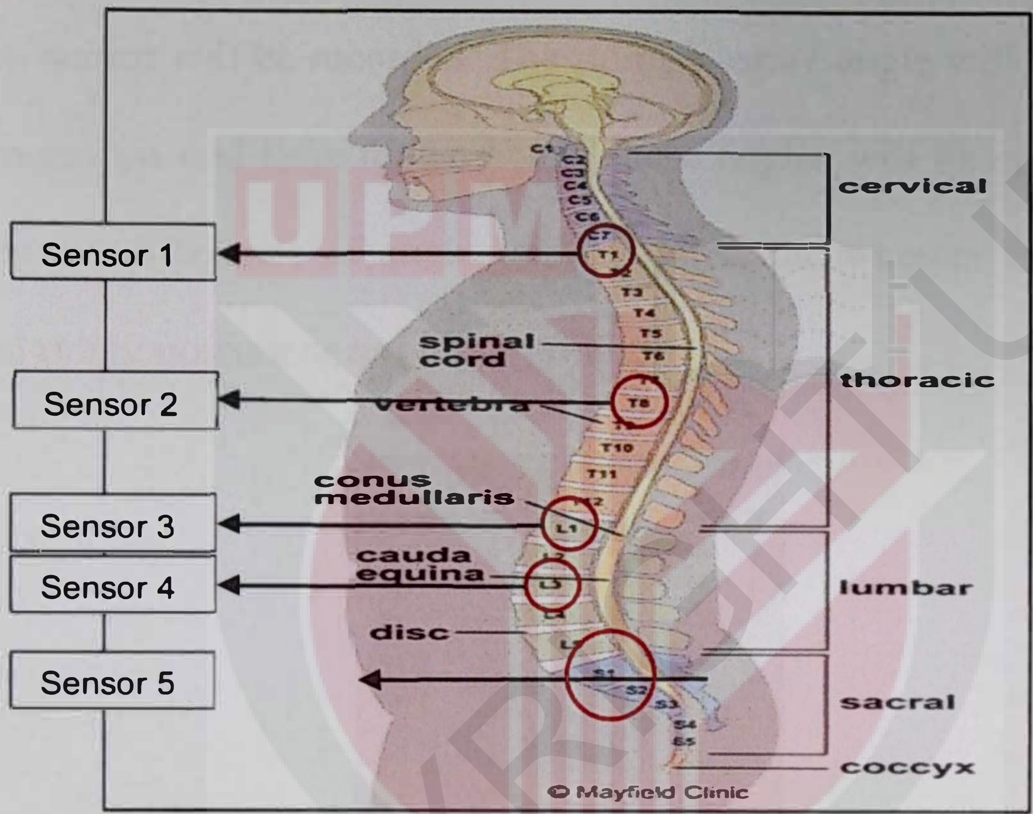

Figure 2.7: Anatomy of the spine (Source: Mayfield Clinic, 2018)

This technology helps the user to monitor the alignment and curvature of the entire spine in several modes including standing and sitting. Truposture mobile app (Figure 2.9) and windows software are available as these tools will help the user to track the posture and record the movement of posture in real time (Adela Health Inc, 2018). The main connection of the Truposture Smart Shirt and the tools is via Bluetooth. However, this smart shirt also can be operated without connecting to a smart phone or computer. Two different colour of line curve displayed through the app. The blue curve indicates the reference posture and the orange curve indicates the actual posture on real time.

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Trusposture mobile app or windows software will display the angle of the spine based on the region through the 5 sensors embedded under the shirt. Truposture smart shirt and its mobile app will be used in this study for a riding posture assessment. The police rider is required to sit based on ideal posture for CBX 750 motorcycle trained by the instructor. This posture will be set as a reference for ideal posture for riding and the angle for each sensor will be recorded. The riding posture angle will be obtained during the riding process on real time for an hour. These angles will be compared with ideal posture to see the difference of angles and to determine whether the police rider can maintain ideal riding posture or not during riding.

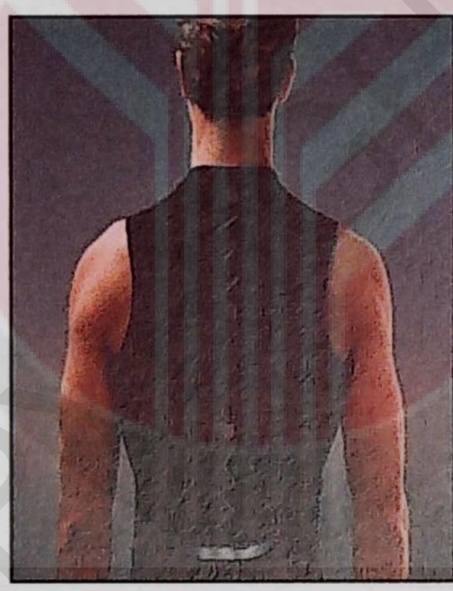

Figure 2.8: Truposture smart shirt

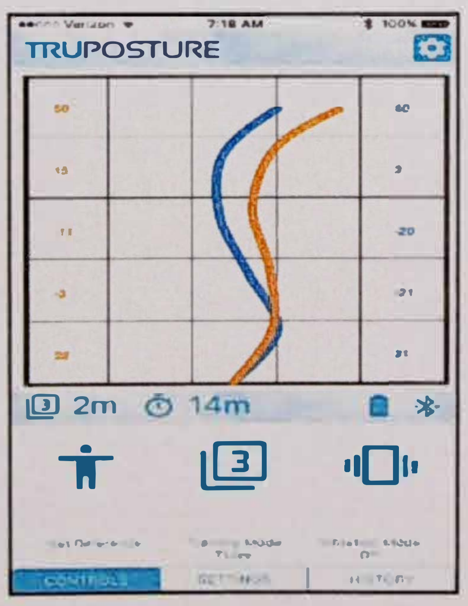

Figure 2.9: Truposture mobile app

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2.11 Questionnaire

Psychophysical methods such as discomfort scales, body maps or questionnaire have been widely used to evaluate the discomfort in order to counter musculoskeletal disorders and enhance work condition (Kee and Karwowski, 2003). Posture also had been studied by using this psychological method to collect the subjective perceptions from the respondents. The common tools used to assess the psychophysical information of the respondents are the Borg Scale and also known as Rating Perceived Exertion. It is used to evaluate the perceived exertion and effort of the respondents (Borg, 1982). Grant et al., (1999) identified that the sensitivity and reproducibility of the Borg scale shown a good finding in their studies. Besides, the Borg scale is also highly applicable in occupational safety and health practice.

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CHAPTER 3

METHODOLOGY

3.1 Study Design

This is a cross-sectional study where the riding posture and body parts discomfort were measured and observed from March 2019 to April 2019.

3.2 Study Location

This study was conducted at Maktab Teknik PDRM in Muar, Johor. The location was selected purposively. The location is the training centre for riding course for police riders. The police officer must undergo training first to be a certified police rider.

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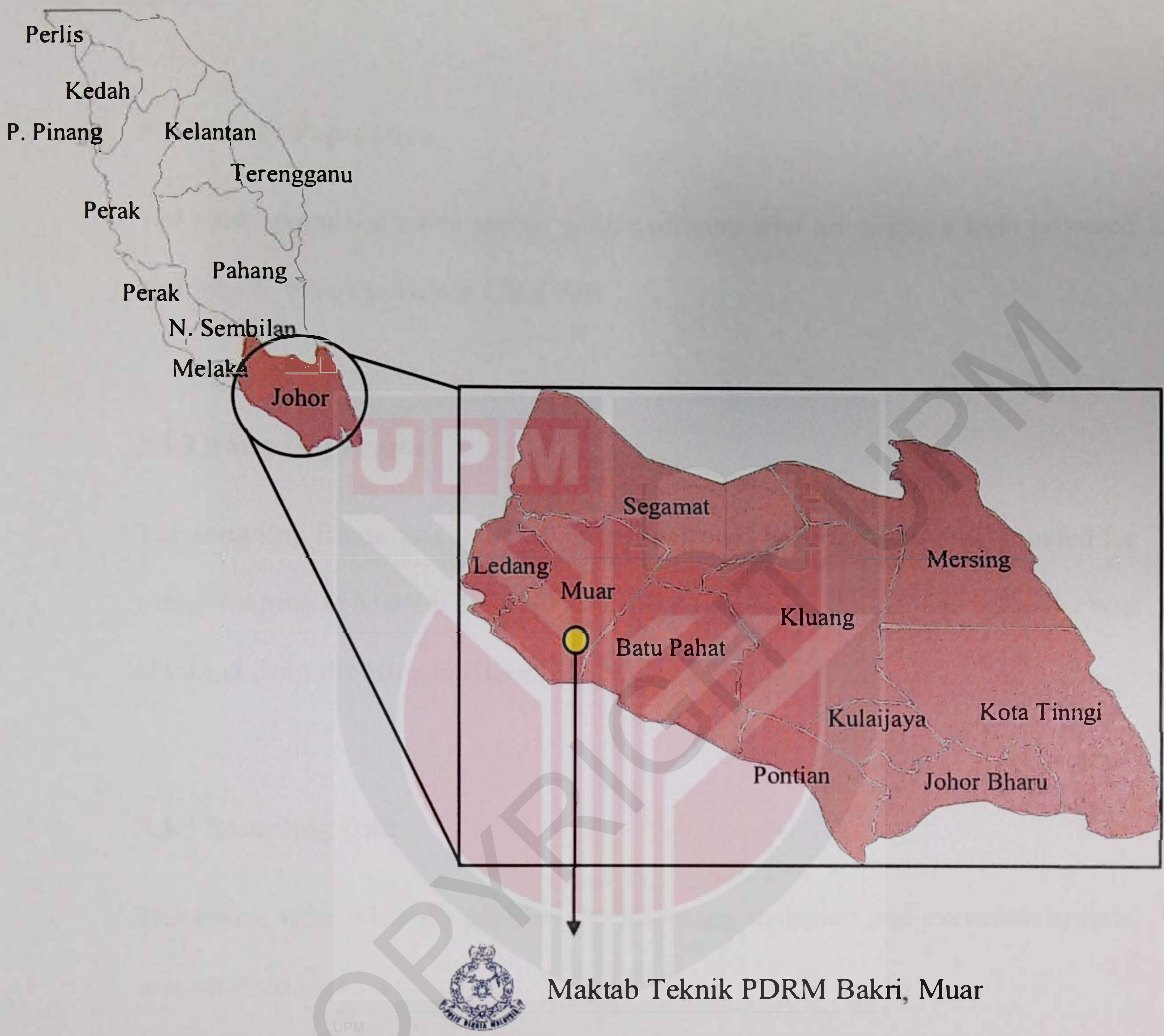

Figure 3.1: Location of study

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3.3 Sampling

3.3.1 Study Population

The study population was among police officers who are riding a high powered motorcycle which is Honda CBX 750.

3.3.2 Sampling Frame

The sampling frame was referred on name list of all police riders participated for riding training at Maktab Teknik PDRM Bakri in Muar, Johor. The name list was obtained from the Human Resource Department.

3.3.3 Sampling Unit

The police rider who has fulfilled the following inclusion and exclusion criteria was selected as a sampling unit.

Inclusive criteria:

a) Male rider as the percentage of traffic police riders is 98% (Athirah Diyana, 2016).
b) Age range between 20 to 55 years old (Athirah Diyana, 2016)
c) Respondents that ride any motorcycles more than one year.
d) Selection of motorcycle type Honda CBX 750 for this study because of longest duration of service and widely used by Malaysia traffic police.

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Exclusive criteria:

a) Has been previously diagnosed with musculoskeletal disorders or injuries before qualifying as police riders.

3.3.4 Sampling Method

The respondents were comprised of participants who fulfill inclusive criteria of the study during riding training in Maktab Teknik PDRM Bakri, Muar.

3.3.5 Sample Size

$$n = \frac{Z^2{}_{1-\frac{a}{2}} P(1-P)}{d^2}$$

Equation 3.1

Where $Z^2{}_{1-\frac{a}{2}}$ = Z-score (1.96 for 95% confident interval)

P = 95% of motorcyclists reported of having discomfort in some or other body parts (Velagapudi & Ray, 2011)

d = Absolute precision required on either side of proportion (Margin of error is ± 5% or 0.05)

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The calculation of estimated sample size:

$n = (1.96)^2 * 0.95 * (1 - 0.95) / (0.05)^2$

$= 3.8416 * 0.95 * 0.05 / (0.0025)$

$= 0.1825 / 0.0025$

≈ 73 respondents

However, after taking in consideration, an additional of 10% from total respondents required to counter-responsive case and reject questionnaire samples.

$= 73 + [(73 \div 0.9) * 0.2]$

$= 73 +$

$= 81.11$

≈ 81 respondents

In short, the minimum sample size needed were 81 respondents to participate in this study.

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3.4 Data Collection and Study Instrumentations

3.4.1 Questionnaires

A set of the questionnaire was used in this study. The questionnaire are consist of 4 different parts. Part A and Part B were adapted and modified from a previous study (Athirah Diyana et al., 2016). Part A consists of a respondent's personal information including age, race, marital status, educational level, smoking status. Part B consists of respondent's job information such as previous job, duration hours per shift, duration per days and duration of riding per days. Part C, a body region discomfort questionnaire was adapted from SAE paper 2005-01-2690, modified and translated to Malay language version to indicate the body parts discomfort symptoms experienced by the respondent including neck, shoulder, back, side of body, pelvis, buttock, thigh and legs. For Part D, a questionnaire was adapted, modified and translated to Malay version from Deros, Daruis and Nor (2009) to point out the level of discomfort on motorcycle seat features by the respondent. Borg Scale CR10 was used for both Part C and Part D.

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3.4.2 Sensor Posture Shirt

The Truposture smart shirt (Figure 3.2) is a ready-made shirt and it was used for monitoring the posture of the respondent during riding. It is a smart shirt that assists back posture and minimizes lower back pain. It consists of 5 sensors technology that help to monitor the alignment of the entire spine. The region of spine that covered by Sensor 1, Sensor 2, Sensor 3, Sensor 4 and Sensor 5 are T1, T8, L1, L3 and Pelvis respectively. The sensor provided the angle data based on the spine curvature for each region covered. The Truposture mobile app (Figure 3.3) in connection with Truposture smart shirt was used to monitor and record the posture in real time (Adela Health Inc, 2018). The respondent wore on top of regular cloth or uniform for an hour during riding for posture assessment.

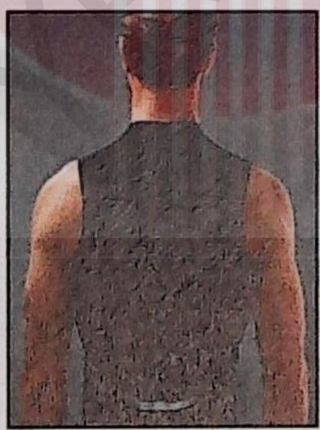

Figure 3.2 Truposture smart shirt

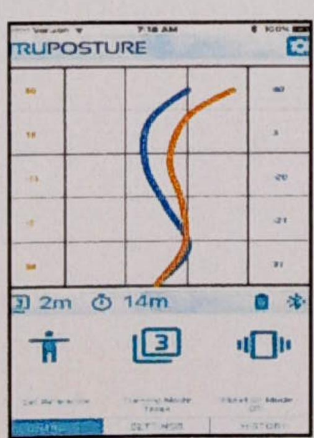

Figure 3.3 Truposture mobile app

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3.4.3 Weighing Scale and Height Meter

The SECA Body Weighing was used for measuring the weight of the respondents. For measuring the height of the respondents, the SECA Body Meter was used. Provided data by these two devices was used to calculate the Body Mass Index (BMI) of the respondents.

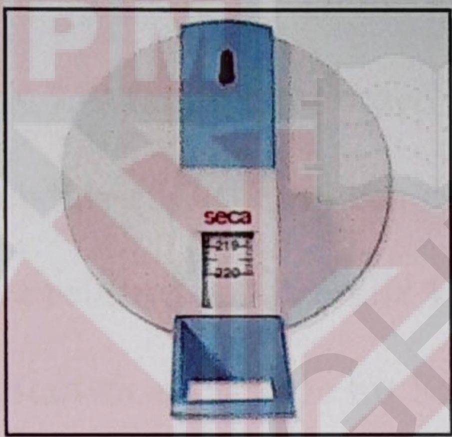

Figure 3.4 SECA Body Meter

Figure 3.5 SECA Body Weighting

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3.4.4 Data Collection Techniques

A set of questionnaire were given to each of the respondents to obtain the data including respondent's personal information, job information, body part discomfort symptoms rating experienced and discomfort rating on motorcycle seat features by the respondent to indicate their level of discomfort. For the posture assessment, respondents were asked to wear the Truposture Smart Shirt and to ride the motorcycle type CBX 750 for an hour based on route set up by the trainer. A Standard Operating Procedure (SOP) has been developed for posture assessment during riding and it can be referred in Appendix 1. The results for all questionnaire were analysed by using Statistical Package for Social Sciences Software (SPSS).

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An approval to conduct a research among police riders was granted

↓

Name list of the workers was obtained from Human Resource Department. The selection of the respondents for the research will be based on inclusion and exclusion criteria

↓

A set of questionnaire that consists of 4 part was assigned to the respondents

↓

Respondents were asked to wear the Truposture Smart Shirt after an hour of rest for muscle resting and ride the CBX 750 motorcycle for an hour based on the route set up by the instructor for posture assessment.

↓

The outcome of the questionnaire and posture assessment will be analysed by using IBM SPSS Version 22

Figure 3.6: Data collection flowchart

Figure 3.7: Route set up by the instructor for medium distance (Google Maps, 2019)

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3.5 Quality Control/Quality Assurance

3.5.1 Pre-test of Questionnaire.

A modified version of questionnaire from Athirah Diyana (2016), SAE paper 2005-01-2690 and Deros, Daruis and Nor (2009) were used to obtain data for the police riders' personal (Part A) and job information (Part B), body parts discomfort symptoms rating experienced by the police rides (Part C) and discomfort on motorcycle seat features rating by the police riders (Part D). Pre-testing of the modified questionnaire was conducted to 10% of the study sample size that has similar characteristics to the study participants to ensure the validity and reliability of data obtained from the study. The value obtained for Cronbach's alpha was 0.712.

3.5.2 Truposture Smart Shirt and Its App

The Truposture smart shirt used in this study to monitor the alignment and curvature of the entire spine during riding process. The shirt is available in 2 size which is are L and XL. This smart shirt and its mobile app have been tested first during the riding to ensure the smart shirt and its app connected and functioned optimally before data collection began. There is no specific calibration available for this instrument. A Standard Operating Procedure (SOP): Posture Assessment during Riding (Truposture Shirt) has been developed to set up the instruments for posture assessment for the mean of this study as attached in Appendix 5. Rest for an hour after performing muscle warm up was considered before starting a ride for muscle resting period.

3.6 Statistical Analysis

IBM SPSS Software (Version 22). The assumption of normality for significant was set up as (p>0.05).

Table 3.1: Table of data analysis

Objectives	Type of Statistical Tests
To determine socio-demographic, occupational and lifestyle profile of police riders	Descriptive analysis
To determine the mean difference between riding posture angle from ideal posture angle for 5 different sensors.	Descriptive analysis
To determine the mean rating of body part discomfort symptoms experienced by the police riders.	Descriptive analysis
To determine the mean rating of discomfort on motorcycle seat features by the police riders.	Descriptive analysis
To determine the relationship between riding time and riding posture angle based on 5 different sensor	Pearson Correlation Spearman`s Rho Correlation
To determine the significant difference of body part discomfort symptoms experienced between preferred riding positions by the police riders.	Kruskall wallis test

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3.7 Ethical Consideration

The approval of the study obtained from the Ethics Committee for Research Involving Human Subjects of Universiti Putra Malaysia with reference number (UPM/TNCPI/RMC/1.4.18.2). The respondents need to sign the participation consent form before the questionnaire distributed. The consent form included the information as follows:

1. The respondent is willing to participate in the study.
2. The nature and purpose of the study explained to the respondents.
3. The respondents have an opportunity to question the researcher.

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CHAPTER 4

RESULTS

4.1 Socio-Demographic, Occupational and Lifestyle Profiles of Police Riders

This study is to determine the riding posture and its relationship with riding discomfort among police riders. A total of 71 male subject were involved as respondents from Maktab Teknik PDRM Bakri, Muar since it is a center for motorcycle training course among police riders. Referring to Table 4.1, the respondents in the study were aged in the range of 22 to 51 years old. Majority of the respondents were in range of 31 to 38 years old (42.3%), followed by in range of 22 to 30 years old (40.8%), in range of 40 to 46 years old (9.9%) and above 47 years old but less than 55 years (7.0%). The mean age of the respondents was 33.3 ± 0.8 years old. In terms of ethnicity, the majority of the respondents were Malay (91.5%) while others and Chinese were only (5.6%) and (2.8%) respectively.

For the marital status, 87.3% were already married and only 12.7% were still single. The mean BMI of the respondents was 26.6 ± 0.6 kg/m^2. Among 71 respondents, 45.1% of them were considered under the normal Body Mass Index (BMI) category within a range of 18.5 to 24.9 kg/m^2, follow by overweight category which in range of 25.0 to 29.9 kg/m^2 (33.8%) and obese which is more than 30.0 kg/m^2 of BMI (21.1%). Next,

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Majority of the respondents had completed secondary educational level (60.6%) followed by Diploma/Degree/Certificate level (29.4%).

Three aspects of lifestyle among respondents were included in the study which is smoking status, physical activity status and history of injury. The study revealed that more 53.5% of the respondents were not smoking while 46.5% of them were smokers. As for physical activity status, 77.5% of respondents were physically active and only 22.5% of them were not physically active. Based on the history of injury, a total of 71.8% of the respondents had a previous history of injury and 28.2% were free of any injury.

The respondents were comprised of several different ranks. Most of the respondents were Corporal (32.4%), Lance Corporal (22.5%), Constable (22.5%), Inspector (15.5%), Sergeant (5.6%) and the least were Sergeant Major (1.5%). In a total of 71 respondents, 63.4% of the respondents were already served as police officers for more than 5 years and above and 36.6% of them were currently under 5 years of services as police officers. By looking at the table below, the mean duration of daily riding among the respondents were 4.7 ± 0.3 hours. The result showed that the number of the respondents ride the motorcycle for less than 4 hours of daily riding and more than 4 hours of daily riding were 46.5% and 53.5% respectively. 64.8% of the respondents frequently practiced non-ideal posture meanwhile only 35.2% practiced ideal posture for riding which is flat position.

Table 4.1 socio-demographics, lifestyle and occupational profile of the respondents.

Variables	N (%)	Mean ± SD
Age (Year)		33.3 ± 0.8
< 30 years old	29 (40.8)	
31-38 years old	30 (42.3)	
39-46 years old	7 (9.9)	
≥ 47 years old	5 (7.0)	
Ethnicity		
Malay	65 (91.5)	
Chinese	2 (2.8)	
Others	4 (5.6)	
Marital Status		
Single	9 (12.7)	
Married	62 (87.3)	
Body Mass Index		26.6 ± 0.6
Normal	32 (45.1)	
Overweight	24 (33.8)	
Obese	15 (21.1)	
Educational Level		
Secondary Education	43 (60.6)	
Diploma/Degree/Certificate	28 (39.4)	
Smoking		
Yes	33 (46.5)	
No	38 (53.5)	
Physical Activity		
Yes	55 (77.5)	
No	16 (22.5)	
History of Injury		
Yes	20 (28.2)	
No	51 (71.8)	
Rank		
Inspector	11 (15.5)	
Sergeant Major	1 (1.5)	
Sergeant	4 (5.6)	
Corporal	23 (32.4)	
Lance Corporal	16 (22.5)	
Constable	16 (22.5)	
Year of Services		10.2 ± 1.0
< 5 years	26 (36.6)	
> 5 years and above	45 (63.4)	
Duration of Daily Riding		4.7 ± 0.3
< 4 hours	33 (46.5)	
> 4 hours	38 (53.5)	
Riding Posture		
Ideal	25 (35.2)	
Non ideal	46 (64.8)	

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4.2 Comparison of Riding Posture Angles from Ideal Posture Angles based on 5 Different Sensors during Riding

Truposture smart consist of 5 different sensors embedded undershirt. Each sensors covered different regions on the spine. The sensors detect the changes of posture angle based on the spine movement in real-time. The positive and negative value of angle indicate position of the spine which are forward and backward respectively. Comparison of mean riding posture angle with ideal posture angle for Sensor 1 during an hour of riding are shown in the Figure 4.2. Sensor 1 covered on T1 region of the spine. The mean ideal posture angle for Sensor 1 was 30.4°. The highest mean of riding posture angles recorded compared to ideal posture angle were 33.5° (5 minutes), followed by 32.8° (35 minutes) and 32.8° (40 minutes). The mean riding posture angles that was closest to the mean ideal posture angle were 30.9° (45 minutes) and 30.9° (15 minutes).

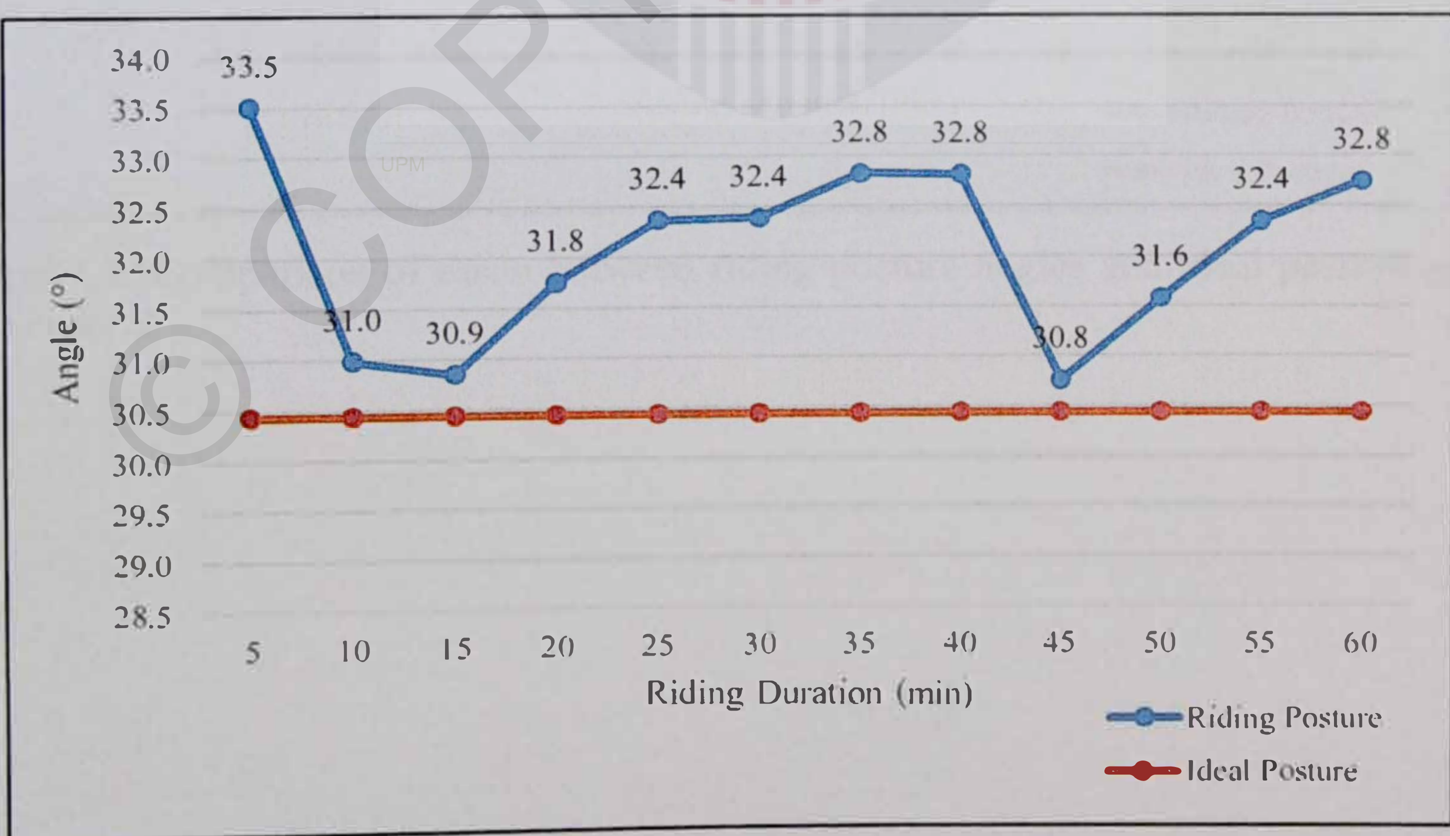

Figure 4.1: Comparison of mean between riding posture angles and ideal posture angle for Sensor 1

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From Figure 4.2 showed the comparison of mean riding posture angles with mean ideal posture angle for Sensor 2 that indicates T8 region of the spine. Most of the mean riding posture angles were consistent throughout the riding with the range of 10.7° to 12.8°. However, the mean ideal posture angle for Sensor 2 was 6.6° which is lower than mean riding posture angles. For the spine region at T8, the highest mean riding posture angle recorded was at the minutes of 60 with 16.6° and have larger difference from mean ideal posture angle compared to other riding posture angles.

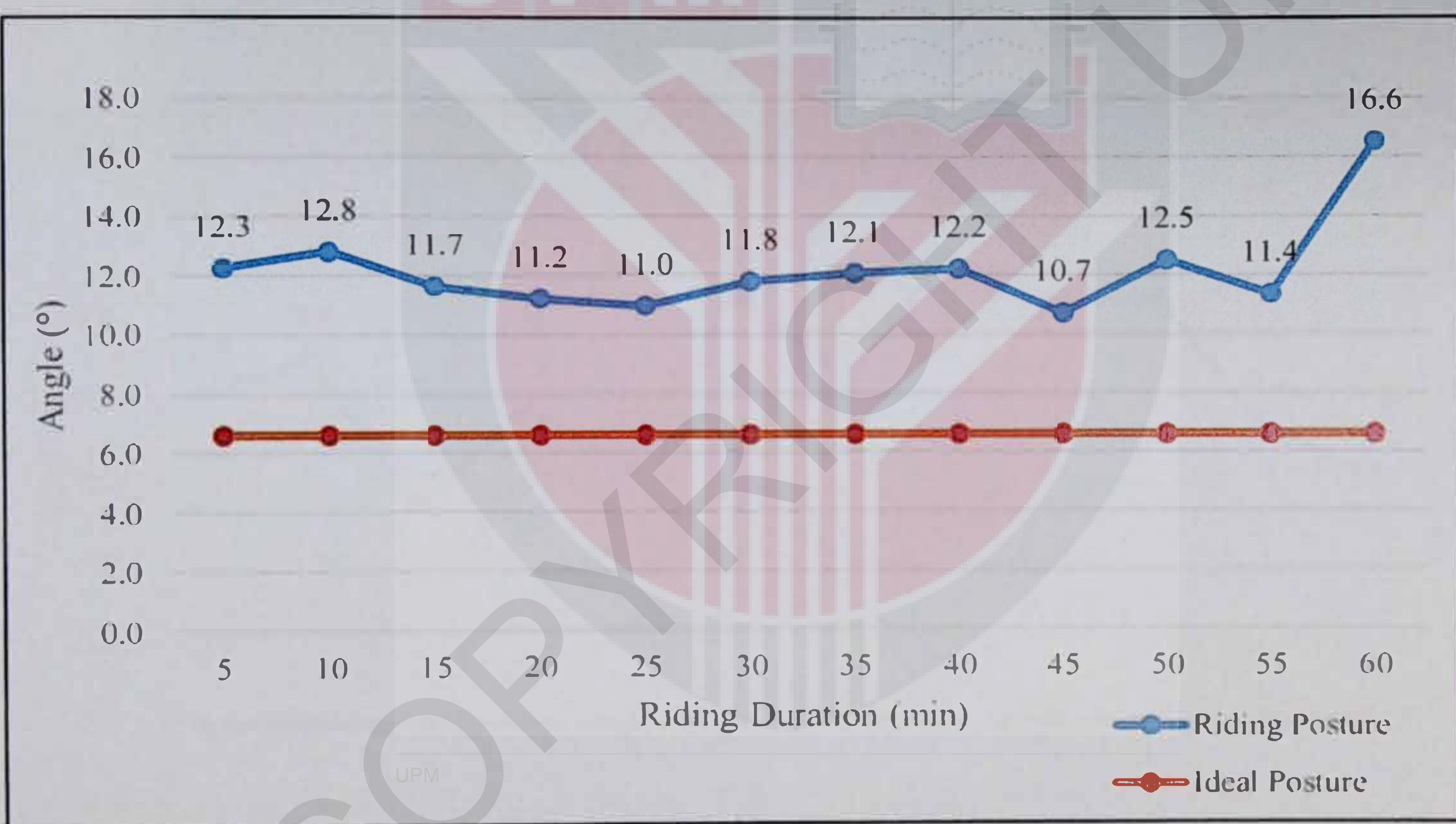

Figure 4.2: Comparison of mean between riding posture angles and ideal posture angle for Sensor 2

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The line graph on Figure 4.3 presented the comparison between mean riding posture angles and mean ideal posture angle for Sensor 3 during riding. Sensor 3 monitored the riding posture angles for L1 region of the spine. The mean ideal posture angle for Sensor 3 was -7.04°. The highest riding posture angles differed from ideal posture angle were -1.2° (40 minutes), followed by -1.7° (30 minutes) and -1.7° (50 minutes). The lowest mean riding posture angles recorded were -4.3° (15 minutes), -3.9° (60 minutes), -3.8° (25 minutes). However, all riding posture angles were not in range of ideal posture angle.

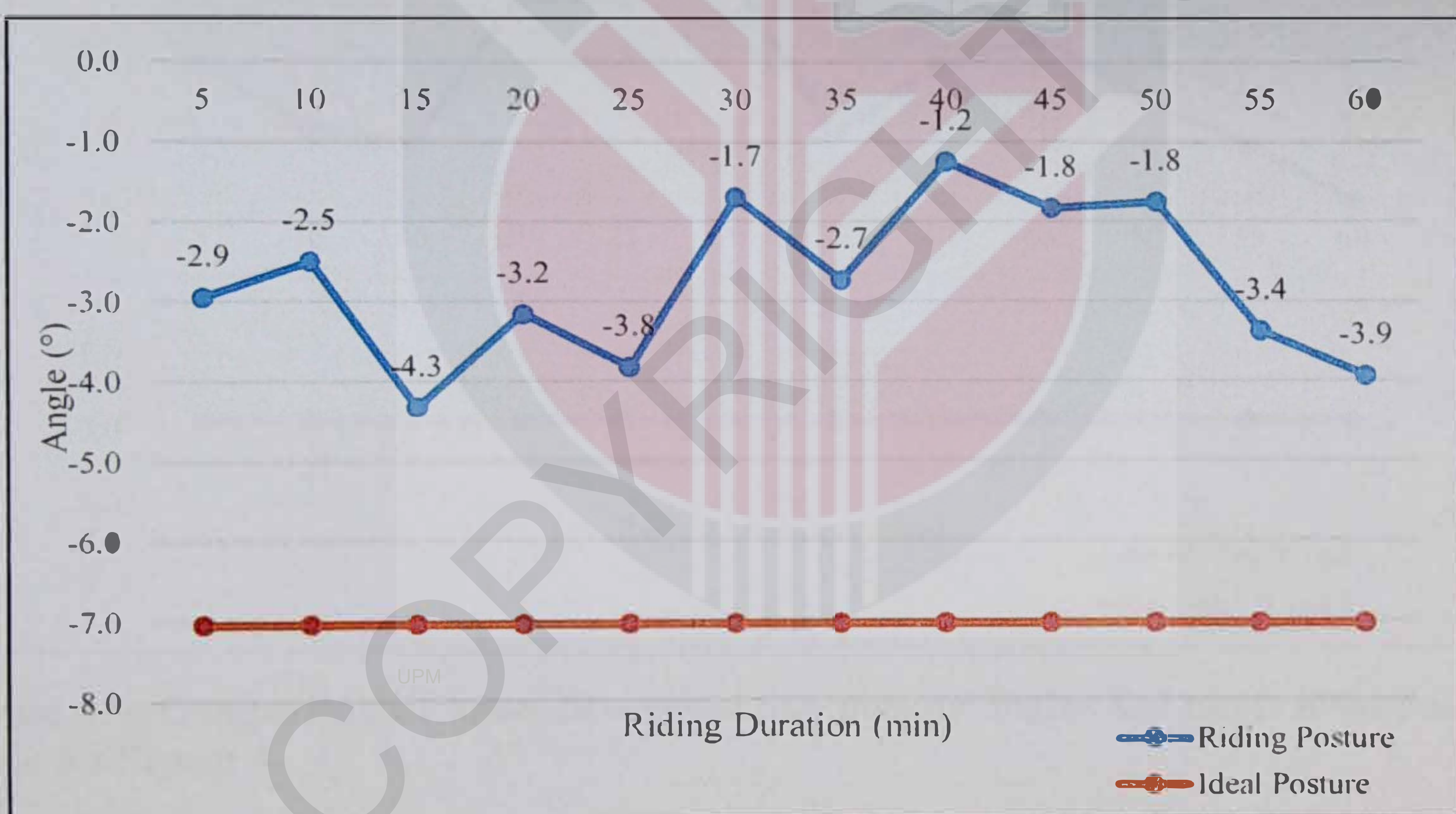

Figure 4.3: Comparison of mean between riding posture angles and ideal posture angle for Sensor 3

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The comparison of mean between riding posture angles with ideal posture angle for Sensor 4 are shown in Figure 4.4. Sensor 4 covered the angle at L3 of the spine. The mean of ideal posture angle for Sensor 4 was -2.9°. Throughout an hour riding, the highest and lowest mean for riding posture angle recorded were 3.1° at the minutes of 30 and 0.0° at the minute of 60 respectively. Same with the previous sensors, the real time angles were not in range of the ideal posture angle for the Sensor 4.

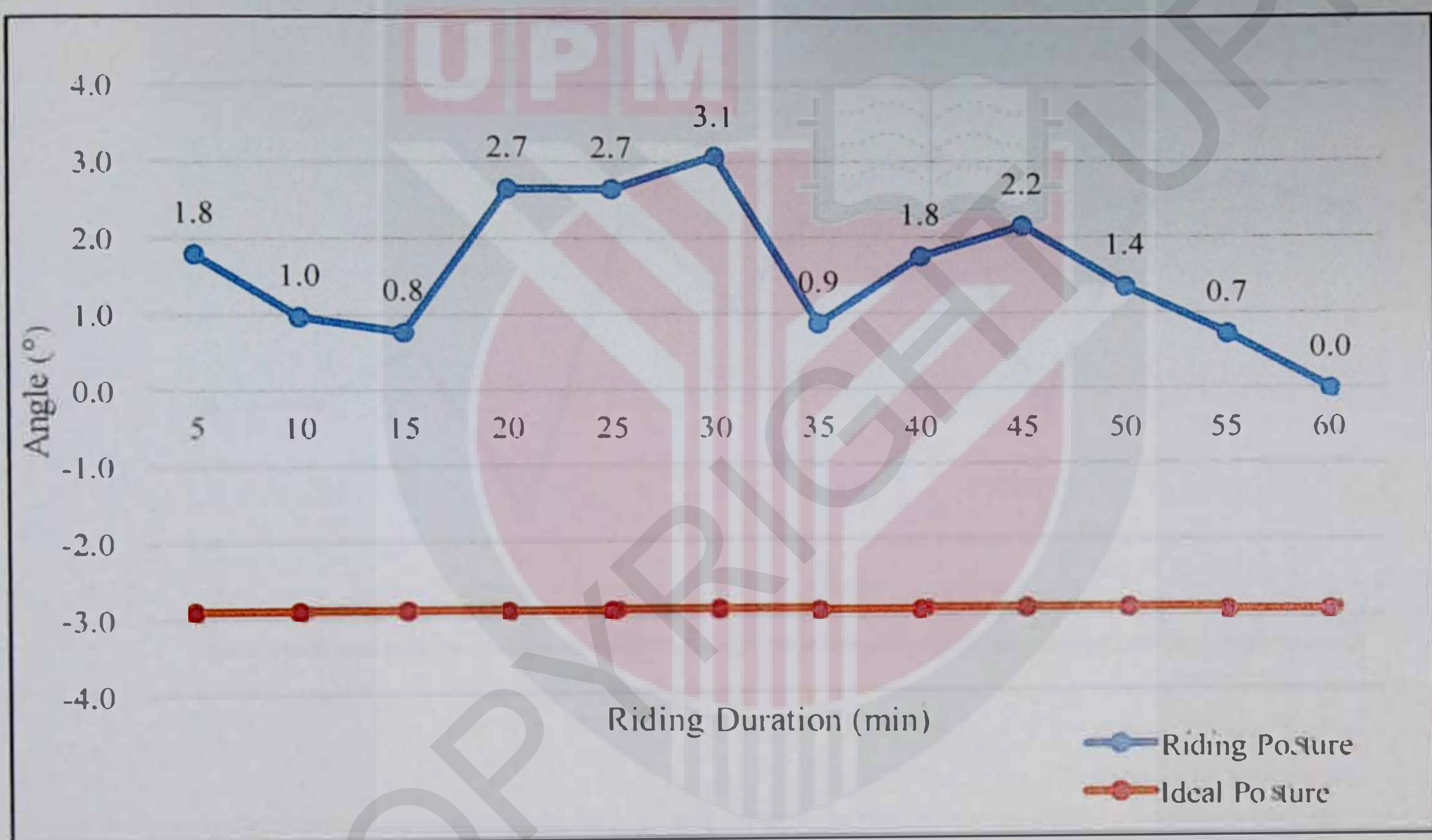

Figure 4.4: Comparison of mean between riding posture angles and mean ideal posture angle for Sensor 4

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For the Sensor 5, it covered pelvic area. From figure 4.5 revealed comparison of mean between riding posture angles with ideal posture angle for Sensor 5. The mean ideal posture angle was -0.6°.Tthe highest mean recorded for riding posture angles for the sensor 5 were 4.1° (40 minutes), followed by 3.9° (55 minutes) and 3.8° (35 minutes). However, the lowest riding posture angle recorded was in the first 20 minutes which is 0.7°. The range of the riding posture angles were in between 0.7° to 4.1°.

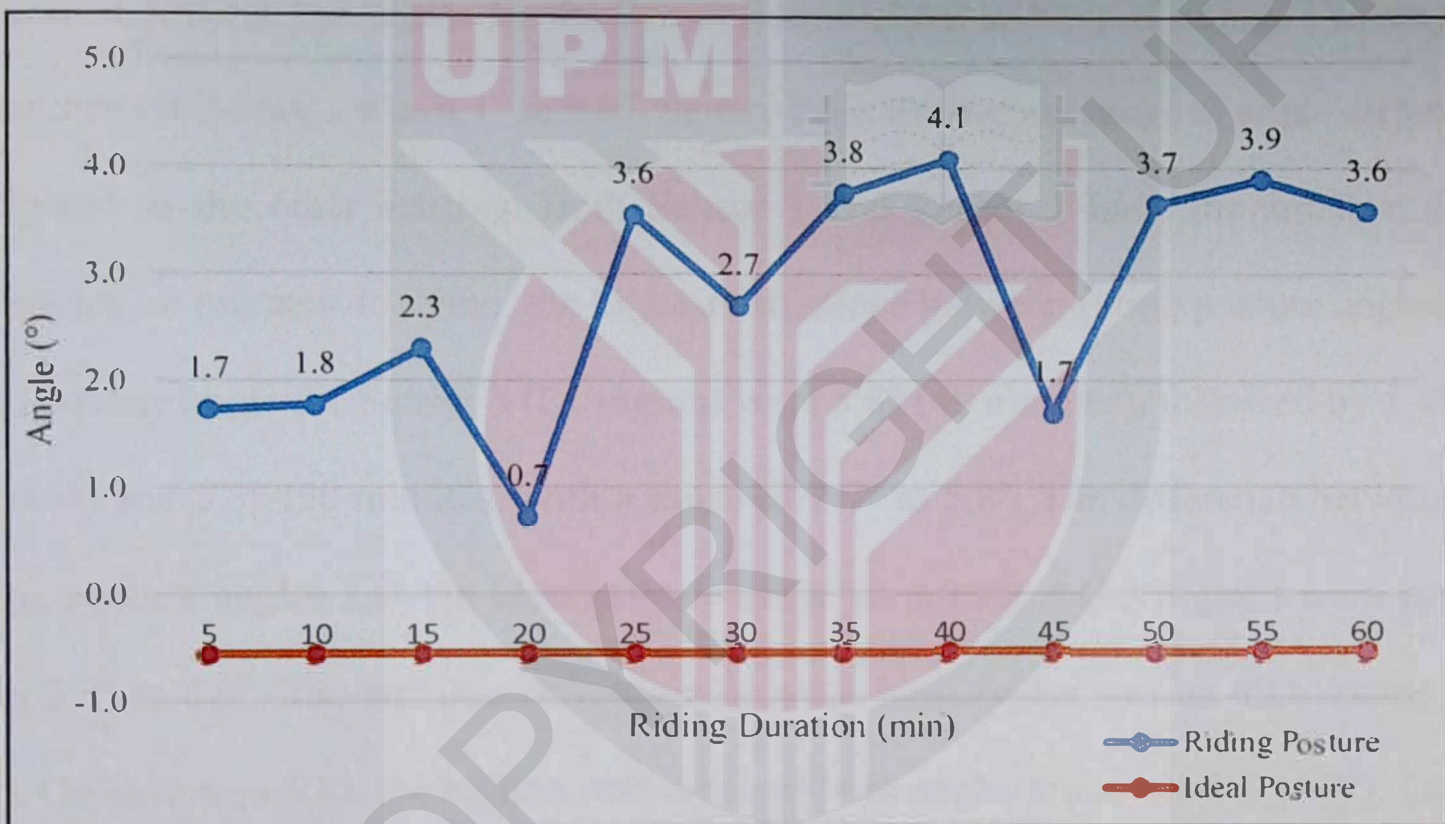

Figure 4.5: Comparison of mean between riding posture angles and ideal posture angle for Sensor 5

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The summary of the mean difference between riding posture angles and ideal posture angle for 5 different sensors are shown in Table 4.2. For the Sensor 1 (T1 region), the highest and smallest difference between riding posture angles and ideal posture angle were on minute 5 by 3.1° and on minute 45 by 0.3° respectively. The range of difference was in between 0.3° to 3.1°. For the Sensor 2 (T8 region), the highest difference was 9.9° from ideal posture angle at the minute of 60. 4.1° on the minute of 45 was the smallest difference between the angles for the Sensor 2 throughout an hour of riding. The range of difference for Sensor 2 was 4.1° to 9.9°. Sensor 2 has the highest range of angle difference compared to the other sensors. Both Sensor 1 and Sensor 2 have the smallest angle difference on minutes 45. Next, the highest difference between riding posture angles and ideal posture angle for Sensor 3 (L1 region) were 5.8° (40 minutes), followed by 5.4° (30 minutes) and 5.3° (50 minutes) with a range of 2.7° to 5.8°. The difference between the riding posture angles and the ideal posture angle for sensor 4 (L3 region) were ranged from 2.9° to 6.0°. The smallest difference between both angles was on 60 minutes with 2.9°. On minutes of 30, the highest difference of both angles was recorded (6.0°). Lastly, the maximum and minimum difference between ideal posture angle and riding posture angle for Sensor 5 that covered pelvis region recorded were 4.7° (40 minutes) and 1.3° (20 minutes) respectively.

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Table 4.2: Summary of mean difference between riding posture angle and ideal posture angle based on 5 different sensors

Sensor	Ideal Posture Angle (°)	Mean Difference between riding posture angle and ideal posture angle														
		Riding duration (Min)														
		5	10	15	20	25	30	35	40	45	50	55	60	Min	Max	Range
1	30.4	3.1	0.6	0.4	1.3	1.9	2.0	2.4	2.4	0.3	1.1	1.9	2.3	0.3	3.1	0.3 - 3.1
2	6.6	5.7	6.2	5.0	4.6	4.4	5.2	5.5	5.6	4.1	5.9	4.8	9.9	4.1	9.9	4.1 - 9.9
3	-7.0	4.1	4.6	2.7	3.9	3.2	5.4	4.3	5.8	5.2	5.3	3.7	3.1	2.7	5.8	2.7 - 5.8
4	-2.9	4.7	3.9	3.7	5.6	5.6	6.0	3.8	4.7	5.1	4.3	3.6	2.9	2.9	6.0	2.9 - 6.0
5	-0.6	2.3	2.3	2.9	1.3	4.1	3.3	4.3	4.7	2.3	4.2	4.5	4.2	1.3	4.5	1.3 - 4.7

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4.3 Body Part Discomfort Symptoms Experienced by the Police Riders

The mean rating of body parts discomfort symptoms experienced by the police riders are shown in Figure 3.1. The results of this study revealed that majority of the police riders experienced discomfort on several body parts as the mean rating of the discomfort is more than 5. The lower back (5.7 ± 3.1) has the highest mean of discomfort, followed by right side of body (5.2 ± 3.2), left side of body (5.2 ± 3.2), tailbone/sacrum (5.2 ± 2.2) and left upper pelvis (5.1 ± 2.3). Besides, the body parts that have mean rating of discomfort below than 5 are right upper pelvis (4.9 ± 2.2), right buttock (4.6 ± 2.7), left buttock (4.5 ± 2.7), left upper back (4.4 ± 2.8), right shoulder (4.3 ± 2.6), left shoulder (4.3 ± 2.7) and middle back (4.2 ± 2.8).

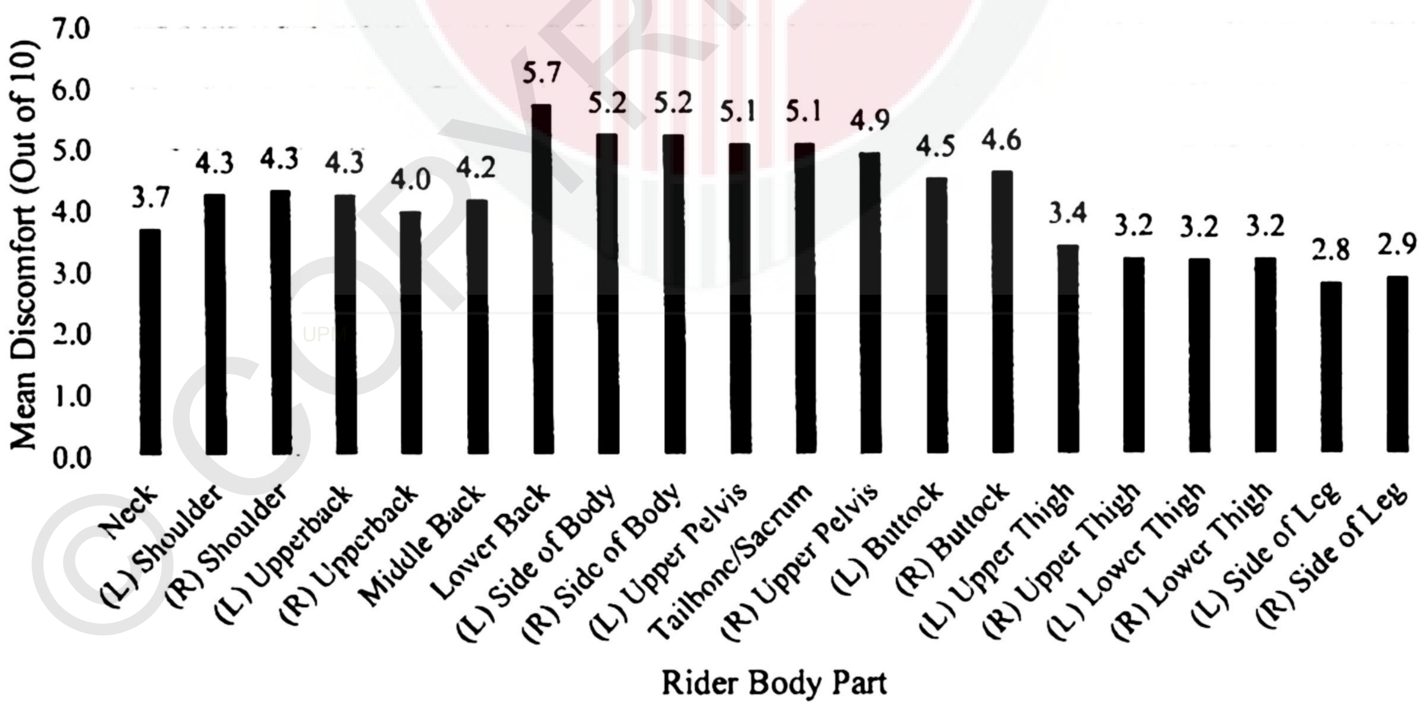

Figure 4.6: Mean rating of body part discomfort symptoms experienced by the police riders (n=71)

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4.4 Discomfort on Motorcycle Seat Features by the Police Riders

The results of the mean rating of discomfort on motorcycle seat features by the police riders are shown in Figure 3.2. The results showed that majority of them felt discomfort (5.1 ± 1.9) with the current motorcycle seat features. It is shown that the highest mean (6.0 ± 2.5) was recorded by the seat features of no lumbar support. The second highest recorded mean was buttock comfort (4.3 ± 2.8), followed by under-knee comfort (3.5 ± 2.7) and thigh comfort (3.4 ± 2.6). However, the respondents felt comfortable with other seat features including width (1.0 ± 0.3), length (1.0 ± 0.3), contour (1.1 ± 0.3), shape design (1.1 ± 0.2), texture and upholstery material of the seat (1.2 ± 0.3).

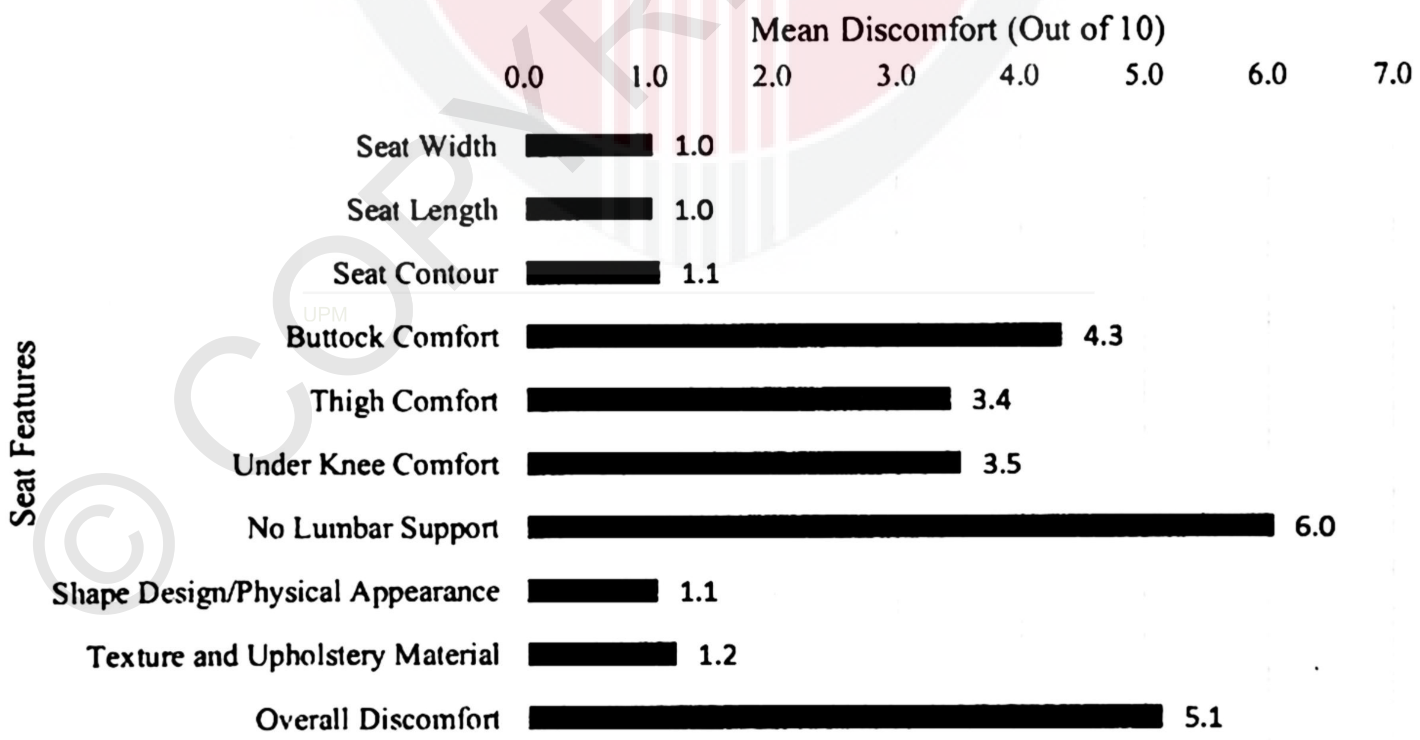

Figure 4.7: Mean of discomfort on motorcycle seat features by the police riders (n=71)

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4.5 Relationship between Riding Duration and Riding Posture Angles for 5 Different Sensors

One of the objectives for this study is to determine the relationship between riding duration and riding posture angles for 5 different sensors, the Pearson correlation was used since the data for Sensor 1, Sensor 3, Sensor 4 and Sensor 5 were normally distributed. Besides, Spearman's Rho correlation also was used as the data for Sensor 2 was not normally distributed. The relationship between riding time and riding posture angles for 5 different sensors are shown in Table 4.3. The finding shows that riding time has a positive good correlation with riding posture angles for Sensor 5 (r=0.638). However, there is no significant correlation between riding time and the riding posture angles for Sensor 1, Sensor 2, Sensor 3 and Sensor 4.

Table 4.3: The relationship (r-value) between riding duration and mean riding posture angles for 5 different sensors (n=71)

Variables	Riding Time (min)	
Sensor	**r**	**p**
1[a]	0.082	0.800
2[b]	0.049	0.880
3[a]	0.158	0.624
4[a]	-0.339	0.281
5[a]	0.638	**0.026***

[a] Pearson Correlation test
[b] Spearman's Rho Correlation test
* Correlation is significant at the 0.05 level (2-tailed)

4.6 Comparison between Preferred Riding Posture (Slump, Flat, Short Lordosis and Long Lordosis) and Body Part Discomfort Symptoms

From Table 4.4 revealed the comparison between preferred riding posture including slump, short lordosis and long lordosis position and body part discomfort symptoms. Kruskal Wallis test was performed since data distribution is not normal to determine if there is a significant difference of median of body part discomfort rating between preferred riding positions by the respondents. Based on table 4.5, it shows that there is a statistical difference of median for discomfort rating on the lower back (z=19.568, p<0.001), left side of body (z=14.848, p=0.001) and right side of the body (z=13.676, p=0.001) between preferred riding positions among the police riders. Post-hoc test (Mann-Whitney U test) of preferred riding positions pairs are significant between slump position, flat position pair and slump position, short lordosis pair for neck, left side of body and right side of body.

Table 4.4: Comparison of body parts discomfort symptoms between preferred riding positions among the respondents.

Variables		Median (IQR)	Z	p
Neck	Slump	4.00 (1.75-6.00)	0.625	0.732
	Flat	4.00 (1.00-6.50)		
	Short Lordosis	1.75 (1.00-6.25)		
Left Shoulder	Slump	5.00 (2.00-7.00)	1.251	0.535
	Flat	4.00 (1.25-6.00)		
	Short Lordosis	2.75 (1.00-7.00)		
Right Shoulder	Slump	5.00 (2.00-7.00)	1.179	0.555
	Flat	5.00 (1.25-6.00)		
	Short Lordosis	3.00 (1.625-5.75)		
Left Upper back	Slump	5.00 (2.375-8.00)	4..097	0.129
	Flat	3.00 (2.00-6.00)		
	Short Lordosis	3.50 (1.625-5.75)		
Right Upper back	Slump	4.00 (2.00-8.00)	3.872	0.144
	Flat	2.50 (1.00-6.50)		

	Short Lordosis	2.00 (1.00-4.75)		
	Slump	4.50 (2.00-8.00)		
Middle Back	Flat	2.50 (1.25-6.50)	4.621	0.099
	Short Lordosis	2.00 (1.00-5.75)		
	Slump	8.50 (4.00-10.00)		
Lower Back	Flat	3.00 (1.75-6.00)	19.586	**<0.001***
	Short Lordosis	3.00 (2.125-6.75)		
	Slump	8.00 (4.00-10.00)		
Left Body Side	Flat	3.00 (2.00-5.50)	14.484	**0.001***
	Short Lordosis	3.00 (1.125-7.50)		
	Slump	7.50 (4.00-10.00)		
Right Body Side	Flat	3.00 (2.00-5.50)	13.676	**0.001***
	Short Lordosis	3.00 (1.125-6.75)		
	Slump	5.00 (3.75-7.00)		
Left Upper Pelvis	Flat	5.00 (3..50-6.50)	2.356	0.308
	Short Lordosis	4.50 (1.50-5.75)		
	Slump	4.00 (4.00-7.00)		
Tailbone	Flat	5.00 (4.00-7.00)	0.772	0.680
	Short Lordosis	5.00 (2.25-7.50)		
	Slump	6.00 (2.75-7.00)		
Right Upper Pelvis	Flat	5.00 (2.75-6.50)	2.748	0.253
	Short Lordosis	4.50 (2.25-5.75)		
	Slump	5.00 (2.00-7.00)		
Left Buttock	Flat	5.00 (1.50-6.50)	0.838	0.658
	Short Lordosis	4.50 (1.00-7.25)		
	Slump	4.50 (1.875-7.00)		
Right Buttock	Flat	5.00 (2.25-6.50)	0.265	0.876
	Short Lordosis	4.50 (1.125-7.50)		
	Slump	2.75 (1..375-5.00)		
Left Upper Thigh	Flat	2.00 (1.00-6.00)	1.295	0.523
	Short Lordosis	1.75 (1.00-2.875)		
	Slump	2.50 (1.375-4.00)		
Right Upper Thigh	Flat	2.00 (1.00-6.00)	0.821	0.663
	Short Lordosis	1.75 (1.00-2.875)		
	Slump	2.50 (1.50-5.00)		
Left Lower Thigh	Flat	2.50 (1.25-5.00)	1.231	0.540
	Short Lordosis	2.00 (1.00-2.875)		
	Slump	2.50 (1.375-4.00)		
Right Lower Thigh	Flat	2.00 (1.00-6.00)	0.745	0.689
	Short Lordosis	2.00 (1.00-2.875)		
Left Leg Side	Slump	2.00 (1.00-4.00)		

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	Flat	1.00 (1.00-5.00)	0.127	0.938
	Short Lordosis	1.50 (1.00-5.125)		
Right Leg Side	Slump	2.00 (1.00-4.00)		
	Flat	2.00 (1..00-4.00)	1.109	0.947
	Short Lordosis	1.75 (1.00-5.25)		

* p value is significant at the 0.05 level (2-tailed)

Post-hoc test (Mann-Whitney U test) of preferred riding positions pairs are significant between slump position, flat position pair and slump position, short lordosis pair for neck, left side of body and right side of body.

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CHAPTER 5

DISCUSSION

5.1 Discussion

5.1.1 Socio-Demographic, Occupational and Lifestyle Profiles of Police Riders

This study is to determine the riding posture and its relationship with riding discomfort among police riders. A total of 71 police riders were involved as respondents from Maktab Teknik PDRM Bakri, Muar since it is a centre for motorcycle training course among police riders. The police riders' age was in the range from 22 – 51 years old and most of them were Malay, followed by Others and Chinese. The mean age of the police riders was 33.3 years old. A mean age from the previous study conducted among traffic police officers in Malaysia was 30.6 years old which most of the them were Malay (Rasdi, Roni & Din, 2017).

Total mean BMI of the police riders was was 26.6 kg/m2. Compared to a previous study by Alghamdi et al., (2017) in Riyadh, there is not too much different with the mean body mass index among police officers which is 27.5 ± 5.1 kg/m2. In this study, majority of the police riders completed at least secondary education level. Moreover, 77.5% of them were involved in any physical activities in order to stay fit and only 46.5% were smokers. Being physically active is important as a police officer as it may help to reduce the risk of injury and also as a body preparation to perform the duties.

According to rank, majority of the police riders were Corporal (32.4%), Lance Corporal (22.5%), Constable (22.5%), Inspector (15.5%), Sergeant (5.6%) and the least were Sergeant Major (1.5%). By referring to Table 3.1, the mean year of services as a police officer were 10.5 years and 63.4 % of the already served as police officers for more than 5 years of service. The mean duration of daily riding among the police riders was 4.7 hours. A previous study conducted among traffic police officer and occupational motorcyclist in Malaysia that found the mean duration of daily riding was more than 5 hours (Mohd Hafizi et al., 2011; Athirah Diyana et al., 2016). Besides, 53.5% of the police riders in this study ride for more than 4 hours per day.

In term riding posture, 64.8% of them frequently practiced non-ideal posture slump and short lordosis position during riding meanwhile only 35.2% practiced ideal posture for riding which is a flat position. Karmegam et al. ,(2013) from a previous study revealed that majority of the respondents preferred non-ideal posture for riding by more than 70%. Flat position for riding was considered as ideal posture in this study.

5.1.2 Comparison of Riding Posture Angles from Ideal Posture Angles based on 5 Different Sensors during Riding

The statistical of the mean difference between riding posture angles and ideal posture angle for 5 different sensors are shown in Table 4.2. Majority of the mean riding posture angles vary over times and above the mean ideal posture angles. The ideal posture angles for each sensor was set before starting a riding according to the ideal riding posture taught by the police motorcycle trainer. The mean ideal posture angle for Sensor 1, Sensor 2, Sensor 3, Sensor 4 and Sensor 5 30.44°, 6.62°, -7.04°, -2.90° and -0.56° respectively. The highest mean difference between ideal posture angle and riding posture angle of each sensor recorded throughout an hour of riding were 3.1° (Sensor 1), 9.9° (Sensor 2), 5.8° (Sensor 3), 6.0° (Sensor 4) and 4.5° (Sensor 5).

The difference between the angles indicates that the body of riders are favoured to move forward rather than backward from ideal posture angles during the riding process. The riders changed their postures irregularly and unconsciously when they need to do something and adapt with riding process and environment. Besides, the riders also tend to change their body posture and sitting when they felt discomfort in the body part. According to Vergara and Page (2002), discomfort can be expressed through large changes in posture. They also explained that small movements is required to reduce pain due to static lumbar and pelvic posture. The riders have a limited space to make an adjustment during riding and this condition made the lumbar and pelvis posture has to be in a static position which may cause discomfort after prolonged exposure. Improper static position may increase the risk of MSD (Loghmani et al., 2013). The actions of sitting for an extended time with the same position and limited space lead to discomfort and fatigue (Motorcycle Council of New South Wales, 2005). The riders cannot maintain a static sitting posture since it can cause discomfort on the body part. Besides, adjusting the posture also helps to avoid the mechanical load and ischemia of the tissue. Lacking back support features contributed to discomfort on the body part (Tan et al., 2008).

However, the condition of the roads and speed also influenced the movement of the body either forward or backward which lead to increasing of angles in real time. For example, uneven road surface or damage may require the riders to reduce or increase the speed by braking and throttling which enable the rider to control the motorcycle normally. So, during the braking and throttling process, the riders cannot hold the body from moving forward or backwards due to inertia. Therefore, the riding posture angles keep changing over time during the riding session. However, changing of posture during acceleration and deceleration helps the riders to balance the motorcycle efficiently (Zhu, Murakami & Nishimura, 2010).

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5.1.3 Body Part Discomfort Symptoms Experienced by the Police Riders

This study discovered that several body parts of the police riders experienced discomfort symptoms due to riding. The results of body part discomforts rating experienced by the police riders were presented through a bar graph as in figure 4.6. The results showed the police riders experienced discomfort in the lower back part, left and right of the body, upper right pelvis and tailbone since the mean discomfort rating of these body parts were more than 5. The study also found discomfort in thighs and legs is generally low.

This study revealed Sensor 3, Sensor 4 and Sensor 5 that covered the lower part of the body have a high difference between riding posture angle and ideal posture angle. It showed that the respondents unable to maintain with ideal posture angles range during riding. Therefore, these angle changes from ideal posture may cause discomfort on affected body parts. This study is in agreement with the previous study (Donnelly, Callaghan & Durkin, 2009) on seating comfort among police officers found that some of lower body parts including lower back, right and upper pelvis and sacrum experienced greater discomfort compared to other body parts. Velagapudi and Ray (2015) also reported from their study that majority of the motorcyclist experienced discomfort back, shoulders, buttock, neck and wrists.

There are several factors that may promote the development of body parts discomfort. First of all, the duration of riding. This study revealed that police riders spent more than 4 hours daily on riding. Alias et al., (2016) stated that buttocks, back and shoulder were the most affected body part by having physical discomfort after riding for an hour. Therefore, this prolonged duration of riding may have contributed to body parts discomfort among the riders. The results of this study are also similar to the previous study that showed police officer experienced low back discomfort after exposure to prolonged driving experience (Gyi & Porter, 1998).

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Besides, the motorcycle itself also considered as unergonomic for the police riders usage. The rider has to maintain the static posture for a long period during riding in order to ride safely. Tan et al., (2008) explained that prolonged static posture can cause rider fatigue and seat discomfort. This is because static posture by the rider may cause interruption of muscular blood supply due to high intramuscular pressure. Lack of oxygen to muscles will lead to discomfort and fatigue to the rider. Athirah Diyana et al., (2016) also demonstrated that vibration exposure, prolonged static sitting during riding contributed to musculoskeletal disorders especially in neck, shoulder and lower back.

The motorcycle also only provide limited space for adjustment which may be different among the riders need (Karmegam et al., 2009). Moreover, carriage of police appointment including a firearm, handcuff and walkie-talkie also may lead to discomfort in the lower part of the body as this equipment are attached to the police's belt. Fitlness, Mitsopoulos-Rubens and Rudin-Brown (2014) revealed that carriage of appointments with normal belt resulted in greater overall discomfort among police officers compared to load-bearing vest/belt combination.

5.1.4 Discomfort on Motorcycle Seat Features by the Police Riders

Seat features played important roles as it also contributes to the discomfort among the riders during riding. One of the objectives for this study is to determine the discomfort rating on motorcycle seat features by the riders. The motorcycle used in this study was Honda CBX 750. Several seat features such as width, length, contour, shape design,

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lumbar support, and texture and upholstery material of seat were assessed on discomfort. Besides, body part comfort including buttock, thigh and under-knee also were considered in this study.

From figure 4.7 revealed that majority of the police riders felt discomfort with the current motorcycle seat features. Seat features with no lumbar support created the highest mean rating of discomfort by the police riders. A few studies have been conducted among the riders and the findings of the research revealed that low back was among the common body part experienced discomfort (Karmegam et al., 2009; Velagapudi & Ray, 2015) since the current motorcycle seat is lacking lumbar support. The respondents need to adapt with the movement of the body during riding which may cause discomfort, especially low back area.

Currently, the design of motorcycle seat is lack with lumbar support which is important to stabilise the intradiscal pressure on the lumbar region (Mathurkar, 2016). Karmegam et al., (2013) conducted a study to test the discomfort among rider with and without the lumbar support. The findings revealed that the rate of discomfort level reduces over time in all body parts when using lumbar support during riding. Therefore, no lumbar support equipped on current police motorcycle seat contributed to the discomfort.

Besides, the mean rating of discomfort for buttock comfort was also high. Vibration from a motorcycle may cause discomfort to the buttock. However, the intensity of vibrations can be determined by many factors. For example, the size of the engine, age

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and type of automobile, body weight, road conditions and type of seating. Buttock and back part received vibrations from the base to vertical axis (Patil, Bajpai & Verma, 2014). Prolonged exposure to vibration can affect the natural processes of the body and lead to discomfort in the body parts.

5.1.5 Relationship between Riding Duration and Riding Posture Angles for 5 Different Sensors

Based on Table 4.3, there is a significant good positive correlation with a correlation between riding posture angle for sensor 5 with the riding time. It indicates the riding posture angles for sensor 5 increased with the riding time. There is no significant correlation with the riding time for the other 4 sensors. According to Truposture smart shirt, sensor 5 covered the pelvis area. Continually movement of pelvis area may contribute to discomfort on the pelvis area for a prolonged period. The previous study among police officer revealed that the right and upper pelvis region have a higher level of discomfort because of prolonged driving experienced (Donnelly, Callaghan & Durkin, 2009). This study also considered that mean rating of discomfort for right upper pelvis and left upper pelvis are also high. De Carvalho & Callaghan (2015) from their previous study concluded that appropriate selection of lumbar support avoids significant changes to the lumbar spine and pelvic posture over time. Therefore, lack of lumbar support for the motorcycle seat may contribute to riding posture angles for sensor 5 varies over time.

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5.1.6 Comparison between Preferred Riding Posture (Slump, Flat, Short Lordosis and Long Lordosis) and Body Part Discomfort Symptoms

This study showed there is a significant difference of the median between preferred riding posture and body part discomfort symptoms among the police riders as shown in Table 4.4. There is a significant difference between the lower back ($p<0.001$), left ($P=0.001$) and right ($P=0.001$) side of the body with riding position. A post hock test (Mann Whitney U) was performed to determine the significant differences between the riding postures. The significance was observed between a slump and flat riding posture and slump and short lordosis posture.

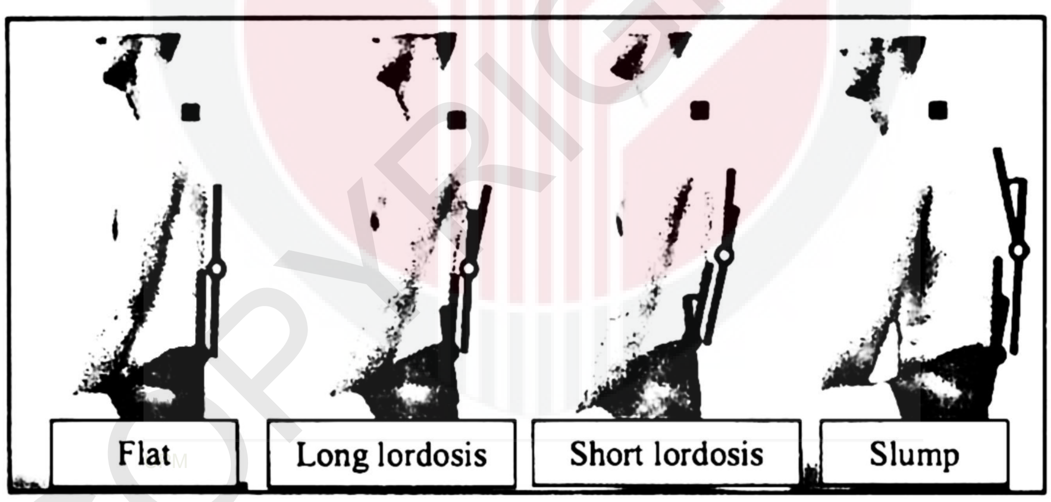

Figure 5.1: Riding posture

Riding process required the riders to practice static seating posture as riding considered as a monotonous task which triggered reduction of blood flow to the muscles and rigidity (Chou and Hsiao, 2005). Therefore, this action can result in discomfort symptoms on the lower back, left and right side of the body. Numerous studies have concluded that non-ideal posture such as slump, long lordosis and short lordosis is viewed

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as possibly harmful. These postures also are assessed as one of the main factors that contribute to several MSDs problems (Griffin & Ebe, 2001; Kyung, Nussbaum & Babski-Reeves, 2008). Besides, Youp Cho et al., (2015) also explained that action of sitting for a long period caused the lumbar lordosis to reduce severely which can promote to increasing of intradiscal pressure that resulted in low back pain over time. Abnormal posture put tension on the muscles and ligaments which affect the spine curvature indirectly.

Besides, the motorcycle also considered as a limited workstation (Robertson & Minter, 1996; Karmegam et al., 2008). Therefore, the riders have difficulties to make an adjustment including the riding posture in order to reduce the discomfort. Since the motorcycle is lacking back support, features to support the spine have been proposed from a previous study (Karmegam et al., 2013). Lumbar support is important to stabilise the intradiscal pressure on the lumbar region. Thus, it helps to reduce the discomfort especially in the lower part of the body.

CHAPTER 6

CONCLUSION & RECOMMENDATION

6.1 Conclusion

In general, the conclusions are summarized as follows:

1. Police riders cannot maintain an ideal riding posture over time since there are varies of riding postures angles from ideal posture angle over the time for each sensor that covered T1, T8, L1, L3 and pelvis region of the spine.
2. Lower back, left and right side of the body, right upper pelvis and tailbone are the most affected body part with discomfort among police rider.
3. Police riders also indicate that they felt discomfort on motorcycle seat features. No lumbar support is reported to have the highest mean rating of discomfort on motorcycle (CBX 750) seat features.
4. There is a significant correlation between time and riding posture angles for sensor 5 that covered the pelvis area. However, there is no significant correlation for the other 4 sensors.
5. There is a significant difference of median rating of body part discomfort symptoms between preferred riding positions by the police riders for the lower back part and left and right side of the body.

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6. Therefore, lumbar support should be proposed to be equipped on the motorcycle seat to reduce lower body parts discomfort and helps to maintain ideal posture during riding.

6.2 Study Limitation

1. This study assesses only on riding posture to a few variables on body part discomfort symptoms experienced by the police rider as well as discomfort on motorcycle (CBX 750) seat features but other factors and variables on body part discomfort symptoms are not taking into account in this study. This may lead to bias or affecting outcome of the data collected.
2. The validity of each respondent's answers that will be given while answering questionnaire cannot be proved clinically since subjective measurement was used. The researcher can only assume that the respondents will answer truthfully and accurately, all data that will be given is valid.
3. No study that used Truposture Smart Shirt for posture assessment. Therefore, the researcher has no references to get a better understanding of how this smart shirt functioned. This study use smartphone to collect data. So, there are limited memory space to keep the results. It is suggested to use wireless time monitoring with bigger memory space.
4. The sample size is not fulfilled due to number of available respondents during that time was only 71. The location of study is purposively selected since Maktak Teknik PDRM Bakri, Muar served as a training centre for riding course among police riders.

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5. Insufficient equipment and time constraint during collecting the data also contribute to the limitation in this study since only 2 Truposture Smart Shirt available which required two smartphones to be used for posture assessment during riding.
6. This study only include medium distance of riding training.
7. This study did not considered the factors that affect MSDs such as age, BMI, marital status, years of service, daily riding duration, daily working duration and rank.

6.3 Recommendation

Administrative control

a) **Medical Surveillance**

1. Medical surveillance should be conducted annually among police riders since mean rating of body part discomfort among police riders is high on several parts. Medical surveillance should be done by Medical Doctor or Occupational Health Doctor before further preventive actions taken to tackle MSD problems in the workplace.

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b) **Training**

1. Intervention program for MSD should be conducted among the police riders to raise awareness and understanding on WMSDs. Risk factors such ideal and non-ideal riding posture and sign and symptoms of WMSDs should be explained during the program. SOP and module for riding posture section also can be improvised by including example of non-ideal riding posture as awareness. Training among police riders also should be conducted frequently as a refreshment for riding skills including ideal riding posture.

c) **Motorcycle and equipment**

1. Improve motorcycle seat may help to reduce overall discomfort of sitting among police riders. Lumbar support should be proposed to be equipped on CBX 750 motorcycle since lower back area is reported of having highest discomfort compared to others body part. Besides, it also helps to maintain the ideal posture during riding.

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d) **Future Research**

1. It is recommended to conduct a cohort study design in the future research as it is the best study design to do regarding riding posture affecting the body part discomfort symptoms experienced by the police riders.
2. Police motorcycle seat with lumbar support should be tested in the future to determine whether lumbar support can reduce body part discomfort because no study have been conducted among the police riders including in a much bigger population.
3. Use bigger sample with more sampling location the future to produce a higher representative rate of the study population.

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APPENDIX 1

CONSENT FORM

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BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Analisis Postur dan Hubungan Ketidakselesaan semasa Menunggang dalam kalangan Penunggang Motosikal Polis : Kajian secara Keratan Rentas

2. PENGENALAN

Polis Diraja Malaysia memainkan peranan yang penting dalam memastikan keselamatan awam dan negara. Pada masa kini, penggunaan motorsikal telah digunakan secara meluas di dalam beberapa jabatan-jabatan Polis Diraja Malaysia. Oleh itu, sejumlah besar polisi trafik telah ditugaskan untuk tugas rondaan dengan menggunakan motosikal. Polis trafik mempunyai kecenderungan untuk terdedah kepada gangguan muskuloskeletal disebabkan pekerjaan. Hal ini kerana polis trafik terdedah kepada postur yang janggal atau tidak selesa untuk jangka masa yang lama disebabkan oleh tiada ruang kerja yang normal. Perubahan polis trafik dari postur yang ideal perlu dikaji kerana ia boleh menyebabkan ketidakselesaan pada badan. Melalui kajian ini, ia akan menentukan sama ada polis trafik mengalami ketidakselesaan atau tidak disebabkan postur semasa menunggang motorsikal.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda perlu menandatangani borang persetujuan bagi menunjukkan anda bersetuju untuk terlibat dalam kajian ini selepas anda membaca dan memahami semua penerangan yang diberikan. Borang kaji selidik perlu dijawab dan borang ini akan merangkumi maklumat latar belakang diri, maklumat pekerjaan, tahap ketidakselesaan anggota badan semasa menunggang motosikal dan tahap ketidakselesaan kerusi motorsikal. Borang persetujuan dan borang kaji selidik perlu dipulangkan sebelum pengukuran dan analisi postur dimulakan. Postur akan dianalisi dengan menggunakan *Truposture* baju pintar. Anda diperlukan untuk memakai baju tersebut untuk tujuan analisis. Penyertaan adalah secara sukarela, dan anda berhak menarik diri dari penyelidikan pada bila-bila masa tanpa sebarang penalti atau kehilangan manfaat yang anda berhak.

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4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Polis trafik yang menunggang motorsikal berkuasa tinggi kurang dari 3 bulan dan polis trafik yang sebelum ini telah disahkan dengan gangguan muskuloskeletal atau kecederaan sebelum layak sebagai polis trafik tidak ada terlibat dalam kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Kajian ini memberikan status kesihatan yang berkaitan dengan ketidakselesaan penunggangan. Beberapa ujian kesihatan akan disediakan dan tiada kos akan dikenakan ke atas subjek. Contoh ujian tersebut seperti Indeks jisim badan (BMI) dan analisis postur. Garis asas dari kajian ini juga mungkin diperlukan oleh majikan untuk menyediakan program untuk mengatasi masalah kesihatan yang berkaitan.

b) KEPADA ANDA SEBAGAI PENYELIDIK?

Kajian ini memberikan status kesihatan yang berkaitan dengan ketidakselesaan penunggangan. Beberapa ujian kesihatan akan disediakan dan tiada kos akan dikenakan ke atas subjek. Contoh ujian tersebut seperti Indeks jisim badan (BMI) dan analisis postur. Garis asas dari kajian ini juga mungkin diperlukan oleh majikan untuk menyediakan program untuk mengatasi masalah kesihatan yang berkaitan.

6. ADAKAH IA BERISIKO?

Tidak ada risiko di dalam kajian ini

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Maklumat dan identiti subjek akan kekal rahsia dan tidak akan didedahkan kepada mana mana pihak. Persetujuan dari peserta adalah diperlukan jika maklumat tersebut akan digunakan di luar kajian ini.

8.0 SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN IN

Sekiranya anda mempunyai soalan tambah semasa mengikuti penyelidikan ini, anda boleh menghubungi penasihat kepada kajian ini, Dr. Karmegam A/L Karuppiah di 03-89472513 (megam@upm.edu.my) atau penyelidik kepada kajian ini, Muhammad Aiman Bin Che Zahari di 013-9257749 / 017-9096181 (aimanzahari42@gmail.com).

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini ______

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9. PERSETUJUAN

Saya………………………………………………… No Kad Pengenalan. …………………………… beralamat……………………………………………………………………………………………………

………………………..dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

Saya setuju/tidak bersetuju untuk imej/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ………………………………… (*Responden*)

Tarikh :…………………………………………

Tandatangan ……………………………………. (*Saksi*)

Nama :………………………………………….

No. K/P: ……………………………………….

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh ……………………………………

Tandatangan ………………………………….. (*Penyelidik*)

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APPENDIX 2

QUESTIONNAIRE

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UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

NO. ID : ....

TARIKH : ....

TANDA TANGAN : ....

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi beberapa bahagian iaitu:

BAHAGIAN A: MAKLUMAT LATAR BELAKANG DIRI
BAHAGIAN B: MAKLUMAT PEKERJAAN
BAHAGIAN C: TAHAP KETIDAKSELESAAN ANGGOTA BADAN SEMASA MENUNGGANG MOTOSIKAL
BAHAGIAN D: TAHAP KETIDAKSELESAAN TEMPAT DUDUK MOTOSIKAL

2. Anda diminta untuk menjawab semua soalan yang ada di dalam borang soal selidik ini.
3. Untuk menjawab, sila tandakan jawapan di bahagian jawapan yang telah disediakan.
4. Borang soal selidik hendaklah dikembalikan kepada penyelidik setelah selesai menjawab semua soalan.

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Untuk kegunaan penyelidik

BAHAGIAN A: MAKLUMAT LATAR BELAKANG DIRI

1.1 Umur : ☐☐ tahun

1.2 Bangsa : 1.☐ Melayu 2.☐ Cina
3.☐ India 4.☐ Lain-lain

1.3 Status : 1.☐ Bujang 2.☐ Berkahwin
3.☐ Bercerai

1.4 Pendidikan : 1.☐ Tidak Bersekolah
2.☐ Rendah/UPSR
3.☐ Menengah/PMR/SPM/STPM
4.☐ Sijil/Diploma/Ijazah

1.5 Tinggi : ☐☐☐☐ cm

1.6 Berat : ☐☐☐☐ kg

1.8 Adakah anda merokok?

1.☐ Ya 0.☐ Tidak

Jika ya, _________ batang sehari

1.9 Adakah anda melakukan sebarang aktiviti fizikal?

1.☐ Ya 0.☐ Tidak

Jika ya, nyatakan: ______________________________

1.10 Adakah anda mengalami sebarang kecederaan di mana-mana bahagian anggota badan berikut:

1.☐ Kepala
2.☐ Bahu
3.☐ Tangan
4.☐ Tulang belakang
5.☐ Pinggul
6.☐ Peha
7.☐ Lutut
8.☐ Kaki

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Untuk kegunaan penyelidik

BAHAGIAN B: MAKLUMAT PEKERJAAN

2.1 Pernahkah anda bekerja di tempat lain sebelum ini?

1.☐ Ya   0.☐ Tidak

2.2 Apakah pekerjaan dahulu?

____

2.3 Berapa lamakah anda telah bekerja sebagai (pekerjaan dahulu seperti di atas)?

__________ tahun

2.4 Adakah anda terdedah kepada sebarang hazad (pekerjaan dahulu) seperti di bawah:

1.☐ Bahan kimia
2.☐ Panas melampau
3.☐ Habuk
4.☐ Bunyi bising
5.☐ Binatang berbisa
6.☐ Gegaran
7.☐ Lain- lain: __________

2.5 Apakah pangkat anda sekarang?

____

2.6 Berapa lamakah anda telah bekerja sebagai polis?

__________ tahun

2.7 Balai manakah tempat anda bekerja?

____

2.8 Bahagian/Jabatan manakah anda bekerja sekarang?

____

2.9 Berapa harikah anda bekerja dalam seminggu?

_______ hari

2.10 Berapa jamkah anda bekerja dalam sehari?

_______ jam

2.11 Shift kerja:

1.☐ Normal
2.☐ Shift

2.12 Adakah anda bekerja lebih masa (OT)?

1.☐ Ya   0.☐ Tidak

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Untuk kegunaan penyelidik

2.13 Jika Ya, secara purata, berapa kerap anda bekerja lebih masa?

0. ☐ Tiada
1. ☐ 1-3 kali sebulan
2. ☐ 3-5 kali sebulan
3. ☐ Lebih dari 5 kali sebulan

2.14 Apakah jenis motorsikal yang anda gunakan semasa kerja?

1. ☐ Honda CBX750
2. ☐ Lain-lain: ______________________

2.15 Berapa lamakah anda menunggang motorsikal tersebut dalam sehari semasa bekerja?

__________ jam

2.16 Berapa tahun (pengalaman) anda menunggang motorsikal polis?

__________ tahun

2.17 Apakah jenis kenderaan yang anda gunakan di luar waktu bekerja?

1. ☐ Motorsikal
2. ☐ Kereta
3. ☐ Lain-lain: ______________________

2.17 Berapa tahun (pengalaman) anda menunggang/memandu kenderaan sendiri?

_______ tahun

2.18 Berapa lamakah anda menunggang/memandu kenderaan tersebut dalam sehari di luar waktu bekerja?

_______ jam

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ARAHAN: Sila tandakan (**X**) **satu (sahaja)**, kaedah (cara duduk) yang **paling kerap anda gunakan ketika menunggang motosikal** pada bahagian dibawah.

☐ Bongkok

☐ Tegak

☐ Sangat tegak

☐ Sedikit tegak

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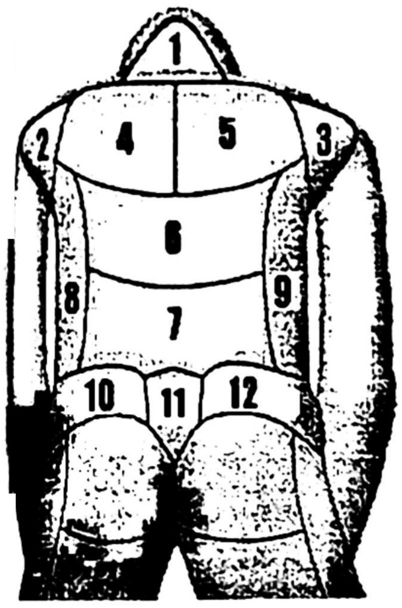
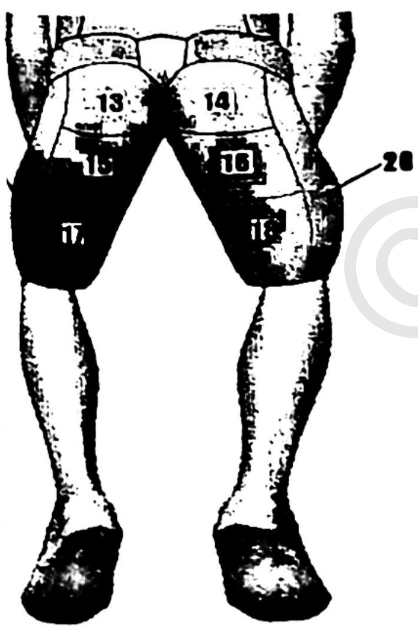
Untuk kegunaan penyelidik

BAHAGIAN C: TAHAP KETIDAKSELESAAN ANGGOTA BADAN SEMASA MENUNGGANG MOTOSIKAL

Tandakan [/] mengikut tahap ketidakselesaan di setiap bahagian anggota badan anda





	Tiada Rasa Apa Apa		Sangat Selesa		Selesa		Sedikit Tiak Selesa		Sederhana Tidak Selesa		Tidak Selesa		Sangat Tidak Selesa			Terlalu Tidak Selesa
	0	0.3	0.5	0.7	1	1.5	2	2.5	3	4	5	6	7	8	9	10
1. Leher																
2. Kiri bahu																
3. Kanan bahu																
4.Kiri atas belakang																
5. Kanan atas belakang																
6.Belakang atas																
7.Belakang bawah																
8. Kiri tepi badan																
9. Kanan tepi badan																
10. Kiri atas punggung																
11.Ekor tulang																
12.Kanan atas punggung																
13.Kiri punggung																
14.Kanan punggung																
15.Kiri peha atas																
16. Kanan peha atas																
17. Kiri peha bawah																
18. Kanan peha bawah																
19. Kiri tepi kaki																
20. Kanan tepi kaki																

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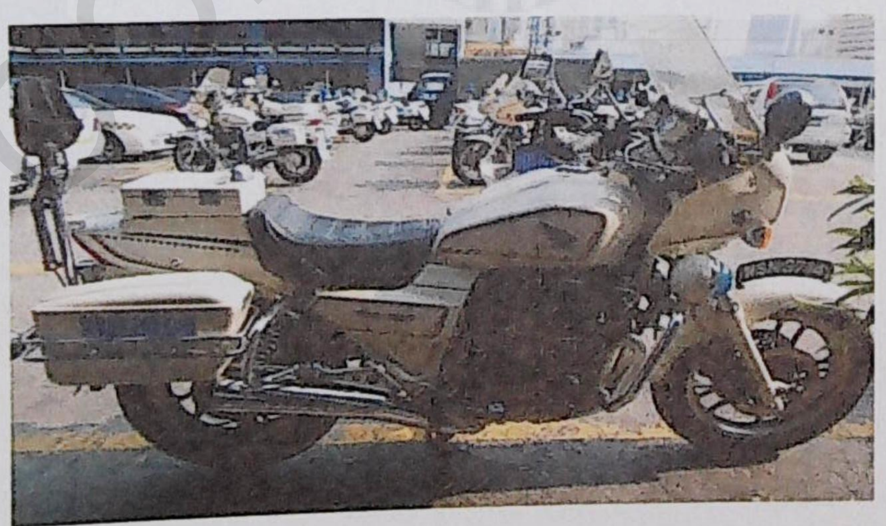
BAHAGIAN D: TAHAP KETIDAKSELESAAN TEMPAT DUDUK MOTOSIKAL

Tandakan [|] pada setiap soalan mengikut tahap ketidakselesaan anda.

	Tidak rasa apa apa		Sangat Selesa		Selesa		Sedikit Tidak Selesa		Sederhana Tidak Selesa		Tidak Selesa		Sangat Tidak Selesa			Terlalu Tidak Selesa
	0	0.3	0.5	0.7	1	1.5	2	2.5	3	4	5	6	7	8	9	10
1. Lebar kusyen (sisi ke sisi)																
2. Panjang kusyen																
3. Kontur kusyen																
4. Keselesaan Punggung																
5. Keselesaan peha																
6. Keselesaan bawah lutut																
7.Ketakselesaan disebabkan tiada sokongan lumbar (Belakang pinggang)																
8. Bentuk rekabentuk/ rupa fizikal																
9. Tekstur dan bahan sarung kusyen																
10.Tahap ketakselesaan keseluruhan																



Motosikal jenis CBX 750

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SEKIAN

-TERIMA KASIH ATAS KERJASAMA ANDA-

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APPENDIX 3

ETHICAL APPROVAL

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APPENDIX 4

APPROVAL LETTER

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APPENDIX 5

STANDARD OPERATING PROCEDURE FOR TRUPOSTURE SMART SHIRT

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Standard Operating Procedure: Posture Assessment during Riding (Truposture Smart Shirt)

1.0 Aim:

This Standard Operating Procedure (SOP) has been designed for qualitative research related to posture assessment. The aim of this SOP is to describe the standard procedures to be followed when conducting posture assessment among riders by using Truposture Smart Shirt.

2. 0 Device:

I. Truposture Smart Shirt: Embedded with 5 sensors to monitor the entire spine.

Sensor	Location on spine
1	T1
2	T8
3	L1
4	L3
5	Pelvis

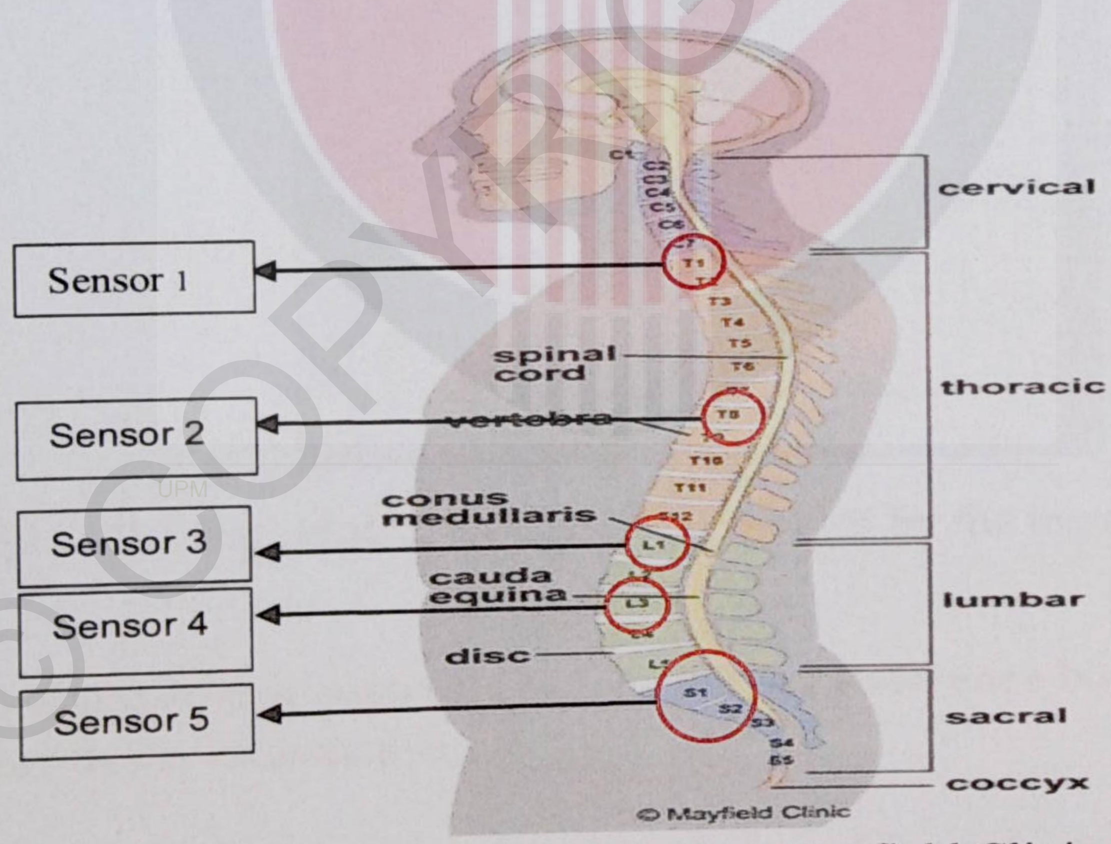

Figure 1: Spine anatomy (Source: Mayfield Clinic, 2018)

II. Smartphone (with Truposture App): Connected to Trusposture Smart Shirt via Bluetooth and it is used to monitor curvature of the spine in real-time.

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3.0 Procedure:

Posture Assessment

1. Selected respondent wears Truposture shirt comfortably on top of regular cloth/uniform. Ensure the Truposture shirt is truly fit with the body.

2. Press the **Power** button once to turn on the Truposture shirt controller.

3. Run the Truposture App and make sure Bluetooth is enabled on the smartphone. The App will scan and display the available Truposture shirt to connect. The connection is established automatically after the selection.

4. The respondent needs to sit as taught by the instructor as shown on figure 3.1 which is considered as ideal riding posture CBX 750 Motorcycle.Tthe ideal posture for CBX 750 motorcycle is sitting in an upright position, elbows are slightly bent, and lower arms are parallel to the ground.

Figure 2: Ideal posture for CBX 750 showed by the instructor

5. Ensure to maintain that posture. Click on the **Set Reference** button on the App to save that posture as the reference in memory.

6. Click on the **Record** button on the App to record the movement of entire spine and posture during riding before starting a ride.

7. The respondent needs to ride a motorcycle for 30 minutes.

8. Press the **Power** button and keep pressing for 5 seconds to turn off the Truposture shirt controller after completing a ride.

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Personal Protective Equipment (PPE)

1. Use the right personal protective equipment (PPE) for the task.

Flowchart: Posture Assessment

Respondent wears Truposture shirt under regular cloth/uniform.

Press the **Power** button once to turn on the Truposture shirt controller.

Run the Truposture App, ensure Bluetooth is enabled on the smartphone. Select the available shirt and the connection is established automatically.

Respondent sits on a motorcycle according to Standard Riding Posture (Figure 1).

Click on the **Set Reference** button on the App to save that posture as the reference while the respondent maintains that posture.

Click on the **Record** button on the App to record the movement of entire spine and posture during riding. (Before starting a ride).

Ride a motorcycle for 30 minutes.

Press the **Power** button and keep pressing for 5 seconds to turn off the Truposture shirt controller.

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