EFFECT FACTORS OF PSYCHOPHYSICAL AND BIOMECHANICAL OF UPPER QUADRANT MUSCULOSKELETAL DISORDER AMONG YOUNG DRIVERS

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MASTER OF SCIENCE IN MANUFACTURING ENGINEERING

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A thesis submitted
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DECLARATION

I declare that this thesis entitle “Effect Factors of Psychophysical and Biomechanical of Upper Quadrant Musculoskeletal Disorder among Young Drivers” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……....

Name : Intan Fatihah binti Ahmad

Date : .....

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering .

Signature : ……..

Name : Dr. Seri Rahayu binti Kamat

Date : .....

DEDICATION

To my Beloved Husband who always support me:

Mohd Zulhilmi bin Ismail

And

To my beloved parent and in-laws,

Ahmad bin Abd Razak

Roslizan binti Sulaiman

Ismail bin Karim

Zaiton binti Md Shah

To my handsome and beautiful sunshine,

Muhammad Yusuf bin Mohd Zulhilmi

Indah Zulaikha binti Mohd Zulhilmi

***To my Supervisor**,*

Dr. Seri Rahayu binti Kamat

To my Families and my Friends

Especially Adilah, Rawaida, Hafiz and others

Thanks for their love and care.

ABSTRACT

Musculoskeletal disorder is commonly associated with driver fatigue problem. Previously, various techniques were proposed to the influence of changes in physical and psychosocial conditions on musculoskeletal disorders. However, the impact factors contribute to the musculoskeletal disorder is still more to achieve. This research aims to identify impact of psychophysical experience, biomechanical and heart rate of drivers towards prevalence musculoskeletal disorder. Moreover, the relationship between presence of musculoskeletal disorder with Time, Gender, BMI and Length of Arm (LoA) will be evaluated.

Participant will be asked to driving for 30 minutes and repeat the procedure for two times. At the same time, the movement of the participant while driving will be capture by Motion Capture and video also is taken. Meantime, the Heart rate of the participant while driving is monitor. Between the replication, the participant will be given questionnaire sheet to be answered. The questionnaire sheet will be answered the part of the participant's body feeling discomfort during the experiment where this discomfort part is potential for musculoskeletal disorder prevalence.

Results identified both upper arm and lower arm problem. Biomechanical analyses found static posture of arm and undesirable wrist positions lead to discomfort. Although the results were promising, there were still some limitations that need to be overcome in future study.

ABSTRAK

Musculoskeletal disorder biasanya dikaitkan dengan masalah keletihan pemandu. Sebelum ini, pelbagai teknik telah dicadangkan mengaitkan perubahan keadaan fizikal dan psikososial pada musculoskeletal disorder. Walau bagaimanapun, banyak lagi faktor-faktor yang menyumbang kepada musculoskeletal disorder perlu dikaji. Kajian ini bertujuan untuk mengenal pasti kesan psychophysical experience, biomechanical dan kadar denyutan jantung pemandu terhadap musculoskeletal disorder. Selain itu, perkaitan antara kewujudan musculoskeletal disorder dengan Masa, Jantina, BMI dan Panjang lengan (LoA) akan dikaji.

Peserta akan diminta untuk memandu selama 30 minit dan mengulangi prosedur tersebut sebanyak dua kali. Pada masa yang sama, pergerakan peserta semasa memandu akan diambil dengan Motion Capture dan video juga diambil. Sementara itu, denyutan jantung peserta semasa memandu akan dimonitor. Peserta akan diberi lembaran soal selidik untuk dijawab setiap kali selepas eksperiment. Soal selidik ini akan menjawab bahagian tubuh yang mana peserta rasa tidak selesa semasa eksperimen di mana sebahagian ketidakselesaan ini berpotensi untuk menjadi musculoskeletal disorder.

Keputusan akhir menunjukkan peserta mengalami ketidakselesaan di bahagian lengan. Analisis daripada keputusan biomekanikal mendapati postur lengan yang static dan kedudukan pergelangan tangan di tempat yang tidak diingini membawa kepada rasa tidak selesa. Walaupun keputusan akhir dapat dicapai, beberapa batasan di dalam kajian ini perlu diatasi di kajian pada masa hadapan.

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BMI	-	Body Mass Index
CLAV	-	Clavicle
C7	-	7th Cervical Vertebra
EMG	-	Electromyogram
HR	-	Heart rate
Ht	-	Height
LELB	-	Left elbow
LFIN	-	Left finger
LFRA	-	Volumetric flow-rate
LoA	-	Length of Arm
LSHO	-	Left shoulder
LUPA	-	Left upper arm A
LUPB	-	Left upper arm B
LUPC	-	Left upper arm C
LWRA	-	Left wrist A
LWRB	-	Left wrist B
m	-	Minutes
Miros	-	Angle
mm	-	Density
Mocap	-	Malaysian Institute of Road Safety Research
MSD	-	Musculoskeletal disorder
T10	-	10th Thoracic Vertebra
UB	-	Upper Body
Wt	-	Weight

CHAPTER 1

INTRODUCTION

This chapter provides information regarding the backgrounds of the study, problems statements, objectives, research questions, scope and limitations and potential benefits of the study. This chapter also presents the outline on how the study been carried out.

1.1 Background of the research

The car has been an important transport to people nowadays. It plays significant role in moving people from one place to another in the most convenient way. It is a safe vehicle. However, many car accidents happen lately and made people worried and they had second thought whether car is a safe transport.

Table 1.1 General Road Accident Data in Malaysia (1997-2014)

(Source: Malaysian Institute of Road Safety Research)

Year	Registered Vehicles	Population	Road Crashes	Injury Severity		
				Road Deaths	Serious	Slight
1997	8,550,469	21,665,600	215,632	6,302	14,105	36,167
1998	9,141,357	22,179,500	211,037	5,740	12,068	37,896
1999	9,929,951	22,711,900	223,166	5,794	10,366	36,777
2000	10,598,804	23,263,600	250,429	6,035	9,790	34,375
2001	11,302,545	23,795,300	265,175	5,849	8,680	35,944
2002	12,068,144	24,526,500	279,711	5,891	8,425	35,236
2003	12,819,248	25,048,300	298,653	6,286	9,040	37,415
2004	13,828,889	25,580,000	326,815	6,228	9,218	38,645
2005	15,026,660	26,130,000	328,264	6,200	9,395	31,417
2006	15,790,732	26,640,000	341,252	6,287	9,253	19,885
2007	16,813,943	27,170,000	363,319	6,282	9,273	18,444
2008	17,971,901	27,730,000	373,071	6,527	8,868	16,879
2009	19,016,782	28,310,000	397,330	6,745	8,849	15,823
2010	20,188,565	28,910,000	414,421	6,872	7,781	13,616
2011	21,401,269	29,000,000	449,040	6,877	6,328	12,365
2012	22,702,221	29,300,000	462,423	6,917	5,868	11,654
2013	23,819,256	29,947,600	477,204	6,915	4,597	8,388
2014	25,101,192	30,300,000	476,196	6,674	4,432	8,598

Table 1.1 shows the statistic of road accident in Malaysia from 1997 until 2014. From the table, road crashes in Malaysia are increasing year by year.

According to Liu and Wu (2009), fatigue has been proofed to be related to road accidents which happened all over the world. Many studies have related to fatigue and some of the factors associated with fatigue are sleep deprivation and prolonged sitting. Most studies has related fatigue to 'endogenous' factors only, however only few studies focusing on 'exogenous' factor (Liu and Wu, 2009). Endogenous is related to internal factors and exogenous is about external factors.

This research will be focused on driver's hand movement while driving. Furthermore, the impact of psychophysical experience towards driver's movement and heart rate will be analyzing whether it would contribute to musculoskeletal disorder

prevalence. Moreover, gender, BMI and Time factors will be identified if they can provide to musculoskeletal disorder presence.

1.2 Problem statement

Musculoskeletal disorder has been ranked as one of health issues among Malaysian driver (Bahri et al., 2014). There have been a lot of injuries were reported that resulting direct and indirect losses to the driver. In order to overcome the problem, many researchers have focused in this area to find the factors contributing musculoskeletal prevalence such as:-

(1) Seating comfort has been found as one of contributing factor for musculoskeletal disorder. The seat adjustments are found will not only affect the comfort perception of the driver but also their feel of fatigue (Durkin et al.,2006 and Kyung et al.,2008).

(2) Psychosocial issues can contribute to musculoskeletal disorder not only to driver but also industrial worker. It is happen when they were in negative mood or carrying the heavy workload. Thus, it is important to paying attention to psychosocial conditions to reduce the musculoskeletal disorder (Fredriksson et al, 2001)

However, the number of drivers experiences the musculoskeletal disorder still not declining but increasing. Moreover, musculoskeletal disorder still be related with driver for example, posture has been stated as an important risk factor for upper limb MSDs (Finneran and O'Sullivan, 2013) such as pain in the lower back (Gallais and Ã, 2006) and shoulder (Ã et al, 2007). Furthermore, there is a minimal study in analysing impact of psychophysical experience, biomechanical and heart rate in musculoskeletal disorder prevalence for Malaysian population especially young drivers when driving.

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1.3 Objective of the research

Specifically, the aim of this research was to evaluate the prevalence of upper body musculoskeletal disorder among young drivers. To achieve the research aim, the following objectives are set:-

(1) To define the association psychophysical experience with upper quadrant musculoskeletal disorder among young drivers.

(2) To identify heart rate and biomechanical factors for hand movement while performing driving task.

(3) To appraise association psychophysical experience and biomechanical risk factor for prevalence upper quadrant musculoskeletal disorder among young drivers.

1.4 Research questions

This research will investigate the effect of heart rate, psychophysical experience and biomechanical risk factors towards upper quadrant musculoskeletal disorder.

(1) Which of body parts experienced the highest levels of discomfort when performing the driving task for first 30 minutes?

(2) Which of body parts experienced the highest levels of discomfort when performing the driving task for second 30 minutes?

(3) Which of body parts experienced the highest levels of discomfort when performing the driving task for third 30 minutes?

(4) Which gender experienced the highest discomfort when performing the driving task?

(5) Which BMI experienced the highest discomfort when performing the driving task?

(6) Did Length of Arm (LoA) affecting level of discomfort while performing the driving task?

(7) How the gender, BMI, Time and LoA can contribute to musculoskeletal disorder?

(8) What is the relationship between hand movements while driving with heart rate?

(9) How movement of hand and heart rate can contribute to musculoskeletal disorder?

(10) How psychophysical experience and biomechanical risk factor is correlates to each other and contribute to the musculoskeletal disorder?

1.5 Scope and limitations

The scope of this research is to study the psychophysical experience, biomechanical risk factor and heart rate during driving. Driving required drivers to use their hands to move the steering wheel and change the gear. Thus, the hand movement will be asses in this research as it is the most affecting body parts when perform the driving task. The participants selected are ensured to be in a good physical and health because this research needs to measure the condition of healthy participant free from a musculoskeletal disorder. The range ages of the participants are 20 to 28 years old as this age group has highest involve in the car accidents compared to other age group (Rashvinjeet S.Bedi, 2011). Moreover, the position of hand on the steering wheel will be synchronized for each participant. The road will be driving by all participants also will be

synchronized for each participant. This research also will be focused on the left hand movement because the left hand is used more force compared to the right hand (Seri R. et al.,2015).

1.6 Potential benefits

The potential benefits can be expected from the proposed study of effect factors biomechanical, psychophysical experience and heart rate are as follows:-

(1) Medical practitioners can detect the early prevalence of musculoskeletal disorder. Industrial automotive can predict the psychophysical experience, hand movement and heart rate of the driver when driving to avoid musculoskeletal disorder presence.

(2) It is also can wide knowledge more about the musculoskeletal disorder risk factor.

(3) The information will help the Automotive industries to improve their product design in order avoid the musculoskeletal disorder ensue to their customer.

(4) Methods, data and models generated by the research can be used as references for the academician for the future reference and research on musculoskeletal disorder.

1.7 Outlines of the research

This research is started with the introduction to the musculoskeletal disorder that commonly happens for drivers. Chapter one provides the background of the study, problem statements, objectives, research questions, scopes and limitations and potential benefits of the study. The main and critical objective is to find the correlation between