

## A STUDY ON MOTORCYCLIST'S RIDING DISCOMFORT IN MALAYSIA

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### ABSTRACT

Studies on discomfort among motorcyclists are seldom seen in literature. The current study was carried out using 957 respondents representing 481 males and 476 females ranging from the age of 18 to 24 years. It attempts to find out the overall discomfort score, the discomfort symptom score and the statistically significant differences on discomfort score among the male and female motorcyclists. A questionnaire survey was used to evaluate those discomfort symptoms. The results indicate that a majority of the male and female motorcyclists experienced discomfort in their body parts during the riding process. The motorcyclists mainly experienced discomfort on their upper body parts (neck or head, shoulder, upper back, arms and hands, low back and buttocks). The female compared to the male motorcyclists have expressed higher discomfort level in their thighs. Meanwhile a majority of both male and female motorcyclists have indicated no discomfort in their lower body parts (knees, calf leg below knee and ankles and feet). Meanwhile, the statistical tests indicate that there is a total of four significant differences ( $p < 0.05$ ) between the male and female motorcyclists. The significant differences were on low back, buttocks, thighs and calf leg below knees. As a conclusion, the results suggest that the motorcyclists in Malaysia do suffer from the discomfort on certain body part during riding. Therefore, this study highlights that there is a lack of motorcycle's ergonomics particularly in the context of interaction between the riders and motorcycle in Malaysia.

**Keywords:** Motorcycle, Ergonomic, Comfort, Discomfort, Body part.

### 1. INTRODUCTION

Motorcycles are considered as a highly convenient and economical means of transportation in Malaysia. Statistics from the Malaysian Road Transport Department has estimated that motorcycle and car are two of the most commonly used transports by the Malaysian. The statistics has indicated that there are a total of 8,487,451 motorcycles and 7,966,525 cars registered in Malaysia until the year 2008 (MRTD,

2009). As the popularization of motorcycles brings affluence and expediency to people's lives, primary and secondary studies on motorcycles are often regarded as top subjects in road safety in European countries (Berg *et al.*, 2005). Unfortunately, most of this research work especially in Malaysia is based on the traffic accidents (Ooi *et al.*, 2005; Shuaeib *et al.*, 2002; Pang *et al.*, 2000; Pang *et al.*, 1999; Pang *et al.*, 1999; Radin, 1994). There is limited research in Malaysia on motorcycle's ergonomics particularly in the context of interaction between the riders and motorcycle.

The International Ergonomics Association defined ergonomics as a scientific discipline to design and optimize human well-being while interacting with industrial product (Kroemer, 2006). The fundamental aim of ergonomics is to eliminate the discomfort symptom which causes low job satisfaction, activity limitation and long term disability (Perreault *et al.*, 2008).

The term comfort and discomfort in ergonomic scope is generally used by the scientific literature to highlight problems related to the 'desk work' condition (Carfagni *et al.*, 2007). However, Robertson and Porter (1987) in their research have used this term to evaluate the comfort and discomfort among the motorcyclists. Relatively the existence of this discomfort on motorcyclist's body parts can be related to the lack of ergonomically interaction of human and machine (motorcycle) in the riding environment (Karmegam *et al.*, 2008; Robertson and Minter, 1996; Robertson and Porter 1987; Robertson, 1986).

The subjective measurements are one of the important methods in measuring the discomfort or comfort level in the respective user. There is a variety of measuring scale for discomfort and comfort levels such as using continuous scale (moving from the extreme comfort to the extreme discomfort) and by considering the two extremities as different discrete states (defined as presence or absence of comfort) (Carfagni *et al.*,

2007). The most common subjective method to assess discomfort is using a body map (Carfagni *et al.*, 2007; Goonetilleke *et al.*, 2001; Lusted *et al.*, 1994; Kuorinka *et al.*, 1987; Corlett and Bishop, 1976). Generally, the participants are required to rate their discomfort (scale from no discomfort to extreme discomfort) level on the given body map (Kuijt-Evers, 2009; Lusted *et al.*, 1994).

Motorcycle is considered as a very interesting scope of study to the researchers and ergonomists in the field of transportation. There is a need to satisfy the motorcyclists in a constrained workstation (motorcycle) where there are very limited adjustments to suit the different need of riders (Robertson and Minter, 1996; Robertson, 1986; Robertson and Porter, 1987). Literature review has highlighted that, there is high frequency of car drivers exposed to discomfort during their driving process which leads to the musculoskeletal symptom on their body parts (Porter and Gyi, 2002). In motorcycle, this can be related to the biomechanical aspect of the riders seating condition. Sitting involves a set of a very complex action and the posture cannot be maintained without discomfort (Motavalli and Ahmad, 1993). These phenomena can also be answered if a further research on the factors affecting the automobile seat comfort (vehicle/package, social, individual and seat factors) can be carried out (Thakurta *et al.*, 1995; Kolich, 2008).

However, there is no research has been undertaken to evaluate the discomfort and comfort levels among the motorcyclists during their riding process. Therefore, this study was undertaken in order to highlight the comfort and discomfort levels surrounding the motorcyclists. The objective of this study was to determine the overall discomfort score, to identify the discomfort symptoms on body parts and to identify the statistically significant differences on discomfort score among the male and female motorcyclists.

## 2. METHODOLOGY

### 2.1 Study model

This is a survey study conducted through quantitative analysis aiming at determining the discomfort symptoms experienced by the motorcyclists and the comparison of body symptoms among the male and female motorcyclists.

### 2.2 Population and sample of the study

The population of this study was selected among the students in Polytechnic of Sultan Azlan Shah, Perak, Malaysia. The students were selected randomly from the polytechnic student's database system. A total of 4227 students were registered with this polytechnic in January 2009 session. A total 500 males and 500 female students were randomly selected as sample size for this study. This total of students is more than appropriate sample size for this study (Krejcie and

Morgan, 1970). For the purpose of this study, the non-motorcyclist students and those having history of musculoskeletal disorder diseases were excluded from this study. There are a total of 13 non-motorcyclists in this sample size group.

The selected students were called for a briefing session at the initial stage of this study. The students were informed on the aim and objective of this study. They were also informed that this is a voluntary basic study and they can opt to pull out from this study if they need or wish to. The survey forms were distributed to the students at this initial stage. The students were request to return the forms after one week (final stage). The one week duration was given in order that the students can provide an effective answer to the required questions in the survey form.

In the final stage, the return ratio of the surveys was 95.7%. A total of 957 complete survey forms from the students were collected. A total of 22 survey forms were invalid as they were not answered properly and 8 survey forms were not returned by the students.

### 2.3 The data collection instrument

A survey method was used to collect data within the scope of the study. There are two parts in the survey questionnaire. The first part was to determine the personal information of the motorcyclists participated in the study. In the second part, previous research work by Goonetilleke *et al.* (2001), Lusted *et al.* (1994) and Kuorinka *et al.* (1987) were adapted with the aim of determining the symptoms of discomforts experienced by the motorcyclists. It consists of a discomfort checklist questionnaire in the form of body chart (Figure 1). The score rating of each discomfort symptom was carried out according to the checklist.

In order to determine the validity, the questionnaire was submitted to the experts in the field and based from their opinions necessary revision was done. The revised questionnaire was tested on a small research group. The value of coefficient of Cronbach alpha was examined in order to test the reliability of the survey. The analysis revealed that the alpha value of 20 items as 0.934. The coefficient of alpha between 0.80 to 1.00 means that it is highly reliable (Gultekin, 2006; Ozdamar, 1997). The latest revised questionnaire was used to collect data from the selected student's population.

## 3. RESULTS AND DISCUSSION

Before analyzing the data, the returned questionnaires were checked individually and the ones that were not answered properly and those that reported of having history of musculoskeletal disorder diseases were excluded from this study. A total of 957 (95.7%) completed and valid questionnaires were returned by the respondents.

In order to determine the overall symptom of discomforts, the average of arithmetic total score (on both left and right sides of the body) given by the motorcyclists were calculated (total score III in Figure 1). The average of arithmetic score distributions (total scores I and II in Figure 1) of the discomfort symptoms experienced by motorcyclist on their body parts were also calculated. Findings were evaluated on the following simplified score rating groups; score 0 to 1.49 = No discomfort (1), score 1.50 to 3.49 = Discomfort (2) and score 3.50 to 5.00 = Very uncomfortable (3).

In the analysis of the data, apart from arithmetic scores, independent *t* test for paired comparisons were also applied. The significance level was accepted as 0.05 in the analyses.

### 3.1 Characteristics of respondent's motorcyclists

Table 1 presents the characteristics of the responded motorcyclists. A total of 481 male and 476 females participated in this study. Their ages ranged from 18 to 24 years. The means for height are 167.81 cm and 158.57 cm respectively for the males and females. The riding experience for male motorcyclist is ranged from 2 to 10 years with a mean of 5.76 and standard deviation of 2.45 years. Meanwhile, the riding experience for female motorcyclist is also ranged from 1 to 10 years with mean of 4.24 years and standard deviation of 2.68 years.

### 3.2 Discomfort symptoms experienced by the motorcyclists

Table 2 and Figure 2 highlight the overall score rating of discomfort symptoms experienced by the male and female motorcyclists respectively. The results indicate that more than 50% of the male and female motorcyclists of having discomfort symptoms during the riding process. It should also be noted that there is a small percentage of 1.87 and 1.26 of male and female respectively to be reported of having very uncomfortable experience of discomforts on their bodies. Meanwhile, 47.82% of male and 43.28% of female motorcyclists have been identified of having no discomfort in their body parts.

### 3.3 Discomfort rating symptoms experienced by the motorcyclists

The results of discomfort symptoms experienced by a total of 957 motorcyclists (481 males and 476 females) are presented in Table 3 and Figure 3. It represents the rating of discomfort symptoms on each of their body parts. The results indicated that the male and female motorcyclists experienced a similar type of discomfort symptoms during the riding process. The results also highlight that the male and female motorcyclists have reported to experience discomfort in all of their body parts.

The male and female motorcyclists have reported of having experienced discomfort (score rating of 2) in the neck or head (male: 51.35%; female: 50.21%), shoulder (male: 55.30%; female: 50.00%), upper back (male: 53.85%; female: 50.00%) and low back (male: 52.39%; female: 50.21%). Meanwhile, more than 50% of the female motorcyclists have experienced discomfort in arms or hands and buttocks, whereas less than 50% of male were reported of having these symptoms.

The no discomfort symptoms are identified by the score rating of 1. The male and female motorcyclists have identified knees (male: 54.26%; female: 49.58%), calf leg below knees (male: 59.88%; female: 47.27%) and ankles or feet (male: 55.30%; female: 54.20%) as having the less discomfort in their body parts.

It is also important to highlight that higher percentage of female motorcyclists (50.84%) have reported to experience discomfort in the thighs compared to male (40.12%). Meanwhile, 51.35% of male have been reported of having less discomfort experienced in their thighs compared to female (38.03%) motorcyclists.

The score rating of 3 represents the most 'very uncomfortable' symptoms experienced by the motorcyclists. The male and female motorcyclists have indicated that they experienced the most uncomfortable symptoms in their low back and buttocks. A total of 27.23% of female and 22.69% of male motorcyclists have been reported of having these uncomfortable symptoms in their low back. Meanwhile, 32.64% of male and 23.11% female are having this uncomfortable symptom in their buttocks.

### 3.4 Comparison of discomfort symptoms among the male and female motorcyclists

The independent t-test was conducted in order to determine whether there is a statistically significant difference between the male and female motorcyclists regarding their reported discomfort symptoms (Table 5). The results indicate that there are a total of four significance differences in the score rating of discomfort between the male and female motorcyclists.

The significant differences were found in low back, buttock, thigh and calf leg below knee. The mean discomfort scores of low back between male and female motorcyclists differed significantly ( $t=2.505$ ,  $df=955$ ,  $p<0.05$ ) with the male score being significantly higher than the female mean. Similarly, the buttocks discomfort score for male are significantly higher than the female mean score with significant differences ( $t=2.047$ ,  $df=955$ ,  $p<0.05$ ) between them.

The mean discomfort score for female on thighs and calf leg below knee are significantly higher than the male mean score. The significant differences on thighs ( $t=-3.812$ ,  $df=955$ ,  $p<0.01$ ) and calf leg below knee ( $t=-3.501$ ,  $df=955$ ,  $p<0.01$ ) was recorded between the male and female motorcyclists.

The findings in Table 4 also shows that there is no significant differences in other male and female motorcyclist's body parts such as neck, shoulder, upper back, arm and hand, knee or ankle and feet.

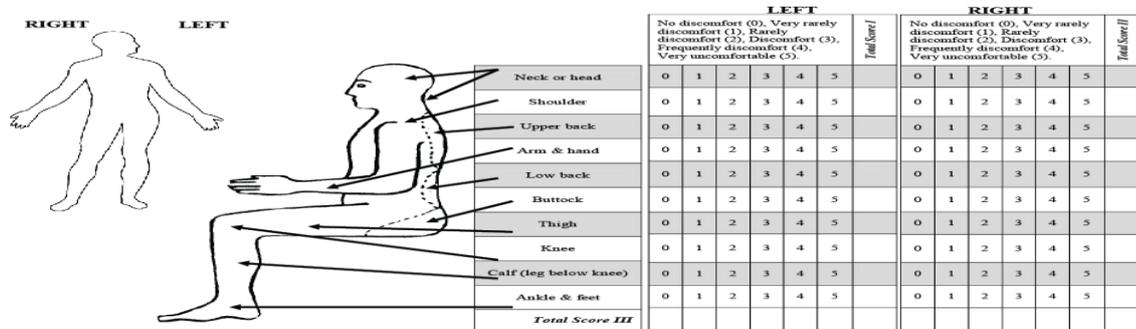


Figure 1: The body chart discomfort checklist (adapted from (Pang et al., 1999; Pang et al., 2000; Perreault et al., 2008).

Table 1: Characteristics of the respondent motorcyclists (n = 957)

Characteristics	Male (n = 481)				Female (n = 476)			
	Min	Max	Mean	Std dev.	Min	Max	Mean	Std dev.
Age (years)	18.00	24.00	20.59	1.21	18.00	24.00	20.48	1.19
Height (cm)	110.00	192.00	167.81	8.57	143.00	185.00	158.57	6.61
Weight (kg)	38.00	115.00	62.89	12.73	35.00	110.00	51.88	9.13
Riding experience	2.00	10.00	5.76	2.45	1.00	10.00	4.24	2.68

Table 2: Total score on discomfort symptoms by motorcyclists

Discomfort score rating	Male		Female	
	N	%	N	%
No discomfort (1)	230	47,82	206	43,28
Discomfort (2)	242	50,31	264	55,46
Very uncomfortable (3)	9	1,87	6	1,26
Total	481	100	476	100

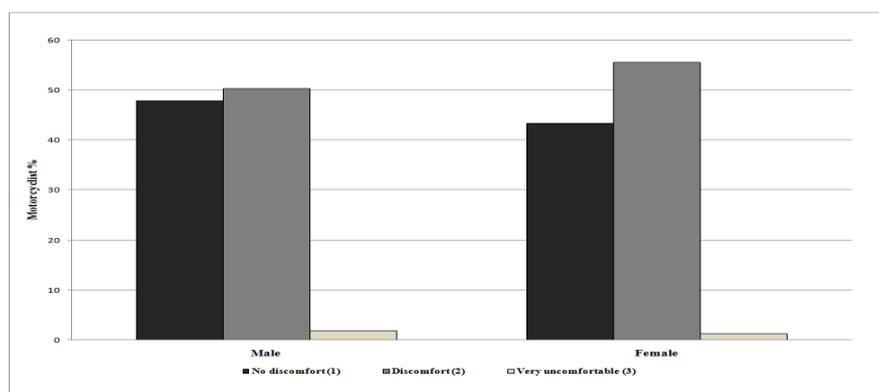


Figure 2: Score rating of motorcyclist's discomfort

Table 3: Rating on discomforts symptoms by motorcycleists (n = 481)

Body Part	Score rating	Male		Female	
		N	%	N	%
Neck or head	1	162	33,68	176	36,97
	2	247	51,35	239	50,21
	3	72	14,97	61	12,82
	Total	481	100	476	100
Shoulder	1	151	31,39	168	35,29
	2	266	55,30	238	50,00
	3	64	13,31	70	14,71
	Total	481	100	476	100
Upper back	1	139	28,90	151	31,72
	2	259	53,85	238	50,00
	3	83	17,26	87	18,28
	Total	481	100	476	100
Arm and hand	1	188	39,09	170	35,71
	2	224	46,57	250	52,52
	3	69	14,35	56	11,76
	Total	481	100	476	100
Low back	1	98	20,37	129	27,10
	2	252	52,39	239	50,21
	3	131	27,23	108	22,69
	Total	481	100	476	100
Buttock	1	119	24,74	118	24,79
	2	205	42,62	248	52,10
	3	157	32,64	110	23,11
	Total	481	100	476	100
Thigh	1	247	51,35	181	38,03
	2	193	40,12	242	50,84
	3	41	8,52	53	11,13
	Total	481	100	476	100
Knee	1	261	54,26	236	49,58
	2	187	38,88	206	43,28
	3	33	6,86	34	7,14
	Total	481	100	476	100
Calf leg below knee	1	288	59,88	225	47,27
	2	164	34,10	216	45,38
	3	29	6,03	35	7,35
	Total	481	100	476	100
Ankle and feet	1	266	55,30	258	54,20
	2	174	36,17	180	37,82
	3	41	8,52	38	7,98
	Total	481	100	476	100

Rating scale: 1= No discomfort; 2 = Discomfort; 3 = Very uncomfortable.

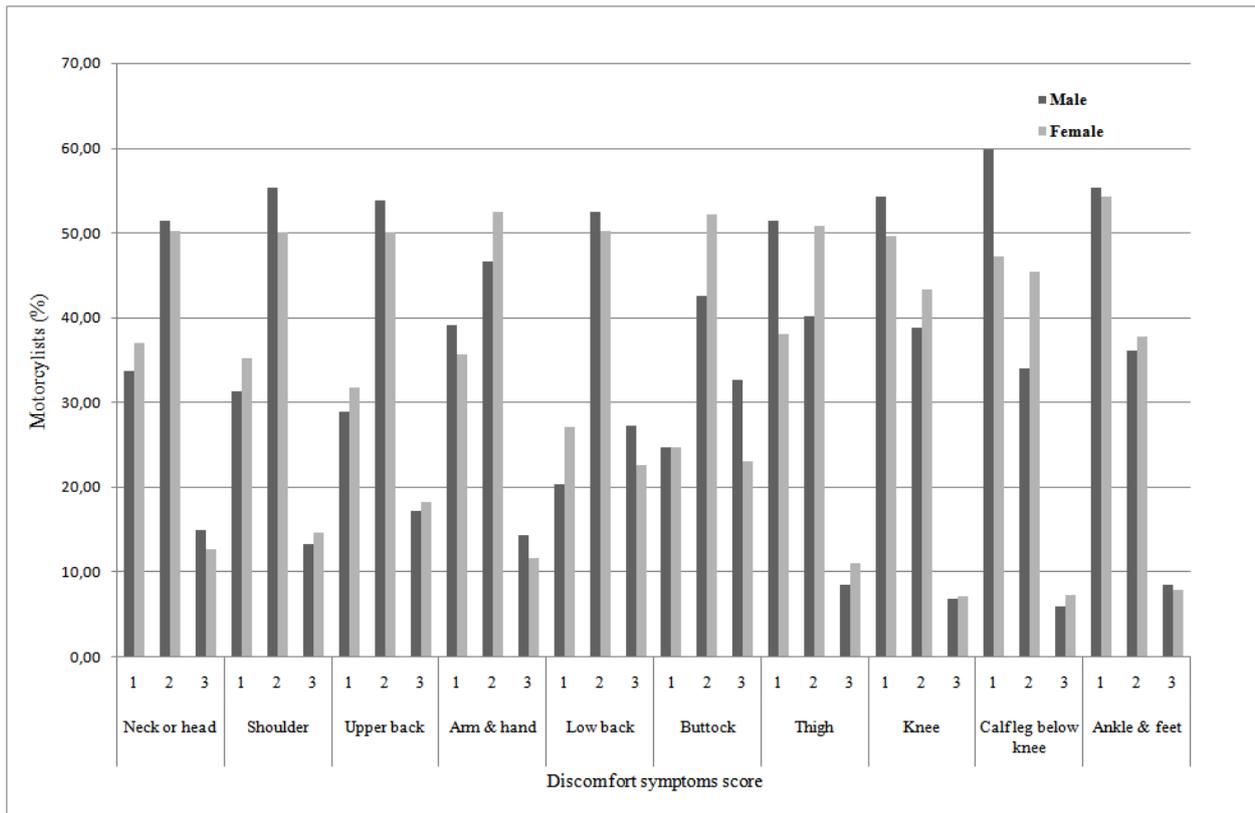


Figure 3: Motorcyclists discomfort symptom score rating

Table 4: Comparison of body symptoms among the male and female motorcyclists (n = 957)

Body Part	Levene's Test for Equality of Variances		t-test for Equality of Means			Mean Difference
	F	Sig.	T	df	Sig. (2-tailed)	
Neck or head	0,304	0,581	1,261	955	0,208	0,054
Shoulder	3,485	0,062	0,585	955	0,558	0,025
Upper back	1,923	0,166	0,409	955	0,683	0,018
Arm and hand	3,894	0,049	-0,183	955	0,855	-0,008
Low back	0,126	0,723	2,505	955	0,012*	0,113
Buttock	13,826	0,000	2,047	955	0,041*	0,096
Thigh	2,572	0,109	-3,812	955	0,000*	-0,159
Knee	0,000	0,999	-1,233	955	0,218	-0,050
Calf leg below knee	0,877	0,349	-3,501	955	0,000*	-0,139
Ankle and feet	0,108	0,743	-0,134	955	0,893	-0,006

\*significant at  $p < 0.05$

#### 4. CONCLUSIONS

The survey on motorcyclist's discomfort in Malaysia were collected, analyzed and summarized in order to achieve the three objectives of this study. The results indicated that majority of male and female motorcyclists experienced discomfort in their body parts during their riding process. The results also indicated that the motorcyclist mainly experienced discomfort on their upper body parts (neck or head, shoulder, upper back, arm and hand, low back and buttock) and whereas majority expressed no discomfort in their lower body part (knee, calf leg below knee and ankle and feet). The statistical test have indicated that there is a total of four significant differences ( $p < 0.05$ ) (low back, buttock, thigh and calf leg below knee) among the male and female motorcyclists. These significant differences indicate that individual factors such as anthropometry and gender do have effect on the motorcyclist sitting comfortability. Therefore, these study findings can be useful for the designers in the automobile (motorcycle) industry in order to enhance the ergonomic relationship between the human (riders) and motorcycle.

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