

MOTORCYCLISTS VS CAR DRIVERS: QUANTIFYING THE MAGNITUDE OF VEHICULAR DISCOMFORTS EXPERIENCED BETWEEN OPERATING A MOTORCYCLE AND A CAR

Article history

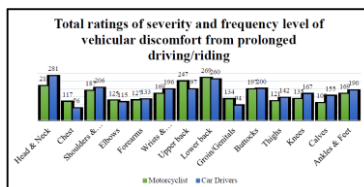
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Graphical abstract



Abstract

Vehicular discomforts are a type of discomforts experienced by a human operator upon operating a vehicle. This type of discomfort could prevail both physically and physiologically. Generally, it could be said that vehicular discomfort is almost inevitable for all vehicles. Even so, from the preliminary studies, it was found that it is a norm for the Malaysian public to have a preconception that a motorcycle possessed a higher degree of vehicular discomfort than as opposed to a car. Hence, this study was made in order to test the validity of this cognitive linkage made by the public. The aim of this research was to quantify the magnitude of differences between the vehicular discomfort experienced between operating a motorcycle and a car. In addition, the sources of vehicular discomfort of these two modes of transportation were also identified. The methods used for this study were working posture assessment and survey studies (consisting of a questionnaire study and semi-structured interviews). From the selected research methodology, it was found that both types of vehicles showed an almost similar vehicular discomfort patterns. Even so, the sources of vehicular discomfort presented by these two types of vehicles are unique. By identifying the sources of vehicular discomfort given by these two types of vehicles, further ergonomics improvements could be implemented and more in-depth research could be performed.

Keywords: Motorcycle, car, ergonomics, vehicle, discomforts

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1.0 INTRODUCTION

1.1 Motorcycling & Motorcycle Ergonomics

Car and motorcycle are considered as the most vehicle that are mainly used around the world [1, 2]. In the industrialized world, the demand for these two vehicles have grown substantially in the last decade [3]. Nevertheless, one of the most prominent effects on human upon operating any types of vehicles is

vehicular discomfort. Generally, vehicular discomfort is almost inevitable for all vehicles. Even so, it was found from the preliminary studies that the Malaysian public to have a preconception that a motorcycle possessed a higher degree of vehicular discomfort in comparison with a car. The aim of this research was to quantify the magnitude of differences between the vehicular discomfort experienced between operating a motorcycle and a car. From this study, the validity of the cognitive preconception made by the public could be tested. In addition, the sources of vehicular

discomfort for these two modes of transportation were also identified.

1.2 Review on Vehicular Discomfort Literature

Vehicular discomfort is defined as a type of physical, physiological and psychological discomforts that prevails, thus, experienced by a human operator from operating a vehicle. From here and in retrospect to the risk factors outlined by Mehta and Tewari (2000), suggestively, most of the effects given by the risk factors on a human operator could be controlled or minimized via a better workstation design [4]. By improving the workstation design, it is anticipated that the issues concerning the working posture and the nature in performing the work could be controlled and/or improved.

With respect to vehicular workstation design, most studies focused on the seat. One major reason for such occurrence is because the seat design would influence the overall level of comfort while operating the vehicle. A full backrest would serve as channel for the distribution of the static loading and force exerted by the human operator's body [4-6]. Minimal issue is found in applying the recommendations given by the literatures for seat designs to a vehicle such as a car. For a car, the seat is complete with a full-back rest. For motorcycles, the seat is generally without any backrest. Without the availability of sufficient lumbar support it was reported by the study on a significant increase of muscular activity in the upper body region, thus, results in discomfort. The findings given by these literatures [7] justified the need or significant impact given by the back rest with respect to the human operator's well-being. Prolonged exposure or in experiencing vehicular discomforts could lead to a more serious impact – mainly the prevalence of musculoskeletal disorders.

2.0 RESEARCH METHODOLOGY

2.1 Questionnaire Study

The objective of the survey study was to determine the public motorcyclists' and drivers' perception on vehicular discomfort for variable body regions. The respondents for the survey study were the

undergraduate students from the Universiti Teknologi MARA, Malaysia. Since the population size is considerably huge, in assuming a 95% confidence level, 0.5 standard of deviation, and a margin of error of +/-1.5, the sample size for the questionnaire study was 50 respondents. The pre-determined inclusion criteria for the respondents are as follow:

- i. Male in gender.
- ii. 18 years old and above.
- iii. The respondent has more than 1 year of experience in driving/motorcycling.
- iv. The respondents must be healthy during the time of the survey.

2.2 Semi-Structured Interview

The objective of the semi-structured interview was to gather more in-depth information, opinions, suggestions and recommendation with respect to vehicular discomfort in operating motorcycles and cars. The total of 6 respondents (three riders and three drivers) was interviewed. The pre-determined inclusion criteria for the respondents are as follow:

- i. Male in gender.
- ii. 21years old and above.
- iii. The respondent has more than 5 year of experience in driving/motorcycling.
- iv. The respondents must be healthy during the time of the survey.

Similarly, prior to the interview, the respondents were given brief description on the objectives of the interview, but, not its true nature by the author. The interview session averagely took 35 minutes to be completed in answering 10 structured questions.

3.0 RESULTS AND DISCUSSION

3.1 Results

Table 1 and Table 2 show the demographics of height, weight, age and driving/riding experience of respondents for this study. Figure 1 shows the total ratings of severity and frequency level of vehicular discomfort from prolonged driving/riding with respect to body regions which were found by this study.

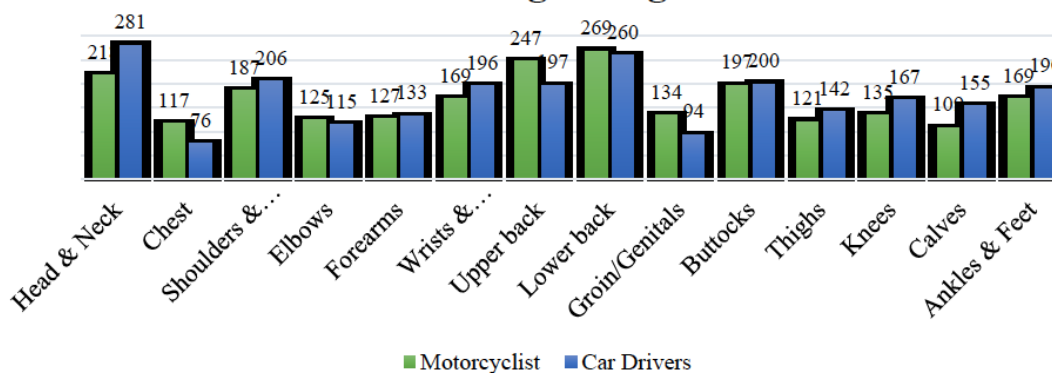
Table 1 Demographics of height and weight of respondents

Group of respondents	Height (cm)			Weight (kg)		
	Mean	SD	Range	Mean	SD	Range
Motorcyclists (n=50)	171.22	5.30	161 - 186	67.48	13.41	48 - 110
Car Drivers (n=50)	167.56	7.58	151 - 182	59.74	12.67	40 - 88
Total (n=100)	169.39	6.54	151 - 186	63.61	13.05	40 - 110

Table 2 Demographics of age and driving/riding experience of respondents

Group of respondents	Age (year)			Driving/riding experience (year)		
	Mean	SD	Range	Mean	SD	Range
Motorcyclists (n=50)	22.12	1.41	20 - 27	7.56	4.07	1 - 16
Car Drivers (n=50)	21.66	1.79	20 - 28	4.26	3.65	1 - 23
Total (n=100)	21.89	1.61	20 - 26	5.91	3.86	1 - 23

Total ratings of severity and frequency level of vehicular discomfort from prolonged driving/riding

**Figure 1** Graph of total ratings of severity and frequency level of vehicular discomfort from prolonged driving/riding

3.2 Discussion

The aim of this research was to quantify the magnitude of differences between the vehicular discomfort experienced between operating a motorcycle and a car. From this study, the validity of the cognitive preconception made by the public could be tested. From the result (see Figure 3) the total ratings of severity and frequency level of vehicular discomfort from prolonged driving/riding were almost identical. Interestingly, out of the 14 body regions, 9 body regions (head & neck, shoulders & arms, forearms, wrists & hands, buttocks, thighs, knees, calves, and ankles and feet) recorded higher total ratings of severity and frequency level of vehicular discomfort for car as opposed to motorcycle. The total ratings of severity and frequency level of vehicular discomfort for motorcycle only showed a higher level than a car for the torso region and groin. This result shows certain level of contradictory value with respect to the cognitive preconception made by the public on vehicular discomfort between these two modes of transportations.

Therefore, in triangulating the findings of this study with the literature, it was concluded that the key sources of vehicular discomfort between motorcycle and car are differ from another. The key sources of vehicular discomforts for a motorcycle are: (i) the

riding posture, (ii) the absent of a full-back support, and (iii) the exposure to the external riding elements. Whilst, for a car, the key sources of vehicular discomforts are: (i) the static sitting posture, and (ii) pressure distribution from surface contact due to sitting. The differences in the key sources or reasons of vehicular discomfort are the factor that separates the prevalence of vehicular discomfort to these two vehicles, though, the pattern of the body regions affected may be almost similar.

For a motorcycle, the combined factor of the working posture practiced (the riding posture) and the absent of full-back support, would result in physical and physiological issues closely associated with physical loading and muscular activation. These issues prevailed from the need to practice and maintain the riding posture independently without much support provided by the cockpit (workstation design). Hence, this results the upper body region such as the upper, middle and lower back to experience higher level of discomfort. Similar finding was also reported in noting the body regions affected by vehicular discomfort [8].

Some may contemplate that if the lack of sufficient backrest is an issue to motorcycle; then have the motorcycle to be integrated with a full-back support – just like a car. Well, indeed this is a welcoming idea. Study already proven that the level of comfort did improve with only just a minimal lumbar support [8]. If

a full-backrest is integrated to a motorcycle, hence, a greater comfort could be achieved. From the perspective of comfort, this is factual. However, from the perspective of the nature of the work (motorcycling work tasks) is slightly contradictory. For a human operator to perform the synchronized body motion in order to manoeuvre and control, the human operator's entire body must be mobile i.e. not restricted in term of motion, and constantly at ready (musculoskeletal system is not at complete rest). The existence of a full-back rest is strongly not recommended since such integration would greatly hinder the human operator (the motorcyclist) to be mobile and ready.

Additionally, due to being an un-enclosed vehicle, while operating a motorcycle, the human operator will be exposed to the external riding elements. From past research, it is noted this in describing the second stage of human and motorcycle interface – the Human-Machine-Environment Interface (HMEI) stage[9]. Examples of the external riding elements are vibration, shocks and jerk, climate and weather. One of the most critical external riding elements that directly related to vehicular discomfort is the windblast. Although still dependent on the aerodynamics characteristics of the motorcycle used, the present of windblasts will affect the human operator with respect to practicing and maintaining the riding posture. If the aerodynamics characteristics of the motorcycle used is challenging, then the human operator is anticipated to exert higher muscular activation in order to maintain the riding posture. This occurs since now the human operator has the need to simultaneously resist the thrusting force provided by the windblasts and maintaining the riding posture independently without support. This in return is anticipated to facilitate the occurrence of vehicular discomfort.

For a car, as noted earlier, although most of the body regions are supported by the seat, result still showed that car drivers actually experienced slightly higher physical and physiological discomforts as opposed to motorcyclists. Due to this working condition (the human operator body is almost fully supported), the working posture became static. As noted in the case of motorcycling, the backrest – in supporting the human operator's body, would hinder the human operator from being physically mobile. The musculoskeletal system is too well rested, thus, making it challenging for the human operator to be mobile. Furthermore, from the support provided by the seat, pressure distribution would persist with respect to the body regions which are in contact with the cockpit (most prominently the car seat). The pressure from surface contact with the cockpit would affect the human operator's physiological system, for example with regards to blood circulation. This would eventually (from prolonged driving sessions) lead to vehicular discomfort. From the interview study, the symptoms of numbness and cramped on the lower body portions were repeatedly reported by the respondents.

From the interview study, it was apparent that the vehicular discomfort indeed affects a human operator both physically and physiologically. Vehicle discomforts are also a localized and transient type discomforts. Commonly, only the body parts which have the highest frequency of usage are affected and the discomfort diminished after a few hours or days (less than 3 days after operating the vehicle for prolonged sessions i.e. more than 2 hours). Furthermore, vehicular discomfort could be the result of various independent or dependent variables such as working posture, workstation design, the work; and even other means such as vibration, shocks and jerks which originated from the external environment. It was also reported and personally experienced by one of the respondents that prolonged exposure to the source of vehicular discomfort could lead to musculoskeletal disorders.

In summary, it was found that the differences in the magnitude of vehicular discomforts experienced between operating a motorcycle and a car is very small. From the result of this study, both vehicles showed almost a similar pattern of vehicular discomfort. In fact, from the survey study, car drivers showed higher level of vehicular discomfort as oppose to motorcyclist. Even so, although the pattern of the vehicular discomfort experienced may be similar, the sources or the causes for these two types of vehicles differ greatly.

4.0 CONCLUSION

Conclusively, in contrast to expectation, both motorcycle and car showed almost similar level of vehicular discomforts. In operating a motorcycle, the most prominent body region affected are the torso (upper, middle and lower back), whilst, from operating a car, almost the whole body is affected. Thus, this study justified that there are little different of vehicular discomforts patterns between these two distinct vehicles. Even so, the sources of vehicular discomforts presented by these two types of vehicles are unique. By identifying the sources of vehicular discomforts given by these two types of vehicles, further ergonomics improvements could be implemented and more in depth research could be performed.

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