

**UNIVERSITI TEKNOLOGI MARA**

**MOTORCYCLIST MUSCLE  
FATIGUE DECISION SUPPORT  
TOOLS IN PROLONGED  
MOTORCYCLE RIDING**

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Thesis submitted in fulfillment  
of the requirements for the degree of  
**Doctor of Philosophy**  
**(Mechanical Engineering)**

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## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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## ABSTRACT

Motorcycle has been known to be a popular type of road transport globally. Increase of motorcycle numbers on the road has been associated with the increase of motorcycle road accidents significantly. Even though vast studies have suggested various countermeasures, the increment continuously spikes every year all around the globe. For that reason, this study ventures into the scientific exploration and explanation of human factors in motorcycling concerning muscle fatigue in prolonged motorcycle riding. Beginning with a theoretical framework adapted from several established studies, an extended risk factors theory of Human-Machine-Environment Interaction (HMEI) anchored this study via three main phases. Quantitative method was used in initial data collection through questionnaire survey involving 330 male motorcyclist respondents. A pilot on-road motorcycle riding experiment was also conducted involving one male motorcyclist which also used a wireless surface electromyography (sEMG) system to measure the respondent's muscle activities. This resulted to the establishment of a full-scale HMEI indoor motorcycle simulator facility. The first phase successfully identified four major motorcyclist's muscle groups which linked to muscle fatigue namely; Extensor Carpi Radialis (forearm), Trapezius (shoulder), Latissimus Dorsi (middle back), and Erector Spinae (lower back). This leads to the achievement of the first study's objective. The second phase involved comprehensive experimental procedures involving extensive prolonged motorcycle riding simulations and sEMG measurements with a group of 30 male motorcyclist respondents. The muscles' time-to-fatigue of 1 hour 27.5 minutes from the simulations was acquired. It was then compared with the questionnaire survey's time-to-fatigue of 1 hour 32.1 minutes. Eventually the optimum duration of riding time was determined with a duration of 1 hour 25 minutes. This lead to the achievement of the study's second objective. The preceding information were then used to develop the decision support tools in the third phase comprising of a motorcyclist ergonomics assessment tool and a motorcycle riding guidelines namely; Safe Prolonged Riding Index Tool (SPRInT) and Prolonged Riding (ProRIDE) Guideline, respectively. A stretching exercise for motorcyclist muscle fatigue management was introduced in the ProRIDE Guideline namely; ABStretch (arms, back and shoulders stretching) exercise. The SPRInT was acknowledged to be viable by potential end users, whereas the ABStretch exercise was validated via sEMG measurements in another prolonged motorcycle riding simulations involving another 5 male motorcyclist respondents. Validation results show that the time-to-fatigue managed to be extended to approximately another 10-30 minutes longer. The SPRInT was further included inside the ProRIDE Guideline before being printed into a brief booklet. This leads to the achievement of the study's third objective and novelties before final conclusions of the whole study were presented. Several recommendations were also proposed to further expand this study in the future. To wrap up the whole study, it is hoped that these contributions will further help motorcyclists to ride better and safer on the roads besides catalysing future research in the motorcycle ergonomics niche area.

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