Musculoskeletal Disorders (MSDs) among Non-Occupational Motorcyclists: What are the issues?

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Abstract: Musculoskeletal disorders (MSDs) related to occupational work or termed as WMSDs are the most common health issues that are experienced by many workers. Either due to the human errors or inconvenient and faulty workplaces, this illness has caused both employers and employees great economic losses. However, when observing the prevalence of MSDs among motorcyclists, again the focus was put among those that use motorcycles during their duties making it very much work-related. For example, police riders, postal delivery workers, and currently food delivery services. But how about those non-occupational motorcyclists or commuting workers or students that only use their motorcycle to commute to work, riding to class or weekend-motorcyclists going for prolonged motorcycle rides? Upon this matter, it became the motivation of this study to look into the possibilities of MSDs prevalence especially related to muscle fatigue among these groups of motorcyclists based on a survey and indoor prolonged motorcycle riding simulations that were conducted earlier. This includes how education and proper training could help them to reduce the risk of experiencing MSDs. Outcomes of this study suggested several other MSD issues that are possible to take place involving other body regions and establishing a prolonged riding guideline could educate them to be more aware of this issue. These possible MSDs were found to not being highlighted in work-related MSDs literature with respect to motorcyclists and very few detailed guidelines are available to educate motorcyclists for a much safer prolonged riding which provide gaps for further investigation and validation.

Keywords: Guidelines, Low back pain (LBP), Motorcyclists, Muscle fatigue, Musculoskeletal disorders (MSDs) Prolonged riding.

1. Introduction

Riding a motorcycle for either work-related purpose, commuting or even leisure have always been risky for the most vulnerable road user; motorcyclists, both male and female (Abdul Rahman, 2012; Crundall, Van Loon, Stedmon, & Crundall, 2013). Not only these groups of road users are directly exposed to the road environments and hazards during an event of a crash, but they are also prone to experience a health issue that may lead to the same event or even worse; fatality. Being known that

riding a motorcycle is physically and mentally demanding (Horberry, Hutchins, & Tong, 2008), motorcyclists are required to be fit to enable them to steer and control their motorcycle safely and properly.

However, when the demanding work tasks of steering and controlling a motorcycle are coupled with the motorcyclist's nature of occupational work during duty, the risk to be involved in a road crash is much higher. Not only that, the prevalence of experiencing musculoskeletal disorders (MSDs) among them shares the same level of risk either it is work-related or not (Mohammad Yusof, 2016; Mohd Hafzi, Rohayu, Noor Faradila, & Wong, 2011). This is where many studies have focused into this road user's health issue especially those involving occupational motorcyclists for example police riders, postal delivery workers and also food delivery service workers (Athirah Diyana et al., 2019; Braga, Trombini-Souza, Skrapec, Queiroz, Sotero, & Silv, 2018; Mohammad Yusof, 2016; Mohammad Yusof, Karuppiah, Rasdi, Sambasivam, Mohd Tamrin, Mani, & Azmi, 2017; Umi, Karmegam, Shamsul, Irniza, & Ayuni, 2014).

Nevertheless, statistics have shown that motorcycle road crashes that also involve commuting accident cases along with non-occupational related accidents do contribute to the increasing numbers every year (Abidin, 2019; World Health Organization, 2015, 2018). Not only that, age factor also does contribute to such events. This could be seen from the statistics being recorded between 2011 to 2015 in Malaysia which showed that motorcyclists between 16-25 years age category presents 8,136 deaths in total (Jabatan Keselamatan Jalan Raya Malaysia, 2016) which portrays a comparable match within the age group testified in the WHO (2015) report. More worrying, motorcyclists within the median age range from the statistics mostly involved students from both high schools and higher learning institutions. In addition, a report by the Road Transport Department (JPJ) Malaysia in 2016 did mentioned that approximately 80% of 117,000 teenager students nationwide are riding motorcycles without license daily (Star, 2016).

Hence, it is also vital to look into the prevalence of MSDs with respect to Human Factors and Ergonomics (HFE) for these groups of motorcyclists that are not rooted from work-related causations with many cases highly involved in the young generations. Therefore, in an effort to look into this matter, researchers at the Motorcycle Engineering Technology Laboratory (METAL), Faculty of Mechanical Engineering, Universiti Teknologi MARA (UiTM), Malaysia, have made several prior studies involving both qualitative and quantitative methods in collecting data to support this study. However as a higher learning institution, efforts in promoting and instilling such safety awareness that are not in the curriculum syllabus is quite challenging (Edwards, 2018) without such studies like this. Therefore, as HFE is already part of the Mechanical Engineering education in UiTM, it could be used as a platform to instill and spread the awareness of motorcycle safety issues among the students along with teaching the main core of engineering courses.

2. Methodology

The methods, procedures and equipment used in this study was approved by the Research Ethics Committee of the Research Management Institute (RMI), Universiti Teknologi MARA (UiTM), Malaysia with the reference number; 600-RMI (5/1/6). Data collection using medical grade devices were also in accordance to standard and established protocols by their respective governing bodies.

2.1 Current Trends in Research

In reviewing the current trends in research with respect to either work-related or non-work related MSDs among motorcyclists, most of the findings lead to the most common MSDs being highly reported; Low Back Pain (LBP). This was extensively reported by Umi, Karmegam, Shamsul & Irniza (2014) in their thorough review among motor vehicle workers internationally and also by Mohd Hafzi et al. (2011) in their cross-sectional study for both occupational and non-occupational motorcyclists locally. Apart from these reviews and cross-sectional study, it was found that workers in the enforcement sectors (e.g. police riders) were given the most attention. Nevertheless, studies on commercial motorcyclist that were conducted at local country of the researchers did portrayed the same

evidence by highlighting LBP as the main MSD experienced by the motorcyclists (Braga et al., 2018; Jaiyesinmi, Areoye, Olagbegi, Bolarinde, & Uduonu, 2018; Oyawale, 2016; Ramasamy, Adalarasu, & Patel, 2017; Shriwastav, 2013).

By comparing these findings, it is evident that LBP is highly ranked for the reason of the motorcyclists' riding posture (Mohammad Yusof, 2016; Oyawale, 2016; Rajhan, 2011), besides the prolonged riding duration that they were exposed to that significantly induces the MSD. Moreover, motorcycle accidents involving high school and higher learning institution students do fall under the category of non-occupational motorcyclists which could also be further studied with respect to this research issue.

2.2 Questionnaire Survey

With LBP leading the most common MSD experienced by motorcyclists, results from a prior survey that was conducted prior to this study using a set of questionnaires showed several insights that may highlight other possible MSDs risking motorcyclists.

A pilot study was initially conducted to refine the questionnaire for better reliability of Cronbach's Alpha, α value of more than 0.7 (Nunnally, 1978). The data were analyzed using IBM SPSS version 22.0. The questionnaire accounted for an initial Cronbach's Alpha, α value of 0.642 before being refined and improved to 0.946 in the following revisions of the 3-page questionnaire. The actual survey was conducted involving 330 male respondents who were motorcyclists from different age range with a mean age of 27 years (± SD 10.05 years) which reside in eight states in the Peninsular Malaysia; Selangor, Kuala Lumpur, Perak, Kedah, Pahang, Terengganu, Kelantan, and Johor. Every state corresponded to an average of 40 motorcyclist survey respondents that took them approximately 7 minutes per person to answer the questionnaire, with assistance. Convenience sampling method (Mahmud, 2008) was appropriate for the survey as it fits the non-probability sampling feature. To acquire a better reliable data, survey respondents were chosen according to profiles and criteria set in this study.

Amongst other questions that were asked besides demographic information of the survey respondents, were sitting posture, hands postures as shown in Figure 1 (extension and flexion respectively), including body regions that start to feel fatigue or aching during the respective durations. Questions regarding the body fatigue or aching covered 19 body regions (both anterior and posterior of the body) as shown in Figure 2.

Fig. 1 Hands posture in the questionnaire survey

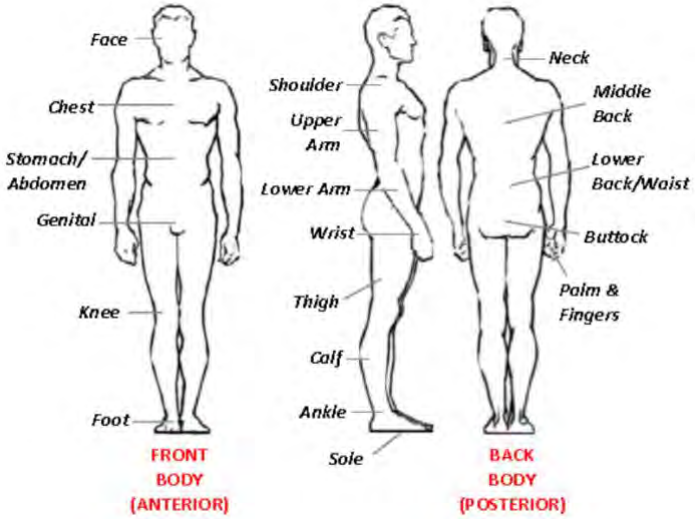

Fig. 2 Body regions in the questionnaire survey

2.3 Observation during Indoor Motorcycle Riding Simulations

In parallel to the survey, indoor motorcycle riding simulations were conducted at the METAL laboratory in UiTM. A full-scale motorcycle simulator facility; the Postura Motergo was extensively used for this purpose. 30 healthy male motorcyclist respondents between the age of 23 – 25 years with normal BMI of mean 23.9 (± SD 4.7) participated in the riding simulations. A medical grade wireless surface electromyography (sEMG) system; Myon 320 was used to capture their muscle activities involving four main muscle groups as shown in Table 1 that were identified earlier as the most contributing muscle group leading to muscle fatigue during prolonged rides. Figure 3(a) and Figure 3(b) shows one of the motorcyclist respondents being attached with the sEMG transmitters before riding the simulator for a prolonged 2-hours duration respectively.

Table 1. Muscle groups contributing to motorcyclist muscle fatigue

Muscle Group	Body Region
Erector Spinae	Lower back
Latissimus Dorsi	Middle back
Trapezius	Shoulders and neck
Extensor Carpi Radialis	Forearms and wrists

(a)

(b)

Fig. 3 (a) sEMG transmitter attached to motorcyclist respondent's body, and (b) Motorcyclist respondent riding the simulator

Throughout the 2-hours prolonged riding simulations, a video camera; JVC Action Camera as shown in Figure 4 was used to record the behaviors for every motorcyclist respondents besides being monitored visually by the researchers throughout the duration as shown in Figure 5. After the session ends, the motorcyclist respondents were interviewed for any fatiguing or aching body regions.

Fig. 4 A researcher setting up the video camera prior to the motorcycle riding simulation

Fig.5 A researcher visually monitoring the motorcyclist respondent during the riding simulation

3. Results of Study

Apart from the survey results with regards to sitting posture, nearly 90% of the survey respondents assumed the standard upright riding posture with respect to their type of motorcycle owned as shown in Figure 6. This clearly reflects that most of the motorcycles are having lower cc such as scooters and *kapchai* which does match the 96.1% number of small capacity motorcycles being registered with the Road Transport Department (JPJ) Malaysia in 2016. These types of motorcycles are also the type that most high school and higher learning institution students are currently using to ride to class.

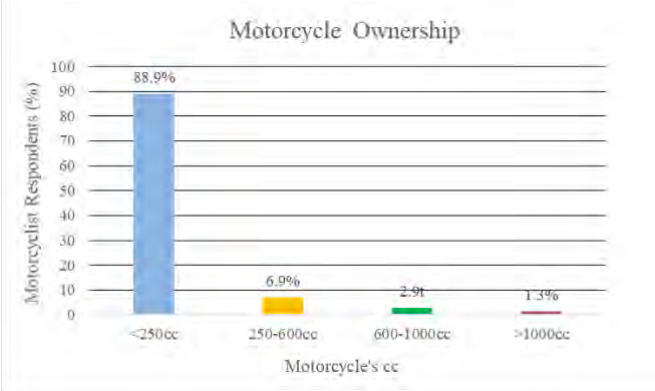

Fig. 6 Survey respondents' sitting posture with respect to type of motorcycle owned

Meanwhile the hands posture when gripping the motorcycle's handlebar showed a significant evident with more than 80% of the survey respondents claiming to assume the extension posture of the hands as shown in Figure 7. This is followed by Figure 8 that shows the highest fatiguing or aching body regions of the survey respondents.

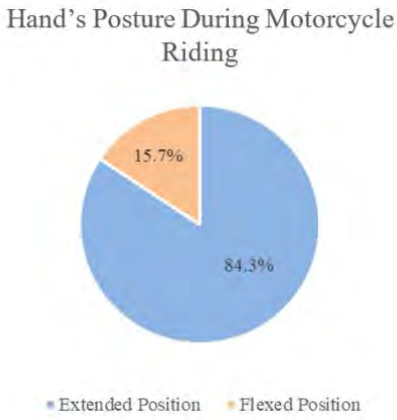

Fig. 7 Survey respondents' hands posture

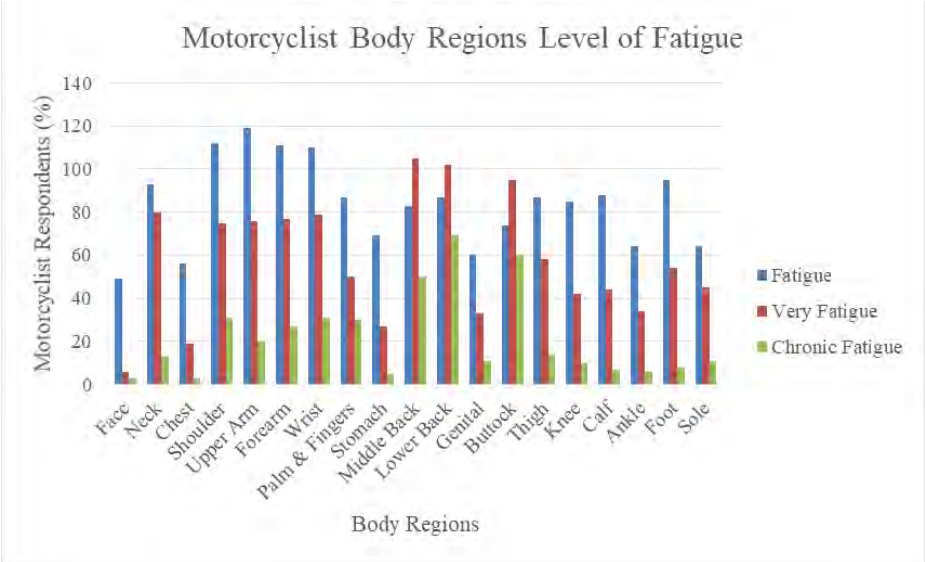

Fig. 8 Survey respondents' body regions level of fatigue

Besides that, observations during the indoor motorcycle riding simulations from both recorded videos and visual monitoring found that the motorcyclist respondents tend to perform several body movements involving shaking the head from side to side, raising their shoulders towards their neck, stretching their back, making circular movements of the wrists including flexing them forward. Apparently, all these movements were performed repeatedly obviously after 1 hour 30 minutes of the prolonged riding duration on the simulator. Additionally, the post interview after the simulation session ends resulted in several claims of feeling ached at the wrists which hands they wear their watches besides comparable claims as shown in Figure 8.

4. Discussions

The discussions comprise the main issues of MSDs among non-occupational motorcyclists and also students of both highschools and higher learning institutions that fall under the non-occupational motorcyclists category which makes up the highest numbers of motorcycle accidents on the roads.

4.1 MSDs Issues Among Non-Occupational Motorcyclists

As being highlighted by Umi et al. (2014) regarding the lack of studies of MSDs among occupational motorcyclists which most of the literature gives more attention to the workers in the enforcement sectors (e.g. police riders), this study managed to provide comparable results of the MSDs prevalence of LBP among motorcyclist. Even though the motorcyclist respondents in this study were non-occupational motorcyclists (both questionnaire survey and simulation motorcyclist respondents), nevertheless the LBP was claimed to be the highest MSDs experienced. This is evident in Figure 8 where the bar chart for the four main muscle groups (Table 1) are highly fatigued including the body's back region which governs the highest fatigue level including chronic fatigue. When the back muscles start to fatigue and are exposed for prolonged durations, MSD of the lower back is highly risked (Mohd Hafzi et al., 2011; Umi et al., 2014). Evident of stretching the back body regions further supports this issue.

However, the wrists body regions did show a significant level of fatigue which are comparable with the shoulders and upper arms level of fatigue. Nonetheless, this issue was not reported or highlighted in the literature being reviewed. But how the fatiguing wrists body regions could be linked with risk of MSDs can be supported by the post interview sessions that were conducted just after the indoor motorcycle riding simulations along with the recorded observations and visual monitoring. Claiming that the wrists of which hands they wear their watches felt aching would be possibly caused by the extension hands posture as shown in Figure 7. The pressure from the extension of the hands posture pushes the watches towards the median nerve at the carpal tunnel which may cause discomfort and numbness when prolonged risking of carpal tunnel syndrome (CTS) MSD (David, Woods, Li, & Buckle, 2008; Marina, Porta, Vallejo, & Angulo, 2011). Evident of the motorcyclist respondents performing circular movements of the wrists and flexing them forward repeatedly further supports this suggested possible MSD risk.

In addition, even though neck pain and fatigued shoulders were reported to be experienced by either occupational or non-occupational motorcyclists in the reviewed literature, they are not highlighted as affected body regions prone to MSDs (Mohd Hafzi et al., 2011). Yet, this study found that there are possibilities of those respective body regions to experience MSD rooting from fatiguing of the muscle groups at those local areas of body regions. This could possibly be further supported by the observed movements performed by the motorcyclist respondents when they start to feel fatigue on their muscles during the prolonged riding simulations. Evident of shaking the head from side to side and raising their shoulders towards their neck repeatedly are acts of relaxing their fatigued muscles (British Motorcyclists Federation, 2016; Page, 2012). This condition may possibly risk the motorcyclists to have stiff shoulders if prolonged which is another possible risk of MSD besides the most common being discussed in literature, that is LBP.

4.2 Implication to Mechanical Engineering Education in Higher Learning

Besides the MSDs risk factor that contribute to the staggering statistics of motorcycle road accidents involving both occupational and non-occupational motorcyclists, age factor is also another factor to be concerned of because most cases involving motorcyclists between the age of 16-25 years in Malaysia (Jabatan Keselamatan Jalan Raya Malaysia, 2016) are mainly students either from high schools or higher learning institutions. As the area of HFE is already part of the Mechanical Engineering education in UiTM, a specific laboratory for motorcycle research; METAL, has been established which provides an indoor motorcycle simulator facility for such research. In addition, the facility is extensively used by students to design and produce many counter measures with respect to motorcyclists safety and research.

These efforts were also visible by a few higher learning institutions that did several surveys involving their students riding motorcycles such as Universiti Kebangsaan Malaysia (UKM) with a total number of 253 respondents (Ramalingam, Media, Sensasi, Berisiko, & Saing, 2020), and Universiti Teknologi Malaysia (UTM) with 210 respondents (Sultan, Ngadiman, Kadir, Roslan, & Moeinaddini, 2016). However, more efforts should be made to instill the awareness of motorcycle safety including MSDs issues towards these groups of non-occupational young motorcyclists without only focusing on Mechanical Engineering education, but also across other faculties and departments. The acceptance for every student from different faculties for example across engineering, medical and education would be unlikely the same as different approaches of teaching are used (Abdullah, 2012), nevertheless, the motorcycles that they are riding are almost comparable.

5. Conclusions

By linking the results from this study with the MSDs issues being discussed in the reviewed literature among both occupational and non-occupational motorcyclists, several MSDs risk besides LBP were further suggested involving carpal tunnel syndrome (CTS) and stiff shoulders. The effect of these MSDs may be further investigated and validated especially towards the non-occupational motorcyclist group including high schools and higher learning institutions students that are very lacking to be studied which also accounts for the high number of motorcycle road crashes and fatalities every year. It is therefore hoped that such findings and effort may at least help to save more lives on the road and deemed essential to be introduced at the lower educational level until higher learning.

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