UNIVERSITI PUTRA MALAYSIA

ASSOCIATION BETWEEN OCCUPATIONAL AND NON-OCCUPATIONAL RISK TO WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG TRAFFIC POLICE RIDERS

NUR ATHIRAH DIYANA BT MOHAMMAD YUSOF

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NUR ATHIRAH DIYANA BT MOHAMMAD YUSOF

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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October 2016

Chairman : Karmegam Karuppiah, PhD
Faculty : Medicines and Health Sciences

Approximately 50% of the traffic police use a motorcycle as their main vehicle while on duty. These professional motorcycle riders are ride for many hours while on duty with the mean 5.64 hours per day which the exposure of vibration becomes critical since overexposure may cause discomfort, decrease their performance and even health risk including work-related musculoskeletal disorders (WMSDs). However, there have been no studies on vibration and WMSDs has been conducted among this group of workers in Malaysia. Thus, it is important that this research needs to be completed in order to identify the factors that can give health effects in developing WMSDs among traffic police riders. A cross-sectional study was done in Traffic Police Station in Kuala Lumpur and Johor Bahru on January until June 2015. One-hundred-and-thirty-seven riders participated in this study. A set of questionnaire which included Standardized Nordic Questionnaire was used. The Svantek 106 is a six-channel human vibration meter was also used to assess and measure the level of Whole Body Vibration (WBV) and Hand Arm Vibration (HAV). The one-year prevalence of WMSDs among the traffic police riders was 67.9%. The highest WMSDs symptom was reported at the neck (35.8%) and shoulder (35.8%). The mean WBV and HAV of frequency-weighted acceleration in eight hours, A(8) was 0.44 m/s^2 and 2.25 m/s^2 respectively. Meanwhile, the level of Vibration Dose Value (VDV) in WBV exposure was 13.85 m/s^2. Multiple logistic regression analysis revealed that duration of riding traffic police motorcycle (OR= 0.175, 95% CI:0.052, 0.581), year of services as traffic police riders (OR=0.152, 95% CI: 0.040, 0.567), and HAV in A(8) (OR=3.053, 95% CI: 1.126, 8.280) were significant risk factors to one-year prevalence of WMSDs. As a conclusion, although the level of WBV and HAV did not exceed both Exposure Action Value (EAV) and Exposure Limit Value (ELV) in term of A(8), the VDV level in WBV was exceeded EAV. In addition, ninety-three of the traffic police riders reported WMSDs symptoms for the past 12 months. Duration of riding (OR= 0.175, 95% CI:0.052, 0.581), year of services as traffic police riders (OR=0.152, 95% CI: 0.040, 0.567) and HAV in A(8) (OR= 3.053, 95% CI: 1.126, 8.280) were found to be most important risk factors for WMSDs among traffic police rider

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

HUBUNGAN DI ANTARA RISIKO PERKERJAAN DAN BUKAN PEKERJAAN TERHADAP KERJA BERKAITAN GANGGUAN MASALAH OTOT RANGKA DI KALANGAN POLIS TRAFIK YANG MENUNGGANG MOTOSIKAL

Oleh

NUR ATHIRAH DIYANA BINTI MOHAMMAD YUSOF

Oktober 2016

Pengerusi : Karmegam Karuppiah, PhD
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Hampir 50% polis trafik menggunakan motosikal sebagai kenderaan utama mereka semasa bertugas. Penunggang motosikal profesional ini menunggang motosikal dalam jangka masa yang lama semasa bertugas dengan min 5.64 jam satu hari di mana pendedahan getaran menjadi kritikal memandangkan pendedahan getaran yang terlalu lama boleh menyebabkan ketidakselesaan, mengurangkan prestasi mereka dan juga risiko kesihatan termasuk kerja berkaitan gangguan masalah otot rangka (KGMOR). Namun begitu, tiada kajian mengenai getaran dan KGMOR telah dijalankan di kalangan kumpulan pekerja ini di Malaysia. Oleh itu, ia adalah penting bahawa kajian ini perlu dijalankan untuk mengenal pasti faktor-faktor yang boleh memberi kesan kesihatan dalam menyebabkan KGMOR di kalangan penunggang polis trafik. Satu kajian keratan rentas telah dijalankan di Balai Polis Trafik di Kuala Lumpur dan Johor Bahru pada Januari hingga Jun 2015. Satu ratus tiga puluh tujuh penunggang motosikal mengambil bahagian dalam kajian ini. Satu set soal selidik yang merangkumi standard soal selidik Nordic telah digunakan. Meter mengukur getaran manusia, Svantek 106 yang mempunyai enam saluran juga telah digunakan untuk menilai dan mengukur tahap getaran seluruh badan (GSB) dan getaran tangan-lengan (GTL). Prevalan satu tahun menghidapi masalah otot rangka di kalangan penunggang polis trafik adalah 67.9%. Gejala masalah otot rangka tertinggi dilaporkan pada bahagian leher (35.8%) dan bahu (35.8%). Min getaran bagi GSB dan GTL pada pecutan frekuensi berwajaran dalam 8 jam, A(8) adalah 0.43m/s^2 dan 2.23m/s^2. Sementara itu, Getaran Nilai Dos (GND) dalam pendedahan GSB adalah 13.85 m/s^2. Analisis regresi logistik menunjukkan bahawa tempoh menunggang motosikal polis trafik (OR= 0.175, 95% CI:0.052, 0.581), tempoh berkhidmat sebagai penunggang motosikal polis trafik (OR=0.152, 95% CI: 0.040, 0.567) dan GTL dalam A(8) (OR= 3.053, 95% CI: 1.126, 8.280) merupakan faktor risiko yang ketara kepada prevalan satu tahun menghidapi masalah otot rangka. Sebagai kesimpulan, walaupun tahap GBL dan GTL tidak melebihi kedua-dua Tindakan Pendedahan Nilai (TPN) dan Pendedahan Nilai Had (PNH) tetapi GND melibihi TPN yang telah ditetapkan.. Selain itu, sembilan puluh enam penunggang polis trafik dilaporkan menghidapi

masalah otot rangka bagi 12 bulan yang lalu. Tempoh menunggang motosikal (OR= 0.175, 95% CI:0.052, 0.581), tempoh berkhidmat sebagai penunggang motosikal polis trafik (OR=0.152, 95% CI: 0.040, 0.567) dan GTL dalam A(8) (OR= 3.053, 95% CI: 1.126, 8.280) adalah faktor risiko yang paling penting untuk masalah otot rangka di kalangan penunggang motosikal polis trafik.

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I certify that a Thesis Examination Committee has met on 4 October 2016 to conduct the final examination of Nur Athirah Diyana binti Mohammad Yusof on her thesis entitled "Association between Occupational and Non-Occupational Risk to Work-Related Musculoskeletal Disorders among Traffic Police Riders" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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I hereby confirm that:

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This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
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Signature :_____
Name of Member of Supervisory Committee: Dr Irniza Binti Rasdi

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LIST OF ABBREVIATIONS

A(8)	Total vibration dose calculated for a standard eight hours per day
BMI	Body Mass Index
CCOSH	Canadian Centre of Occupational Safety and Health
DOS	Department of Statistics
DOSH	Department of Occupational Safety and Health
EASHW	European Agency for Safety and Health at Work
EAV	Exposure Action Limit
ELV	Exposure Limit Value
EU	European Union
GDP	Gross Domestic Product
HAV	Hand-Arm Vibration
HAVS	Hand-Arm Vibration Syndrome
Hz	Hertz
ISO	International Organization of Standard
LBDs	Low Back Disorders
MIROS	Malaysian Institute of Road Safety Malaysia
MSDs	Musculoskeletal Disorders
NHIS	National Health Interview Survey
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RMP	Royal Malaysia Police
RMS	Root-Mean-Square
SNQ	Standardized Nordic Questionnaire
SOCSO	Social Security Organisation
UEMSD	Upper Extremity Musculoskeletal Disorder
UKIOSH	United Kingdom Institution of Occupational Safety and Health
UPM	Universiti Putra Malaysia
UUM	University of Maryland Medical Center
VDV	Vibration Dose Value
WBV	Whole-Body Vibration
WHO	World Health Organisation
WMSDs	Work-related Musculoskeletal Disorders

CHAPTER 1

INTRODUCTION

1.1 Background

The workplace is the one of important environment for workers. In 2004, World Health Organisation (WHO) stated that around 2.9 billion workers across the world are exposed to the hazard and risk in the occupational sector. There is five main type of hazards that workers may expose which are ergonomic, chemical, biological, psychosocial, and physical hazard. However, the ergonomic hazard is the hardest hazard to spot since it does not immediately give harm and strain to the body but long-term exposure can result in serious long-term illness. In a recent year, the ergonomic factors role of the workplace in the development of musculoskeletal disorders has been a topic of interest and debate worldwide. Ergonomics is defined as adapting task, tools, equipment and work stations to fit the workers which can help in reducing physical stress and eliminating any potentially serious and disabling work-related musculoskeletal disorders (WMSDs) among workers (McPhee, 2005).

One of the ergonomic hazards is vibration. The vibration always occurs among workers who are involved in a mobile machine, hand-held tools and vehicle including riding a motorcycle (Donati et al., 2008; Moreno et al., 2011). Human vibrations are divided into two categories which are whole body vibration or also known as WBV and hand-arm vibration (HAV). WBV presents when workers sit or stand on vibrating machine. Long exposure in a high level of WBV can cause motion sickness, headaches and fatigue (Patil and Salunke, 2016). Meanwhile, HAV is defined as a vibration transmitted from hand-held equipment such as handlebar and steering wheel into the hand-arm of operators. This exposure can lead to vibration induced white finger or also known as VWF. However, if this problem detected early, this disease can be cured and if not, it can cause permanent disability in the workers' hand (Patil and Salunke, 2016).

Motorcycles are a common type of transportation mode in Malaysia. An estimated 11 million motorcycles are used in Malaysia followed by 10 million cars, 62 thousand buses, 99 thousand taxies and 862 thousand for other vehicles which led to the number of vehicles available in Malaysia about 26 million in 2015 (Road and Transport Department, 2016). Although motorcycles are usually used for short-distance transport since they are most convenient and effective, they are also used as a main transportation mode for some occupations such as courier, food delivery, and postal delivery including traffic police.

According to Sunderlal et al. (2007) there are three type of hazard factors involving motorcycle riders which are i) Environmental factor such as inadequate road networks and surfaces, less physical space, overcrowded road conditions

and objects or obstruction in the road; ii) Human factor including poor visual acuity, impaired hearing, physical defect, negligence of personal protective measures, psychosocial problems, addiction and abuse of substance and; iii) Machine factor such as bad maintenance and poor monitoring.

Ndimila et al. (2013) stated that the type of interruption mostly affecting rider's comfort while riding a motorcycle is random vibration which due to the unpredicted loads and road roughness. WBV exposed to the human can result transmission of vibration energy to the whole the entire body and leads to localised effects that affect normal functioning of the body and health (Satou et al., 2007; Shivakumara et al., 2011). Chen et al. (2009) conducted research in Taiwan found that WBV exposure level for motorcycle riders are higher compared to car drivers. The previous study in Tanzania also found that motorcycle riders have higher health risk compare to car drivers due to vibration (Ndimila et al., 2013). Besides that, the rates of finger numbness and shoulder pain were significantly higher among traffic police riders compared to control group due to vibration from motorcycle itself especially handlebar in Japan (Mirbod et al., 1997).

One of the occupation that involving motorcycles are traffic police. Traffic police are defined as a uniformed body who are ordered by national authorities to facilitate the movement of traffic flow and to prevent any breach of road traffic regulations (The Free Dictionary, 2014). In Malaysia, traffic police are responsible for investigating all traffic accidents, coordinating special event traffic control and control the traffic congestion. Traffic police use various type of vehicles including motorcycles in carrying out their duties. Most of the motorcycles that used are high-powered motorcycle which average of the engine power is 750 to 1300 cc. Based on European Occupational Safety and Health Risk Observatory report, occupational safety and health issues for the riders profession are always related to ergonomic hazards and risks especially exposure to work posture, prolonged sitting, and fatigue. CCOSH (2014) stated that over exposure to this ergonomic hazards could contribute to the stress, muscle fatigue, tingling and numbness in the body area that exposed which related to musculoskeletal disorders.

Work-related Musculoskeletal Disorders (WMSDs) can involve suffering and extensive economic consequences among workers, employer and society in the form of medical care, sick leave and early retirement pension. Weinstien et al. (2014) wrote a book about "The Burden of Musculoskeletal Diseases in the United Stated" stated that the musculoskeletal disorders (MSD) are the leading cause of disorders or physical inability in United State country. Besides, a study on the Global Burden of Disease proved that MSD affects more than 1.7 billion people worldwide. In 2012, National Health Interview Survey (NHIS) found that approximately 126.6 million adults in US were reported in a musculoskeletal medical condition which 76% of them were rated under chronic MSD greater than chronic circulatory conditions. Thus, the cost is rising rapidly to treat this pain and disability which the annual average cost (because of lost work)

attributable to persons with a MSD were $213 billion between 2009 and 2011 (Weinstein et al. 2014).
Various risk factors are known to be associated with WMSDs, including vibration exposure, repetitive movement, heavy lifting, bending and twisting, uncomfortable working condition, exerting too much force, working too long without break, and psychosocial factors (Institution of Occupational Safety and Health (IOSH), 2016). Other risk factors may be the workplace design, long working hour, age, body mass index (BMI), and smoking (Choobineh et al., 2009). WMSDs continues to present a challenge in virtually every occupational sector (Haukka, 2010; Szeto and Lam, 2007).

1.2 Problem Statement

In Malaysia, an increase in economic growth and in the standard of living have made the total number of vehicles on the road also increase from year to year (Figure 1.1) (Department of Road Transport, 2014). The highest number of vehicles that used by road users is motorcycle especially in Kuala Lumpur (1,626,718) and Johor Bahru (1,646,941). Thus, it makes the responsibility of traffic police in patrolling and control traffic congestion and burden in work task become greater from year to year.

Traffic police are the one of the occupational vehicles that involve a motorcycle. Approximately 50% of the traffic police use a motorcycle as their main vehicle while on duty. These professional motorcycle riders are ride for many hours while on duty with the mean 5.64 hours per day which the exposure of vibration becomes critical since overexposure may cause discomfort, stress, decrease their performance and even health risk including WMSDs (Moreno et al., 2011). Mirbod et al. (1997) suggested that the rider who ride a motorcycle more than 5 hours per day was categorised as overexposure which the WMSDs symptoms will start develop after a few hours in riding motorcycle among respondents. However, health problem especially in vibration injuries and WMSDs among motorcycle riders are often overlooked in research area although they are large size of users in Malaysia.

There are many motorcycle contributing factors influencing the vibration level such as type of motorcycle, engine power, year of manufacturer, and maintenance. The results for factors that contribute to the vibration level in vehicles is inconsistent. Moreno et al. (2011) proved that motorcycle age, engine size, speed and driver weight had been important factors in determine the level of vibration which the most unfavourable combination factors are old motorcycle (more than 3 years), small engine and slow speed but Khamis et al. (2014), Chen et al.(2009) and Ismail et al. (2010) found that slower riding speed may lower the vibration exposure. Besides, different types of road also give different level in vibration such as bituminous road (0.1794 m/s^2), dirt road (0.381 $m/s^{2)}$, concrete road (0.516 m/s^2), tarmac road (0.649 $m/s^{1.75}$) and pavement road (0.725 $m/s^{1.75}$) (Czech, 2016; Khamis et al. 2014). However, there is not much different in vibration level to the same type of road (paved road) with different location urban and province area with 0.88 m/s^2 and 0.82 m/s^2 respectively (Chen et al., 2009).

Several studies from other countries have conducted research to evaluate the relation between vehicle vibration and disease. Bovenzi and Huslof (1999) found that WBV was related to the low back pain development in review of epidemiologic study and Mirbod et al. (1997) found that the HAV exposure (2.0 m/s^2) was considered as a risk factor in suffering hand-arm symptoms among riders with 750 cc motorcycle engine and 5.5 hours in duration of riding motorcycle per day. Meanwhile, Stark et al. (1990) concluded that one cause of white finger was excessive motorcycle riding. The WBV exposure level and health risk of motorcycle riders (1.11 m/s^2) are higher compare to car drivers (0.55 m/s^2) with the motorcycle engine of 125 cc (Chen et al., 2009; Wang et al., 2006).

WMSDs is one of the most important causes of occupational injury and disability in developed and developing countries including Malaysia (Gardner et al., 2014). Bevan et al. (2009) also stated that WMSDs is the most prevalence of all work-related injury and it is costly. Even mortality rate related with WMSDs are low, it can give impact in the form of disability rates, medical costs, and quality of life of an individual (Ogdie et al., 2014).

Research in other countries among police officers showed that more than fifty percent of respondents suffered WMSDs such as the study done in Bangladesh with 80% respondents with WMSDs (Nazmul, 2013). In Korea, 76.8% of police officers and 75.0% of respondents in Brazil suffered WMSDs (Cho et al., 2014; Ana et al., 2015). The vibration exposure during driving or riding is one of the factors that suggested by researchers that caused a high number of the prevalence of WMSDs among police officers. However, there is no exact value for vibration level exposed by the respondents.

The consequence of WMSDs is significant for employee and employer which it can give impact to lost workdays, early retirement, and reduce productivity of workers Based on the Integrated Benefits Institute (IBI) in 2014 for the US workforce, among hundred working people in the population, at least 28% of them reporting one WMSDs condition, fifty-nine of them had short-term disability days and forty-one had long-term disability days for WMSDs (Summers et al., 2015). Medical Expenditure Panel Survey (2011) also estimated that total medical costs for MSDs treatment were $1,745and $1,938 for back problems per person. Due to this reason, WMSDs have been established as a top cause of work disability in the US (Summers et al., 2015). Besides, Centre of Excellence for Ergonomics had conducted study on overall compensation for occupational disease in Malaysia which they found that the cost of permanent disability compensation related to ergonomics was RM 25 313 per case compared with the average compensation costs for other cases which is RM 22 841.

The epidemiological studies and literature review stated that there are two categories of risk factors can be considered in developing of WMSDs which are occupational and non-occupational factors (Nunes, 2009a). The occupational factors include awkward posture (Karmegam et al., 2011), vibration (Okunribido

et al., 2006; Lopez-Alonso et al., 2013), rank (Rhee et al., 2013), year of service (Ghasemkhani & Mahmudi, 2008) and long riding duration (Bovenzi et al.,2006). Meanwhile, non-occupational factors are race (Weinstein et al., 2014), marital status (Amin et al., 2014), educational level (Ekpenyong and Inyang, 2014), age (Deborah et al., 2010), body mass index (Maria et al., 2009; Viester et al., 2013), history of injury (Yu et al., 2012), and smoking (Govindu and Babski-Reeves, 2012). These problem highlights the need for studying risk factors in develop WMSDs problem among traffic police in Malaysia. Thus, it is very crucial to investigate the factors contribute to the development of WMSDs including vibration exposure among traffic police in Malaysia.

1.3 Study Justification

In Malaysia, traffic police riders are qualified and well-trained to ride a high-powered motorcycle of traffic police. Their work task requires them to physically fit and medically healthy at all times. Any WMSDs linked to long term occupational vibration exposure might decrease their performance, strength, and capability. However, there is scanted reference data, profiles and even baselines regarding statistics among traffic police on occupational health especially in vibration and its adverse health effects. This limited availability of data makes it difficult to develop evidence-based prevention programs for workers. There is also no such specific guideline related to the law enforcement workers on occupational safety and health in Malaysia compared to developed country such as United State of America. Thus, this study can be one of the baseline data for vibration and WMSDs among traffic police in Malaysia to use in developing the guidelines for workers in law enforcement.

The study on incidence and prevalence of WMSDs related with HAV or WBV exposure among tractor drivers (Ramazan & Mostafa, 2010), military armoured vehicle drivers (Rozali et al., 2009), mail delivery (Stefano et al., 2011), truck drivers (Stephan, 2008), and motorcycle riders (Shivakumara & Sridhar, 2009; Jaimon et al., 2013; Khamis et al., 2014) have been widely conducted and published in the scientific literature. However, there is still no study in Malaysia related with vibration exposure and WMSDs has yet been conducted among traffic police riders.

Besides, traffic polices also play a vital role in managing road traffic that always involved many injuries and mortality cases among road users. They are involved in many aspects of task from general duty, facilitate the movement of traffic flow and proactive patrol to the specific criminal activities. Since traffic police involved such a wide scope of activities, they may expose to various hazards and risks on health and safety. One of the hazard that they were exposed is vibration from motorcycle, which they need to ride the motorcycle daily in the line of duty. Thus, it is important that this research need to be completed in order to identify the level of vibration exposure and the effect on traffic police health which any hazard that poses a threat to their health cannot be neglected.

1.4 Research Objective

1.4.1 General Objective

The general objective of this study is to identify the occupational and non-occupational risk factors of Work-related Musculoskeletal Disorders (WMSDs) among traffic police riders.

1.4.2 Specific Objectives

The specific objectives of this study were as follows:

1. To determine the socio demographic profile, lifestyle and occupational profile of the respondents.
2. To determine the level of whole body vibration (WBV) and hand arm vibration (HAV) exposure among traffic police riders.
3. To determine the overall prevalence of work-related musculoskeletal disorders (WMSDs) among traffic police riders within the past 12 months.
4. To compare the median of whole body vibration (WBV) between traffic police riders with WMSDs and without WMSDs.
5. To compare the median of hand-arm vibration (HAV) between traffic police riders with WMSDs and without WMSDs.
6. To determine the association between non-occupational factors and occupational factors with WMSDs.
7. To determine the risk factors associated with WMSDs among traffic police riders.

1.5 Study Hypotheses

1. There is a significant difference median of WBV between traffic police riders with WMSDs and without WMSDs.
2. There is a significant difference median of HAV between traffic police riders with WMSDs and without WMSDs.
3. There is a significant association between non-occupational factors and occupational factors with WMSDs.
4. There is a significant association between associated risk factors with WMSDs among traffic police riders.

1.6 Definition Of Terms

1.6.1 Hand-Arm Vibration (HAV)

Conceptual

Hand-Arm Vibration is known as segmented vibration which the vibration is transferred from a work process to a workers' hand and arm through operating hand-held power tools or by holding machine (Middlesworth, 2015).

Operational

The measurement of HAV was done by using Human Vibration Meter (Svantek 106). To measure hand-arm vibration a tri-axial accelerometer (SV 105A) was used and attached at Svantek 106 meter which wore by the rider while riding motorcycle. The daily exposure action value standardized for hand-arm vibration is 2.5 m/s^2 based on European Union (EU) Directive (2002).

1.6.2 Whole-Body Vibration (WBV)

Conceptual

Whole-body vibration is defined as mechanical vibration which transmitted to a person's entire body when contact with vibration source which leads to localized effect (Benjamin et al., 2015)

Operational

The measurement was done by using Human Vibration Meter (Svantek 106) with a seat accelerometer (SV 38V) which was setup on the rider's seat and measured during riding. The results then were compared with EU Directive (2002) of 0.5 m/s^2 as daily exposure action value.

1.6.3 Work-related Musculoskeletal Disorders (WMSDs)

Conceptual

WMSDs is a condition which effects muscles, tendons, nerves, and supporting structures of the body initiated by the work performance and cause of pain, disability, reduce productivity, high financial cost and absenteeism among workers (Collins et al., 2011; Tinubu et al., 2010).

Operational

Prevalence of WMSDs in this study was determined by using Standardized Nordic Questionnaire (SNQ) adopted from Shahmi et al. (2014) with translated Malay language version. The questionnaire set enables the researcher to obtain information about WMSDs symptoms experienced by the respondents in their lifetime, in the past 12 months. The specific body parts affected by WMSDs includes neck, shoulders, elbows, upper and lower back, wrists and hands, hips and thighs, knees, and ankles and feet. The overall prevalence of WMSDs was determined based on complaints concerning any body parts.

1.6.4 Riding Back Posture

Conceptual

Riding back posture refers to the possibility of developing any of the WMSDs symptoms due to the characteristics or the way in which someone hold their body when sitting while riding motorcycle. In other word, riding posture refers to the likelihood of getting WMSDs from different body positioning (Karmegam et al.,2011).

Operational

In this study, postural WMSDs risk was measured by using most preferred riding back posture questionnaire adopted from Karmegam et al. (2011). This riding posture was categorised into four type of postures which were slump, flat, long lordosis and short lordosis.

1.6.5 WMSDs Risk Factors

Conceptual

WMSDs risk factors refers to the conditions by which when it is present, it will cause the WMSDs symptoms to develop in an individual. The risk factors can be divided to occupational and non-occupational factors. (Tamrin et al., 2007; Middlesworth, 2013; CCOSH, 2014).

Operational

Occupational and non-occupational (individual) risk factors information was obtained by using the self-constructed questionnaire.

1.7 Conceptual Framework

In work-related transportation, workers are mainly exposed to five types of hazards which are biological, chemical, physical, psychosocial, and ergonomics (Kudasz et al., 2010). However, the main hazard of this study was ergonomic hazard which focused on vibration exposure and WMSDs as the outcome of this study. The motorcyclist can be exposed to the two type of vibrations: hand-arm vibration and whole-body vibration (Jaimon et al., 2013).

Motorcyclist who are exposed to the high level of vibration during work which riding in long period of time, will tend to get WMSDs. However, the severity of this problem is also depends on other risk factors such as age (Deborah et al., 2010), race (Weinstein et al., 2014), marital status (Amin et al., 2014), body mass index (BMI) (Maria et al., 2009; Viester et al., 2013), history of injury (Yu et al., 2012), smoking (Govindu & Babski-Reeves, 2012) and education level (Ekpenyong & Inyang, 2014) for individual factors which also known as non-occupational factors.

Meanwhile, duration of riding motorcycle (Bovenzi et al.,2006), riding posture (Karmegam et al., 2011), rank (Rhee et al., 2013) and year of services (Ghasemkhani & Mahmudi, 2008) for occupational factors. WMSDs can be worst if these risk factors are present and does not being assessed and control. The conceptual framework was visualised in Figure 1.1 and the subject of interest in this study were highlighted with blue colour, red and green color were used to highlight dependent variable and independent variables respectively.

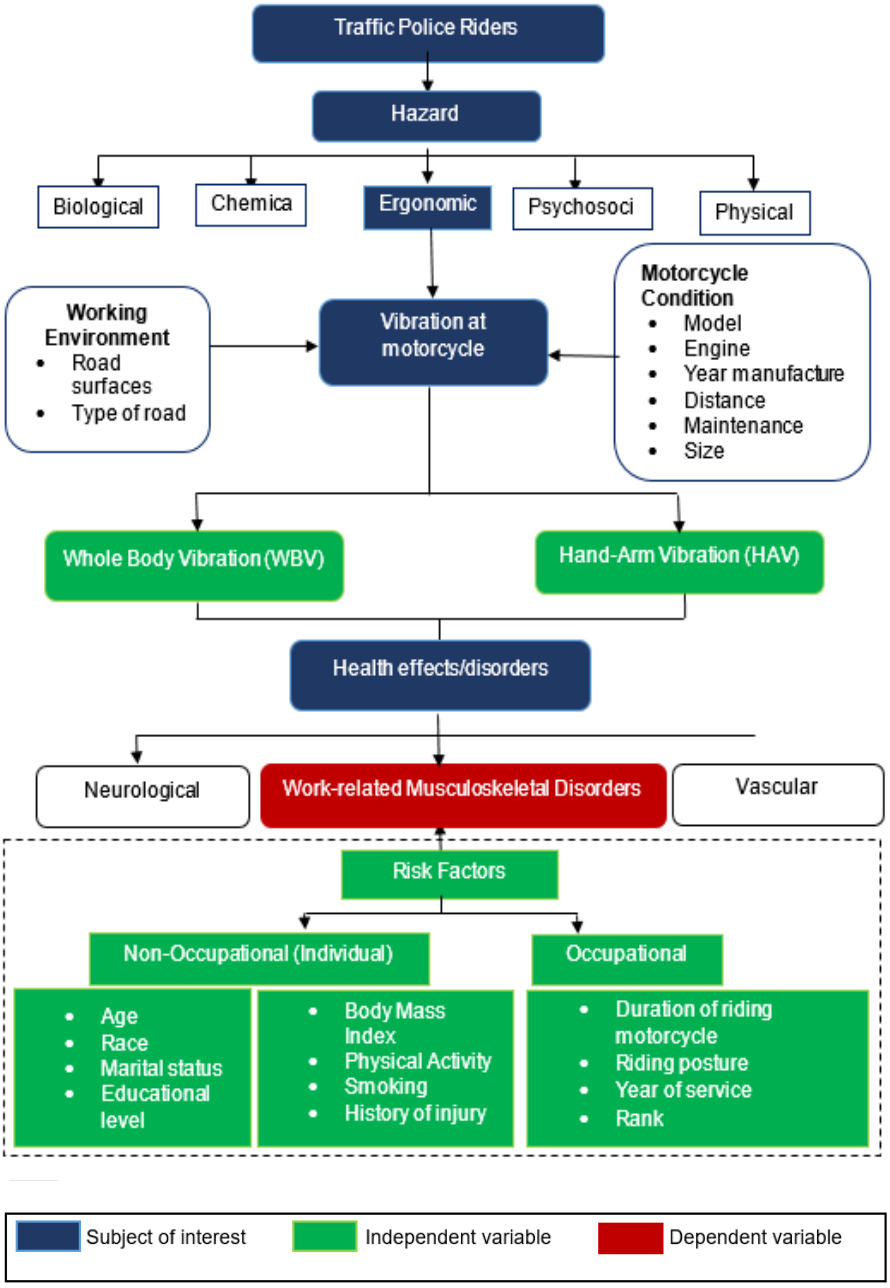

Figure 1.1: The Conceptual Framework

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