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Work-related musculoskeletal disorder (WMSDs) and functional status of firefighters in Klang Valley

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Abstract:

Firefighters have high risk to get work-related musculoskeletal disorders (WMSDs) due to great physical demands needed in their duty. The purpose of this cross-sectional study was to investigate the WMSDs and functional status of firefighters in Klang Valley. A total of 101 respondents from three Fire and Rescue Department in Klang Valley completed two self-rated assessments which were The Malay Version of Cornell Musculoskeletal Discomfort Questionnaires (CMDQ-M) and COOP/WONCA Chart. Lower back had been found to have the highest WMSD prevalence among all the body regions examined. The multiple regression test identified WMSDs at the upper back, lower back, left wrist, and left thigh have significant relationship with 50% of the aspects of functional status. In addition, the multiple regression test also revealed that WMSDs at the right arm, left wrist, right thigh, left calf and left knee appeared to become the main factor contributing to each aspect of functional status. By using independent sample T-test, age, smoking status, back pain history, working experiences, and exercise routine had been revealed as the factors associated with increased of WMSDs symptoms. WMSDs were disabling and potentially disruptive to the firefighters' functional status.

Keywords: Cornell Musculoskeletal Discomfort Questionnaire, COOP/WONCA, functional Status

1. INTRODUCTION

Work-related musculoskeletal disorder (WMSDs) is referring to inflammatory conditions or impairments occur at the structure of the body such as muscles, joints, tendons, ligaments, bones, nerves, and supporting blood vessels that result in pain and functional impairment. This condition is contributed either by tasks in the job itself or influenced by the environment the job is carried out, but it may not be the sole source of WMSD development [25,18]. WMSD often occur among firefighters due to the great physical demands needed in their duty [23]. Hong et al [23] reported that, about 66% of 285 firefighters get injured when performing their task. When being compared to private-sector workers, firefighters were 3.5 times more likely to develop workplace injury and 3.8 times more likely to develop WMSD [23].

Musculoskeletal disorders(MDS) occurs most commonly in the upper and lower limb with 44% and 45%, respectively and commonly occur in more than one body regions for the firefighters with older age [17]. Other study reported that back pain as the most common WMSD occur in firefighters with 6.0% of complaint compared to 3.4% at the neck and 3.3% at the foot due to the awkward activities and also heavy equipment. However, smaller number of complaints received on pain at shoulder, hand and arm region

MSD caused burden to the affected person by not only causing limitation in their movement, dexterity, and functional mobility, but also gave impact to their work and social roles participation [25]. In the firefighter profession, WMSD could disrupt the firefighters' abilities to perform their duties as it gave impact to their level of performance and led to increase of absenteeism [3]. In addition, WMSD was also proven to be closely related to the individual's psychological issues. As having chronic pain able to interrupt the workers' job performance, it would then lead to chronic depression problems in the affected person [5]. Kim et al. [12] supported the findings by exposing the firefighters with WMSDs were 1.86 times most likely to develop depression compared to those who were not.

The negative impact of WMSD among firefighters has also been revealed by Oh et al. (2014) in their scientific findings when the result shows the low health-related quality of life (QoL) in the firefighters with symptoms of WMSD. QoL is closely related to functional status. Limitation in functional

status able to lead to a reduction in QoL of an individual. Husky et al.[17] said that back pain able to give impact to individual daily activity and cause functional limitation. As far as the study is concerned, there is still lack of literature addressed association between WMSD and functional status in firefighters in Malaysia which in turn causes poor practice of WMSD prevention measures are done to reduce the consequences.

Therefore, this study intended to identify the most common body region affected by WMSDs and investigate its relationship with the functional status of firefighters. In addition, this study would like to identify the main body regions affected by WMSDs that influence this professional functional status. Besides that, this study is also conducted to compare the WMSDs and profile of firefighters.

2. MATERIALS AND METHOD

2.1 Study design, setting and population

This is a cross sectional study of 101 firefighters out of the total 135 firefighters from three fire stations in Klang Valley which include Sungai Buloh, Bukit Jelutong, and Shah Alam Seksyen 15. Respondents in the study must within the age of 18-60 years old, full-time firefighters and able to participate along the assessment process that took approximately 25 minutes. All the respondents were provided with consent forms before they participated in this study.

2.2 Data collection

The self-rated questionnaires were used for data collection. The questionnaires comprised of three sections which are demographic data, WMSD, and functional health status. For demographic data section, the variables involved are age, gender, marital status, education level, type of work, smoking, history of accidents at work, back pain history, working experience as firefighters, work tasks, monthly salary and exercises frequency.

The level of musculoskeletal discomfort in 11 parts of different body regions in firefighters was assessed using the Malay version of Cornell Musculoskeletal Discomfort Questionnaires (CMDQ-M). These include the neck, shoulders, upper back, upper arm, lower back, forearm, wrist, hip/buttocks, thigh, knee, and lower leg. Information about how often they experienced discomfort during the previous work week, how uncomfortable they felt due to the discomfort and whether the discomfort interfered with their working ability were gathered for all the body parts of each participant.

The COOP/WONCA Chart was used to measure six core aspects of functional health status which include physical fitness, feelings, daily activities, social activities, change in health and overall health. Each item needed to be rated using a 5-point ordinal scale, ranging from 1 to 5 and the response scales were accompanied by a pictogram to illustrates the level of functioning.. Based on the scales, higher scores showed the more unpleasant level of health or condition. To interpret the results, the total summary score was not required as each item independently provide measurement to an aspect of functional status [24].

2.3 Statistical Analysis

A complete data was entered and analyzed using the Statistical Package for Social Sciences Software (SPSS) version 22. The results for the problem in six core aspects of functional status (physical fitness, feelings, daily activities, social activities, change in health and overall health) among firefighters in Klang Valley were presented as frequency (n) and percentage (%), and the most body region affected by WMSD among firefighters was presented in mean (*M*). Other than that, multiple regression test was used to investigate the relationship between WMSDs and functional status of firefighters in Klang Valley. In addition, the multiple regression had also been used to determine the main body regions affected by WMSDs that influence the functional status of firefighters in Klang Valley. Lastly, to compare the WMSDs and profile of firefighters in Klang Valley, independent sample T-test was used.

3. RESULT AND DISCUSSION

3.1 Subject's Functional Status

The problem in six core aspects of functional status of the respondents are as portrayed in Table 1 . In term of physical aspect, most firefighters involved in heavy physical activity in their past two weeks (39.6%). For feelings, 41.6% of the firefighters reported that they had been slightly bothered by emotional problems such as feeling anxious, depressed, irritable, downhearted or stress. More than half of the firefighters had no difficulty to perform their daily usual activities both inside and outside house because of their physical and emotional health problem (53.5%). In social activities, 43.6% of the firefighters had reported having no difficulties in joining social activities with family, friends, neighbours or groups due to physical and emotional health problem. When the firefighters were requested to rate their change it health at the present compared to their past two weeks, 43.6% of them claimed to have much better, 46.5% have little better, 8.9% about the same, and 1.0% of the firefighters claimed to have a little worse of health status. For overall health, majority of the firefighters rated their health as good, 38.6%.

Table 1. Table of Frequencies and Percentage on Six Aspects of Functional Status among Firefighters

Variables	Frequencies	Percentage
Physical fitness		
Very heavy	32	31.6
Heavy	40	39.6
Moderate	24	23.8
Light	5	5.0
Feelings		
Not at all	23	22.8
Slightly	42	41.6
Moderately	28	27.7
Quite a bit	8	7.9
Daily activities		
No difficulty at all	54	53.5
A little bit of difficulty	26	25.7
Some difficulty	18	17.8
Much difficulty	3	3.0
Social activities		
Not at all	44	43.6
Slightly	47	46.5
Moderately	9	8.9
Quite a bit	1	1.0
Change in health		
Much better	13	12.9
A little better	34	33.6
About the same	32	31.7
A little worse	22	21.8
Overall health		
Excellent	8	7.9
Very good	33	32.7
Good	39	38.6
Fair	21	20.8

3.2 WMSD by Body Regions among Firefighters

The result of WMSD symptoms by body regions presented in Table 2. The lower back has the highest means value of WMSD among all the body regions examined (M=10.97), which means this part is the most affected regions among all. In contrast, the hip region had the lowest value (M=1.10) compared to others. The study finding is agreed with the reported study by Kim et al., (2013) which recognized back pain as the most common WMSD. The challenging physical demands such as pushing, pulling, twisting, lifting and bending that may become possible factors for this prevalence of low back pain among firefighters. Moreover, heavy fire protective equipment itself able to cause WMSD due to persistent unbalanced body positions along the working period [12].

Table 2. Table of WMSDs by Body Regions

Body Regions	Minimum	Maximum	Mean (*M*)
Neck	0.00	30.00	4.11
Right Shoulder	0.00	90.00	9.19
Left Shoulder	0.00	90.00	7.12
Upper Back	0.00	45.00	6.24
Right Arm	0.00	90.00	5.29
Left Arm	0.00	20.00	3.14
Lower Back	**0.00**	**90.00**	**10.97***
Right Forearm	0.00	90.00	3.31
Left Forearm	0.00	20.00	1.43
Right Wrist	0.00	90.00	4.75
Left Wrist	0.00	20.00	1.66
Hip	0.00	21.00	1.10
Right Thigh	0.00	90.00	4.34
Left Thigh	0.00	21.00	2.44
Right Knee	0.00	90.00	7.74
Left Knee	0.00	90.00	6.46
Right Calf	0.00	90.00	3.44
Left Calf	1.00	45.00	3.36

* The highest means value of WMSDs

3.3 The Relationship between WMSD and Functional Status of Firefighters

As shown in Table 3, WMSD at the upper back, lower back, left wrist, and left thigh have significant relationship with 50% of the aspects of functional status. There is limited research to support the finding, however, WMSD at each of these four parts of body able to give impact on an individual functional status

Table 3. Table of Multiple Regression between WMSD (based on Body Regions) and Functional Status of Firefighters

Body Regions	Physical Fitness		Feelings		Daily Activities		Social Activities		Change In Health		Overall Health	
	Sig.	Beta-value	Sig.	Beta-value	Sig.	Beta-value	Sig.	Beta-value	Sig.	Beta-value	Sig.	Beta-value
Neck	0.473	0.085	0.675	0.061	0.517	0.083	0.023	**-0.280**	0.177	-0.218	0.079	-0.235
Right Shoulder	0.726	-0.063	0.916	0.023	0.327	0.19	0.892	0.025	0.276	-0.267	0.236	-0.240
Left Shoulder	**0.000****	**0.354**	0.212	0.110	0.808	0.018	**0.018***	**0.174**	0.713	-0.035	0.057	0.153
Upper Back[a]	0.479	-0.087	0.112	0.243	0.259	0.15	**0.004****	**0.376**	**0.034***	**0.359**	**0.001****	**0.480**
Right Arm	**0.017***	**0.594**[b]	0.437	-0.234	**0.007***	**0.726**	0.267	-0.279	0.958	-0.017	0.627	0.133
Left Arm	**0.031***	**-0.198**	0.256	0.127	0.875	0.015	0.464	0.068	**0.074***	0.220	0.600	0.053
Lower Back[a]	0.098	0.164	**0.017***	**0.292**	0.552	0.063	**0.000****	**0.549**	0.168	0.185	**0.000****	**0.431**
Right Forearm	0.989	0.006	0.233	0.645	0.261	0.530	0.245	0.522	0.143	0.875	**0.011***	**1.276**
Left Forearm	0.055	0.326	0.141	-0.306	0.432	-0.142	0.218	0.212	0.618	-0.114	**0.062***	-0.354
Right Wrist	0.996	0.001	0.198	-0.218	0.582	-0.081	0.814	0.033	0.451	-0.140	0.217	-0.190
Left Wrist[a]	**0.021***	**-0.247**	**0.000****	**0.588**[b]	0.141	-0.168	0.510	-0.071	0.520	0.092	**0.046***	**0.239**
Hip	0.593	0.053	0.723	-0.043	0.947	-0.007	**0.018***	**-0.242**	0.510	-0.088	0.161	-0.155
Right Thigh	0.708	0.167	0.101	-0.908	**0.017***	**-1.161**[b]	0.432	-0.360	0.280	-1.346	**0.000****	**-1.910**[b]
Left Thigh[a]	0.937	-0.017	0.761	0.078	**0.029***	**0.498**	0.336	0.205	**0.016***	**0.693**	**0.001****	**0.776**
Right Knee	0.402	0.276	0.452	-0.304	**0.035***	**-0.754**	0.237	0.399	0.159	-0.631	0.949	0.024
Left Knee	0.575	0.209	0.107	0.746	**0.008***	**1.086**	0.381	-0.336	**0.012***	**1.294**[b]	0.230	0.504
Right Calf	0.909	0.254	0.275	2.989	0.282	2.574	**0.003****	**6.930**	0.471	2.169	0.213	3.108
Left Calf	0.636	-1.056	0.288	-2.925	0.240	-2.827	**0.003****	**-7.062**[b]	0.429	2.395	0.231	-3.007

*p-value < 0.05

**p-value < 0.005

[a] Body region that have significant relationship with 50% of the aspects of functional status

[b] The main body regions that influenced the functional status of firefighters

According to Husky et al. (2018), back pain would restrict the daily activities in the affected person which then lead to functional limitation. In addition, WMSD at left wrist also has a significant relationship with parts of the functional status of firefighters. This is as a result of right-handed firefighters who often used their dominant hand to perform multi task, and utilized their non-dominant hand for static tasks. The continuous static position in the non-dominant hand may then elicit pain, following the excessive forces exerted.

As had been mention earlier, WMSD on left thigh was also

associated with the few aspects of functional status. The reason of this case is still unclear. Therefore, at present, we assume that, to maintain squat position during load transfers, hips and knees extensor muscles need to work harder. According to Lanshammar et al., [12] the extensors muscles were weaker in the non-dominant leg. Therefore, the excessive forces given on the weak extensors muscles of the non-dominant leg may result in pain which was then result in mobility restriction.

3.4 The Main Body Regions Affected by WMSDs that Influence the Functional Status of the Firefighters

By referring to Beta-value in Table 3, this study was able to determine main body regions affected by WMSD that influence the functional status of firefighters in Klang Valley. The main WMSD that contribute to the low physical fitness among firefighters was at the right arm region (Beta-value = 0.594). Most previous studies found how insufficient physical activity and fitness associated with the development of WMSD. However, there was limited literature studied on the level of physical activity commonly performed by individuals with WMSD. This study believed that the presence of pain or discomfort at anybody regions able to negatively affect the physical activity of the individuals and cause activity impairment. Therefore, further evaluations were required to have a better understanding on this phenomenon.

Next, WMSDs at the left wrist was the leading contributor to affect feelings of the respondents (Beta-value = 0.588). Good wrist and hands' joint and muscle function at both sides are important to ensure job efficiency in firefighters. Based on the previous study by Antonopoulou et al.,[5] on rural Greek citizens identified that MSD threatened their studied sample psychological health as higher experience of mental distress, bad physical functioning and bodily pain were reported among citizens who complained of MSD compared with the person without MSD. In addition, experienced of chronic pain were likely to bring negative impacts on job performances in term of working ability and effectiveness. As a result, it may elicit psychological issues on the affected person such as chronic depression

Other than upper limbs, WMSDs in lower limb regions had also been revealed as factors leading to degradation in activities of the person with this occupational injury. This study recognized the left calf as the main factor that influenced social participation (Beta-value = -7.062), while the left knee provided great influence towards the change in health of the firefighters (Beta-value = 1.294). In addition, WMSD at right thigh had been found to become the main factor that affected daily activities and overall health of the firefighters with Beta-value -1.161 and -1.910, respectively.

The pain in the knee, other than lower back and hip were mostly triggered by standing, walking and lifting activities [16][22]. Strains and sprains were the most common injuries occurred to lower extremities of firefighters, followed by fracture and wound/bleedings. Although MSDs at lower limbs regions usually given short awareness by the public, these injuries actually required significant concern as they were sources of high degree in mobilization and thereby could give impact not only to their daily activities and social participation, but also to their change in health as well as overall health.

3.5 The WMSDs and Profile of firefighters

In term of age, this study had categorized the age of firefighters into two groups which were younger age group (aged 40 years old and below) and older age group (aged 41 years old and above). As Table 4 shows, the highest WMSDs symptoms found among younger age group was similar to a previous study by Yasobant et al. (2014), who assessed the prevalence of WMSDs among a variety of India tertiary care hospital workers, reported high WMSDs incidence among these younger health care professionals. Not only that, a study which focused on medical laboratory professionals also identified the high WMSD symptoms in younger employees than older workers [1]. In conjunction with that, Agrawal et al. (2017) believed that musculoskeletal symptoms were strongly related to the work itself, and denied the aging effect on this problem.

However, it was found that the older age group with the age of 41 and above experienced higher WMSDs incidence at the left arm and lower back regions. This finding was contrary to the previous study from Damrongsak et al. (2017) that revealed firefighters with the age range of 30 years to 39 years had reported to experience most frequent WMSD incidence at the back region of their body. Therefore, this study came into a conclusion that WMSD can affect people of all ages, from young to elderly. Thus, it was suggested to be more concerned on this issue starting from the early stage of working career and the top management must ensure each employer follows the principles of injury prevention, regardless of their age.

Next, WMSDs at the hip and both side calves affected smokers more compared to respondents who were not smoking. There was limited study obtained to explain more on this phenomenon. However, Holley et al. (2013) who previously studied the smoking consequences on chronic musculoskeletal pain among young adult twins discovered that risk for the twins who were smoking to develop chronic musculoskeletal pain increased twice a time greater than the non-smokers sample. In another study, the significant association had been revealed between the lifetime history of chronic musculoskeletal complaints with smoking habits [28].

This study also revealed higher lower back pain in firefighters who were not smoking. This result is in contrast with the previous finding, which suggested smoking may lead to adverse health problems such as coughing and lung impairment. As a consequence, coughing may increase abdominal pressure and intradiscal pressure which cause the smokers to exacerbate strain in the spine and develop chronic low back pain [18, 28].

In the other hand, there was also study recognized positive relationship between smoking and musculoskeletal disorder as they believed that cigarettes contained nicotine that have tendency to promote physiological effects in stimulating the nervous system to enable the smokers to be more relax and energetic [11]. As for this, this study believed that smoking is able to increase the risk of the onset of WMSD, however,

the smoking status alone was not the primary causative factor of this injury.

Besides that, WMSD prevalence was higher in firefighters with history of back pain than to individuals with no back pain history. It was reported that the risk to experience relapses of back pain was higher in the person who experienced three or more episodes of back injury in compared to individual with fewer than three previous episodes. The factors of socio-demographics, use of medications, physical activity, work status (in paid employment or compensable case), and psychological problems had been found to have no association with poorer prognosis and relapses of back pain in the study sample [14].

This study also found a greater incidence of WMSD at the regions of the upper back, lower back, hip and left calf in respondents who had involved in the firefighting profession less than 15 years. The current research findings supported by previous result that identified higher prevalence of WMSDs in employees with less than 5-year professional experience (Yasobant and Rajkumar, 2014). This is because, the younger employees might have lack of exposure to the working environment in addition to their vigorous working style, which contrary to the senior workers' adaptation to the workplace and their compliance to most of the safe working standards. However, based on Negm et al. (2017), the higher rate of WMSDs was reported among firefighters with longer duration of services, suggesting prolong exposure to the injuries throughout the services. Due to the conflicting results reported in the literature, more studies are needed to examine the relationship between working experience and WMSDs incidence.

There was also higher WMSD incidence reported in firefighters who did not exercise regularly. As fire ground tasks was very challenging, optimal cardiovascular and muscular fitness ability were critical aspects needed to become a firefighter. Garber et al. (2011) explained benefits of regular exercise to person which include a reduction in risk of all-cause mortality, cardiovascular disease events, development of functional limitation, and non-fatal illness. Referring to a study by Moore (2013), it was found that firefighters who were least-fit would be 10 times more possibly to obtained injury compared to most-fit firefighters. Griffin et al. (2015) who implemented physical fitness intervention in their study has also revealed the effectiveness of being fit in reducing the potential of injury and compensation claim costs in the firefighting profession. Therefore, in order to maintain these physical fitness levels, it was crucial for the firefighters to practice exercise regularly [21].

Table 4. Table of T-test between WMSD and Profile of Firefighters

Body Regions	Age (Mean)		Smoking Status (Mean)		Back Pain History (Mean)		Working Experience (Mean)		Exercise Routine (Mean)	
	Young	Old	Yes	No	Yes	No	<15 Years	≥15 Years	≥3 Times	<3 Times
Neck	4.207	3.887	3.216	5.868	6.750**	3.373*	3.853	4.636	2.979	5.093
Right Shoulder	9.407	8.710	9.194	9.191	11.432	8.570	8.544	10.530	4.809*	13.009**
Left Shoulder	5.786	10.129	7.672	6.029	7.955	6.886	5.228	11.015	8.181	6.194
Upper Back	7.271**	3.903*	6.567	5.588	6.682	6.114	7.368**	3.909*	4.479	7.769
Right Arm	4.793	6.419	5.754	4.382	5.864	5.133	4.757	6.394	1.713*	8.407**
Left Arm	2.314*	5.000**	2.612	4.177	5.432	2.500	2.272*	4.924**	1.819*	4.287**
Lower Back	7.214*	19.452**	6.806*	19.177**	17.273	9.215	6.838*	19.485**	5.255*	15.944**
Right Forearm	3.971	1.807	4.194	1.559	3.773	3.177	4.177	1.515	0.649*	5.620**
Left Forearm	1.343	1.613	1.358	1.559	3.273	0.911	1.588	1.091	0.521*	2.213**
Right Wrist	5.871	2.226	6.060	2.177	7.773	3.911	5.838	2.515	7.491*	7.491*
Left Wrist	1.664	1.645	1.530	1.912	2.500	1.424	1.713	1.546	1.117	2.130
Hip	1.550**	0.097*	1.575**	0.177*	2.727	0.652	1.596**	0.909*	0.840	1.333
Right Thigh	5.236	2.323	5.515	2.029	5.455	4.032	5.302	2.364	1.521	6.796
Left Thigh	2.579	2.129	2.769	1.794	5.455**	1.601*	2.566	2.182	1.160	3.556
Right Knee	7.757	7.710	8.448	6.353	7.796	7.728	7.412	8.424	3.947	11.046
Left Knee	6.629	6.081	6.933	5.529	6.750	6.380	6.346	6.697	3.053	9.426
Right Calf	4.743**	0.484*	5.045**	0.265*	3.727	3.354	4.706	0.818	1.362	5.241
Left Calf	4.679**	0.517*	5.131**	0.265*	3.523	3.442	4.706**	0.726*	1.322	5.241

*p<0.05

** Group with higher WMDSs symptoms (based on body regions) at p<0.05

4. CONCLUSION

The results of this study revealed that WMSDs is a issue in the firefighting profession as its prevalence is substantial. This occupational injury is disabling and potentially disruptive to the firefighters' functional status even it is occur in the non-dominant side. Therefore, highlighting the risk factors involved and the immediate prevention measures may be helpful in reducing this alarming occupational problem.

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