

PREVALENCE OF MUSCULOSKELETAL DISORDERS
AND ERGONOMICRISK FACTORS AMONG
FIREFIGHTERS



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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Physical Therapy
Department of Physical Therapy
FACULTY OF ALLIED HEALTH SCIENCES
Chulalongkorn University
Academic Year 2022
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ความซุกของความผิดปกติของระบบกล้ามเนื้อและกระดูก และปัจจัยเสี่ยงทางการยศาสตร์ในนัก
พจญเพลิง



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชากายภาพบำบัด ภาควิชากายภาพบำบัด
คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2565
ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

แอนช่า ฟารุก : ความชุกของความผิดปกติของระบบกล้ามเนื้อและกระดูก และปัจจัยเสี่ยงทางการศาสตร์ในนัก
ผจญเพลิง. (PREVALENCE OF MUSCULOSKELETAL DISORDERS AND
ERGONOMICRISK FACTORS AMONG FIREFIGHTERS) อ.ที่ปรึกษาหลัก :
ผศ. ดร.มนทกาน ไชย कुमार

ที่มาและความสำคัญ : การบาดเจ็บต่อระบบกระดูกและกล้ามเนื้อ หรือ ความสามารถในการเคลื่อนไหวของ
ร่างกายในมนุษย์ เรียกว่า โรคทางระบบกระดูกและกล้ามเนื้อ ได้แก่ กล้ามเนื้อ เอ็นกล้ามเนื้อ เอ็นข้อต่อ เส้นประสาท หมอน
รองกระดูก หลอดเลือด เป็นต้น การดับเพลิงเป็นงานที่ต้องใช้ร่างกายอย่างหนักและอันตราย พนักงานดับเพลิงปฏิบัติงานภายใต้
การฉุกเฉิน ป้องกันและระงับอัคคีภัย ซึ่งมักเกิดโรคทางระบบกระดูกและกล้ามเนื้อ

วัตถุประสงค์ : เพื่อศึกษาความชุกของโรคทางระบบกระดูกและกล้ามเนื้อ และปัจจัยเสี่ยงด้านการศาสตร์ในกลุ่ม
พนักงานดับเพลิง

วิธีการวิจัย : การศึกษานี้ใช้แบบสอบถาม Nordic musculoskeletal questionnaire เพื่อรายงาน
โรคทางระบบกระดูกและกล้ามเนื้อในนักดับเพลิงจำนวน 106 คน และใช้แบบสอบถาม Quick Exposure Check
(QEC) ในนักดับเพลิงจำนวน 20 คน ซึ่งมีลักษณะงานที่แตกต่างกัน 3 งาน เพื่อประเมินปัจจัยเสี่ยงด้านการศาสตร์

ผลการศึกษา : ผลการศึกษา พบว่า นักดับเพลิงประสบกับอาการปวดหลังส่วนล่างเป็นสำคัญในช่วง 12 เดือนที่
ผ่านมา ตามมาด้วยอาการปวดไหล่ และปวดคอ อาการปวดหลังส่วนล่าง และปวดเข่าทำให้เกิดปัญหาในการทำงานในช่วง 12
เดือนที่ผ่านมา ส่วนอาการปวดในช่วง 7 วันที่ผ่านมา ได้แก่ ปวดหลังส่วนล่าง รองลงมาคือ ปวดเข่า และปวดหลังส่วนบน
งานที่มีการแบกบันไดไว้บนไหล่ เป็นปัจจัยเสี่ยงด้านการศาสตร์หลักๆ ที่จะพัฒนาไปสู่โรคทางระบบกระดูกและกล้ามเนื้อ เมื่อ
เทียบกับงานถือสายยาง และพับสายยาง

สรุปผล : ความชุกของโรคทางระบบกระดูกและกล้ามเนื้อในพนักงานดับเพลิง พบได้ใน หลังส่วนล่าง, เข่า, คอ
และไหล่ งานที่มีการแบกบันไดไว้บนไหล่ เป็นปัจจัยเสี่ยงด้านการศาสตร์ที่พัฒนาไปสู่การเกิดโรคทางระบบกระดูกและกล้ามเนื้อ

คำสำคัญ : นักดับเพลิง โรคทางระบบกระดูกและกล้ามเนื้อ ปัจจัยเสี่ยงด้านการศาสตร์ QEC (quick
exposure check), Nordic musculoskeletal questionnaire

สาขาวิชา กายภาพบำบัด
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ลายมือชื่อนิสิต

ลายมือชื่อ อ.ที่ปรึกษาหลัก

6470019337 : MAJOR PHYSICAL THERAPY

KEYWORD Firefighters, Musculoskeletal disorders, ergonomic risk factors,

D: QEC(quick exposure check), Nordic musculoskeletal questionnaire

Hamza Farooq : PREVALENCE OF MUSCULOSKELETAL DISORDERS AND ERGONOMICRISK FACTORS AMONG FIREFIGHTERS. Advisor: Asst. Prof. MONTAKARN CHAIKUMARN, Ph.D.

Background: Injury to the musculoskeletal system or the human body's ability to move is known as a musculoskeletal disorder (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.). Firefighting is a physically hard and dangerous job. Firefighters carry out emergencies and prevent fire and respond to disaster. Workers who deal with fireworks often have musculoskeletal disorders.

Objective: To investigated the prevalence of musculoskeletal disorders and ergonomic risk factors among firefighters.

Methodology: Nordic musculoskeletal questionnaire was used to report musculoskeletal disorders in 106 firefighters and quick exposure check (QEC) questionnaire was used in 20 firefighters for 3 different tasks to evaluated the ergonomic risk factors.

Results: Firefighters experienced low back pain as major pain in last 12 months. Followed by shoulder and neck pain. Low back pain along with knee pain caused trouble in working in last 12 months. While pain in last 7 days were low back pain followed by knee and upper back pain. Task of lifting ladders on shoulder was the major ergonomic risk factor for developing musculoskeletal disorders as compared to holding up hose and folding the hose task.

Conclusion: High prevalence was shown in low back, knees, neck and shoulder. Lifting up ladders on shoulder task leads to ergonomic risk for development of musculoskeletal disorders.

Keywords: Firefighters, musculoskeletal disorders, ergonomic risk factors, QEC (quick exposure check), Nordic musculoskeletal questionnaire.

Field of Study: Physical Therapy

Student's Signature

Academic Year: 2022

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Advisor's Signature

Year:

.....

ACKNOWLEDGEMENTS

I am very grateful to God Almighty ALLAH who gave me strength, ability and guidance to carry out my research project and to preserve and to complete it satisfactorily. I would like to express my sincere gratitude to Assistant Professor MONTAKARN CHAIKUMARN, Ph.D. my research supervisor, for her assistance, guidance and immense knowledge. I would also like to thank all members in Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University for their throughout support. I also thank my parents for the unceasing encouragement, support and attention. I would like to thank all study participants. I would also like to thank all of my friends at Chulalongkorn University for their support. I would also like to thank Chulalongkorn research ethics committee and Rescue 1122 department, Pakistan to give permission and carry out this study. I would also like to thank Dr. Noman Awan PT, who helped me in data collection.

I am very thankful to all of you for making this study successful.

Hamza Farooq



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CHAPTER 1

INTRODUCTION

1.1 Background

Work-related musculoskeletal disorders defines as a disease of degeneration and inflammation within structures that related to physical and psychosocial exposures at workplace (Buckle & Devereux, 2002).

Firefighting is a profession that requires high physical strength. This usually requires the incumbent to be prepared for unexpected situations. Multiple scientific investigations have sought understand the physical requirements of the job. A training plan can be developed to improve the ability of firefighters and the performance to reduces their risk of injury (McGill et al., 2013).

Firefighting service remains one of the most dangerous industries in the country, with a work-related injury rate exceeding most other industries for example, in 1998, the fire department's rate of work-related injuries was more than four times that of private companies, and one out of every three firefighters was injured while on duty (Walton et al., 2003).

Due to highly dangerous and physical nature of firefighter's profession, high level of job-related injuries found in firefighters. Over excretion of musculoskeletal

system are associated with large number of injuries which can then result in disability (Butler et al., 2013).

Firefighting has been a tough job with stress and different occupational exposures like physical and emotional demands and working shift. Many disorders have been reported among firefighters like cardiovascular, musculoskeletal, sleep and fatigue. Normal performance of firefighters may be affected by these disorders while performing firefighter's activities and tasks (Bos et al., 2004a)

Many studies have reported that firefighting is one of the most physically demanding job. Extreme psychological responses can be caused by different conditions like working under hot, polluted and humid environments, holding PPE and self-contained breathing apparatus (Michaelides et al., 2011).

It is mandatory for firefighters to perform their job duties by maintaining fitness level. Because firefighters' occupation is a dangerous and a physically demanding occupation. Tasks performed by firefighters include lifting objects, patients transport and carrying heavy equipment's. Recent researches show obesity is also greater in firefighters so obesity is one of a major factor which effect firefighters performance for performing tasks and activities (Jahnke et al., 2015).

Firefighting is a tough job which is performed under utmost environmental conditions. Waiting for long periods of time between periods of intense activity characterized those firefighting demands are on and off and unpredictable. The

irregular movements of firefighters during activity are the components for developing stress among firefighters. There are many of physiological factors or demands of firefighters like stress of heat associated with heat from fire, energy cost while performing firefighting activities (Guidotti, 1992).

1.2 Rationale of study

As firefighters go through different dangerous tasks which require their physically input in hot environment. While performing tasks, holding of heavy load equipment, carrying PPE firefighters are at high risk of developing musculoskeletal disorders.

Therefore this study was aimed to determine the prevalence of MSDs and ergonomic risk factors among firefighters of Faisalabad, Pakistan because there was none of study has been done on firefighters in Pakistan yet.

1.3 Objectives

- To determine the prevalence of Musculoskeletal disorders among firefighters of Faisalabad, Pakistan.
- To evaluated ergonomic risk factors among firefighters of Faisalabad, Pakistan.

1.4 Hypotheses of study

- High prevalence of musculoskeletal disorders will be found in Pakistani firefighters.
- Ergonomics will be the risk factors responsible for developing musculoskeletal disorders.

1.5 Brief method

Firstly, participants were recruited from various fire stations of Faisalabad, Pakistan. They were asked to fill out consent form after reading. There were 14 fire stations in Faisalabad, Pakistan. Those who took part in rescue peoples from fire and emergencies and took control of such conditions were our participants.

Secondly, questionnaire was given to them. The first part of questionnaire was Nordic Musculoskeletal Questionnaire and second part was Quick Exposure Check. In the first part they were asked about prevalence of pain, age, sex. The participants who met the inclusion criteria were included in this study.

1.6 Advantages of study

- The results of this study told us about the prevalence of musculoskeletal disorders and ergonomic risk factors among firefighters.

- This study may help researchers to understand work related problems of firefighters. So better management can be plan of working organization and environment to prevent developing of MSDs.



CHAPTER 2

LITERATURE REVIEW

2.1 Firefighters

Firefighting is a type of profession which is characterized by long periods of work with low intensity and sometimes from moderate to severe intensity occasionally. Sometimes according to situation firefighters work for unpredictable time duration in such great heat environment. High physical requirement for the tasks needs by firefighters at firefighting place. Most of energy used of firefighters while performing their tasks like carrying or holding equipment's, performing in heavy protective covering clothes and task done or deal by hands (Barr et al., 2010).

Firefighting has been a mentally and physically demanding job. Many accidents or complaints have been seen in firefighters like premature deaths, musculoskeletal complaints, health complaints and high rates of injuries. These demands of work and tasks highly increase the rates of these complaints. Heart rate can be increase due to high intense energy requirement for performing tasks which may results in lower cognitive performance, fatigue and over exhausted which leads to human accidents and errors. Fatigue can be caused by irregular hours of working and high intensity energy load during 24 hours of duty. Firefighters can be considered at high risk at job on the basis of these observations. For preventing this, demand of

work should be minimized and should take step to balance between fitness level and working conditions (Bos et al., 2004b).

Firefighting is a high demanding job which require physically participation with high risk of danger and risky environments of job. This profession has high risk of job-related injuries. Over excretion of musculoskeletal system results in large number of injuries. Risk of musculoskeletal injuries increases with high stress of job (Salar et al., 2017).

2.1.1 Prevalence of MSDs in firefighters

Nazari and colleagues (2020) conducted a study to evaluate the percentage of musculoskeletal disorders in Canadian firefighters on the basis of their age and sex. He did this study also to evaluate either sex, age or duration of their duty timing can be used to predict about incidence of musculoskeletal symptoms in them. A number of 390 firefighters included in this study which include females 118 and males 272. 11 item standardized questionnaire was used to collect data from firefighters. They were asked to fill up that questionnaire to identify musculoskeletal symptoms whether in last 7 days you have any pain in body region. The options in questionnaire were “yes” or “no” on head, neck or other parts of body. 212 out of 390 indicate about musculoskeletal disorders within time of last 7 days. Back region was the most incidence part of musculoskeletal symptoms which was about 123 firefighters. Shoulder was about in 92 and in neck it was about 74, knee it was 70. While going through duty timing and age difference, women were more likely to develop

musculoskeletal symptoms about 1.4 to 1.6 times higher than men. Overall prevalence was 54% of musculoskeletal symptoms (Nazari, Osifeso, et al., 2020).

Aurangabadkar and colleagues (2019) performed a study to identify the prevalence of self-reported MSK disorders among Mumbai firefighters. Both males and females from different fire brigade centers with 70 participants were included in this study. A valid questionnaire was given to them to get their information about job type, status and demographic data with reporting musculoskeletal issues. Rapid entire body assessment was used to analyze their working postures. The prevalence of neck was 24%, shoulder was 23%, elbow was 13%, upper back was 7% and lower back was 6%. About 27% of firefighters said they have not any feel or symptom of musculoskeletal problems. Conclusion made in this study that there was high prevalence in neck and shoulder region among firefighters from different centers of Mumbai (Aurangabadkar et al., 2019).

A cross sectional study done by Negm and colleagues (2017) to check the incidence of self-reported musculoskeletal disorders and how they vary by their time of service, duty and demographic data. in firefighters from the city of Hamilton fire service who were enrolled in FIREWELL. 294 firefighters who were activated on duty participated in this study and fill up the diagram of body to locate their musculoskeletal pain and its intensity. Neck Disability Index (NDI), Roland Morris Disability Questionnaire (RMDQ), Lower Extremity Functional Scale (LEFS), or the Short Form of Disabilities of the Arm, Shoulder and Hand (Quick DASH) were used to access musculoskeletal pain and its intensity. ANOVA test was used to check the

prevalence of musculoskeletal pain. Neck prevalence was 20%, back, upper limb was 44%, back was 33% and lower limb was 45%. Firefighters with older age and longtime of duty was on high risk for developing musculoskeletal disorders (Negm et al., 2017).

Soteriades and colleagues (2019) performed a study in firefighters to know about any association between MSK symptoms and occupational stress. Questionnaires were used among firefighters anonymously to collect data. Survey was completed by 430 firefighters. Age of firefighters fall in the range of 21-60 years. Copenhagen psychosocial questionnaire and depression, anxiety and stress scale were used to assess stress. 11% of firefighters experienced moderate to severe stress. 40% of firefighters experience musculoskeletal symptoms mostly in back region. After adjusting obesity, age and smoking it was concluded that 50% of occupational stress is associated with musculoskeletal symptoms. So, conclusion was made that high prevalence of MSK symptoms associated with occupational stress (Soteriades et al., 2019).

Kim and colleagues (2013) conducted a cross sectional study to know about relationship or association between job stress and work-related musculoskeletal disorders in Korean male firefighters. Around 21,466 firefighters participated in this cross-sectional study. General characteristics and musculoskeletal disorders were assessed by the Korean occupational stress scale, center of epidemiologic studies depression scale questionnaire. Correlation or relationship of musculoskeletal disorders, general characteristics and job stress was evaluated by chi square test and

univariate and multivariate logistic regression analyses. Most common work-related musculoskeletal disorder was back pain. So, conclusion was made that there was relationship between musculoskeletal disorders and job stress (Kim et al., 2013).

A study done by Kodom and colleagues (2019) to examine how relationship of work demand and work-related musculoskeletal disorders of firefighters moderated by their task characteristics. In greater Accra region of Ghana, 320 firefighters were selected. work demand of firefighters was checked by a questionnaire of van Veldhoven and Meijman's. Task characteristics were measured by Van Zyl and Van der Walt's questionnaire of experience of work and life. Work related musculoskeletal disorders were measured by Standardize Nordic questionnaire. Descriptive statistics, regression and correlation was used for analyzing data. Positive effects on work related musculoskeletal disorders have been revealed by work demand and task characteristics of firefighters. So, development of work-related musculoskeletal disorders can be minimized by modifying tasks and work demand of firefighters (Kodom-Wiredu, 2019).

Saremi and colleagues (2019) carried a cross sectional study among 250 firefighters in Tehran to assess workability and musculoskeletal disorders and mental workload. Data was collected from 120 different existing working stations. Mental health was assessed by National aeronautics and space administration task load index questionnaire. Musculoskeletal disorders were investigated by body discomfort chart. Workability was assessed by work ability index questionnaire. Linear regression and

descriptive statistics were applied. So, conclusion made that reduction in work ability associated with age increase and marital status. In firefighters with low musculoskeletal disorders have high work ability and mental workload (Saremi et al., 2019).

A study done by RAS and colleagues (2018) on firefighters of Brazil to confirm about relationship between musculoskeletal disorders prevalence with service time and age. Prevalence of musculoskeletal disorders was measured by Nordic questionnaire. 27 firefighters participated in this study. They were divided into two groups according to their service time. Group A >5 years and group B < 5 years. Mann-Whitney test was used to compare the prevalence of musculoskeletal disorders between these groups. Spearman test was used to confirm correlation between age of firefighters and prevalence of musculoskeletal disorders. 89% of firefighters reported musculoskeletal disorders in which back pain is most significant. There was no any significant relationship observed between musculoskeletal disorders symptoms and age (RAS et al.).

Abbasi and colleagues (2020) conducted a study to check the prevalence of musculoskeletal disorders and its association with insomnia among firefighters. Firefighters from Qazvin participated in this study. Study was cross sectional. Questionnaires used were insomnia severity index, body map and Nordic musculoskeletal. Demographic data was also collected of participants. Questionnaires were completed by firefighters. Data analysis was done by chi square test, student's t-

test, and descriptive analysis. Number of participants in this study were 118 firefighters. Overall musculoskeletal disorders prevalence was 54.2%. and most common part of body was low back with 30.5%. Middle lumber was noted the most painful area. Firefighters with subclinical insomnia were about 20.3% and who have insomnia moderate to severe were about 30%. Insomnia severity was more significant in firefighters with musculoskeletal disorders rather than those without musculoskeletal disorders. Conclusion was made that severity of insomnia associated with musculoskeletal disorders around lumber region (Abbasi et al., 2020).

Azmi and colleagues (2019) conducted a cross sectional study on firefighters in klang valley to investigate about functional status and work-related musculoskeletal disorders of firefighters. 101 firefighters took part in this study. They were from 3 different fire stations in klang valley. The Malay Version of Cornell Musculoskeletal Discomfort Questionnaires (CMDQ-M) and COOP/WONCA Chart were used for assessment. Most effected body region was low back. Significant relationship of lower back, upper back, left thigh and left wrist was identified by multiple regression test with 50% of functional status. It was also revealed that work related musculoskeletal disorders at right thigh, left wrist, left calf, right arm and left knee seemed to be main contributing factor for each functional status (Azmi & Masuri, 2019).

A study performed by Nazari and team (2020) among firefighters to describe percentage distribution of number, location of painful areas. Study was also done to

determine whether age, painful areas or sex have any effect on work limitation.

Through an online survey or by paper format work limitation questionnaire was used among 325 firefighters. Data was analyzed by ANOVA test. Results came for percentage of number of painful areas was about 43% pain free, 17% on 1 painful area, 19% on 2 painful sites and 21% three or more painful regions. Percentage of sites of pain was 43% no pain, spine was 41%, upper extremity was 7% and lower extremity was 9%. So, conclusion made that firefighter with age greater than 45 years gone through more physical work limitations than those who are less than 45 years old. One painful location was reported by most of firefighters and spine was the most painful area. So, workout limitations depend on age, location of painful sites and number of painful regions (Nazari, MacDermid, et al., 2020).

Lee and colleagues (2014) conducted a study on firefighters to evaluate about their quality of life how work-related musculoskeletal disorder effect on their quality of life. 366 participants were selected to obtain data. NIOSH symptom table used as a questionnaire to measure work related musculoskeletal disorders symptoms and SF-36 was used to measure health related quality of life. In upper limbs percentage of musculoskeletal disorders was 38%, 21.6% in lower limbs, 35.5% in lower back and 59.3% in 2 or more than 2 regions of body. Firefighters with work related musculoskeletal disorders symptoms have low scores on quality of life in all dimensions as compared to those without any musculoskeletal disorder symptoms. So, conclusion was that quality of life can be improved by preventing work related musculoskeletal disorders (Oh et al., 2014).

Katsavomi and team (2016) conducted a study to find the relationship between burnout post traumatic disorder symptoms and work-related injuries among firefighters in Greece. Questionnaires used for data collection were Maslash burnout inventory, a work-related injuries questionnaire and impact of event scale revised Greek version. Multivariate and univariate logistic regression analysis were used for data analyses. 3289 firefighters of population participated in this study. Results came into a great association between age, physical condition, work experience and post-traumatic stress order symptoms, work related injuries and burnout syndrome. Rescue of a child and dealing with death was the most traumatic event and responsibility of victim's quality of life was the top stress factor. So high importance should be given to early response to psychosomatic issues in firefighters (Katsavouni et al., 2016).

A study conducted by Pelozato and colleagues (2021) among military firefighters in Brazil to check the percentage of chronic low back pain. Study was cross sectional and it was carried out among firefighters at department of Brazilian Federal District. Sample size was about 608 military firefighters. Three trained physiotherapist and ten under graduated students collected data. Descriptive analyses were used for data analysis. 575 complete and valid questionnaires out of 623 participants were analyzed. Chronic low back was reported by 183 participants which indicated percentage of chronic low back pain about 31.8%. 9.2% was acute or sub-acute low back pain and with no back pain was 59%. In men between age 40-49 years, chronic low back pain was most common who were overweight and inactive.

So, chronic low back pain was reported by one third on population selected for study (Pelozato de Oliveira et al., 2021).

Plat and team (2012) performed a study among Dutch firefighters. Study aim was to check how work ability of firefighters according to age effected by chronic diseases. In Netherlands, 3 work stations were selected in this study. Work ability index questionnaire was used for checking work ability. For chronic diseases questionnaire was filled out about 9 types of chronic diseases and their prevalence by firefighters. Fisher exact test was used to calculate the difference in work ability in 4 age groups and total with chronic diseases and without chronic diseases. Chronic diseases were reported by 23% among 276 firefighters with varying rate in age groups between 18 to 41%. 8 was the median of workability. So, no any major difference was found in firefighters' workability with and without chronic diseases independent of age groups (Plat et al., 2012).

Damrongsak and colleagues (2018) conducted a study in firefighters to identify the predictors of back pain. Study was aimed to identify the variables like age, body mass index, history of back pain, job satisfaction and occupational stress. Sample of 298 firefighters were taken in this study. Correlation study design was done among these firefighters who completed questionnaires. Current back pain about 30.20% was reported by one third of firefighters. So, factors that predicted the current back pain was, occupational stress, age, history of pain and BMI (Damrongsak et al., 2018).

Sepidarkish and colleagues (2014) performed a study among firefighters to check the prevalence of occupational stress and how it correlates with them. Study was done in Iran among Tehran firefighters. By multi sampling firefighters around about 312 were selected from 5 different operating region. Participants fulfilled occupational stress questionnaire and demographic data. SPSS was used for data analysis. Overall occupational stress was 2.2%. In demand area it was 5.8%, in control area 41%, in role area 1.5%, in communication area 12.5%, in change area 17%, in peer support area 5.4% and in manager support area 14.1%. Between married status, career history there was a significant correlation found with occupational stress. Overall occupational stress prevalence was low in firefighters of Tehran (Sepidarkish et al., 2014).

A study done by Kim and colleagues (2021) in male firefighters of south Korea. Study was aimed to compare low back pain prevalence in firefighters according to their job nature and to identify risk factors of low back pain. 72 office workers of hospital and 277 male firefighters completed questionnaire and MRI was done on them. Low back prevalence was higher in firefighters than control group. The Odds ratio of low back pain with insomnia was higher statistically as compared to those who had low back pain without insomnia. Odds ratio of low back pain with herniated disc L4-L5 was statistically higher than those without herniated disc. So, odds ratio of low back pain among rescue workers were greater than control ones and

low back pain was affected by job nature, insomnia and lumbar disc herniation in firefighters (Kim & Ahn, 2021).

2.2 Work related musculoskeletal disorders

Work related MSDs can be described as huge range of diseases degenerative and inflammatory. Pain and functional impairment can be seen as result of these disorders and shoulder, neck, hand, wrist and elbow may be affected. According to the world health organization work related musculoskeletal disorders are those when work condition and activities contribute to such disorders development (Buckle & Devereux, 2002).

Disorders to musculoskeletal system which may come from repeated activities and exposure to various risk factors in place of work are the musculoskeletal disorders. MSDs can be found in different industries and their rate varies or higher than other industries depending on working conditions (Ispăsoiu et al., 2021).

Disorders of soft tissues and structures surrounding them are the musculoskeletal disorders which not caused by any trauma or acute event. Disorders which are related to work performance and environment are musculoskeletal disorders. MSDs are different from occupational diseases. Several risk factors of work place associated with musculoskeletal disorders (Hales & Bernard, 1996).

2.2.1 Model of work-related musculoskeletal disorders

“Workstyle model” was constructed by Feuerstein et al. The concept was used to explain why the workers who exposed in the same work tasks vary in the development and aggravation of upper extremity WMSDs, especially focused on behavioral mechanisms. This concept has been defined as behaviors of individuals, cognitions, and physiological reactivity that co-occur while working. Workstyle responses involved to cognitive and behavioral reactions, the more increasing of work demands can result in physiological changes. Repetition can contribute to the development, aggravation, and/or maintenance of WMSDs. This high-risk workstyle can be triggered by increasing work demands. The workplace psychosocial stressors, work demands, and ergonomic stressors can trigger a high-risk workstyle response. These 3 factors can lead to the musculoskeletal hazard (such as symptoms, disorders, disability), which consequently increase the negative impact of workplace psychosocial stressors and work demands by increasing the possibility that the worker will sustain a high-risk workstyle to accommodate the demands. If the high-risk workstyle is maintained, negative health and work outcome can persist (R. A. Nicholas et al., 2005).

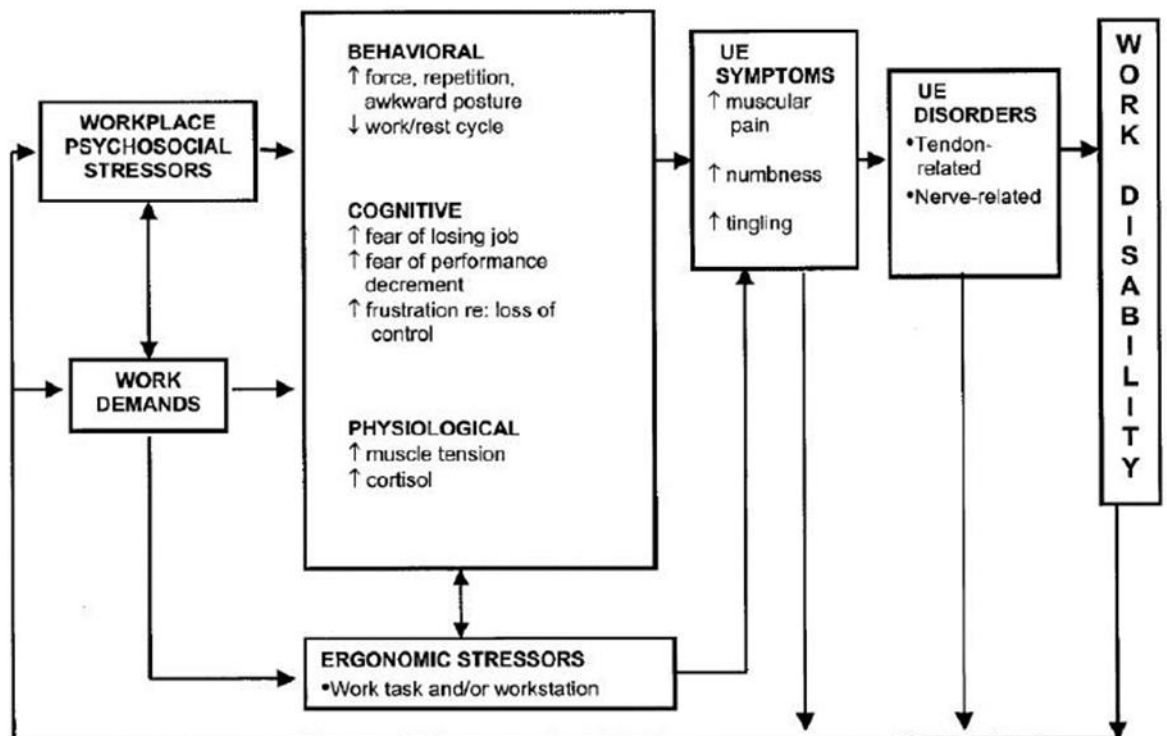


Figure 1 A workstyle model (Rena A Nicholas et al., 2005)



2.2.2 Pathophysiology of musculoskeletal disorders

Since late 1980s, work related musculoskeletal disorders have been responsible for workers injuries in many of industrialized nations. Despite the fact of epidemiological reasoning of developing such musculoskeletal disorders by repetitions and force, further clarification required for completely understanding these health complaints related to occupation on tissue response pathophysiological mechanism in early stages of such disorders or complaints. Several experiments and

clinical study showed results that micro trauma of tissues occurred due to repetitive performing tasks and forceful tasks and this type of tissue injury leads to inflammation including structural and fibrotic tissue changes (Barbe & Barr, 2006).



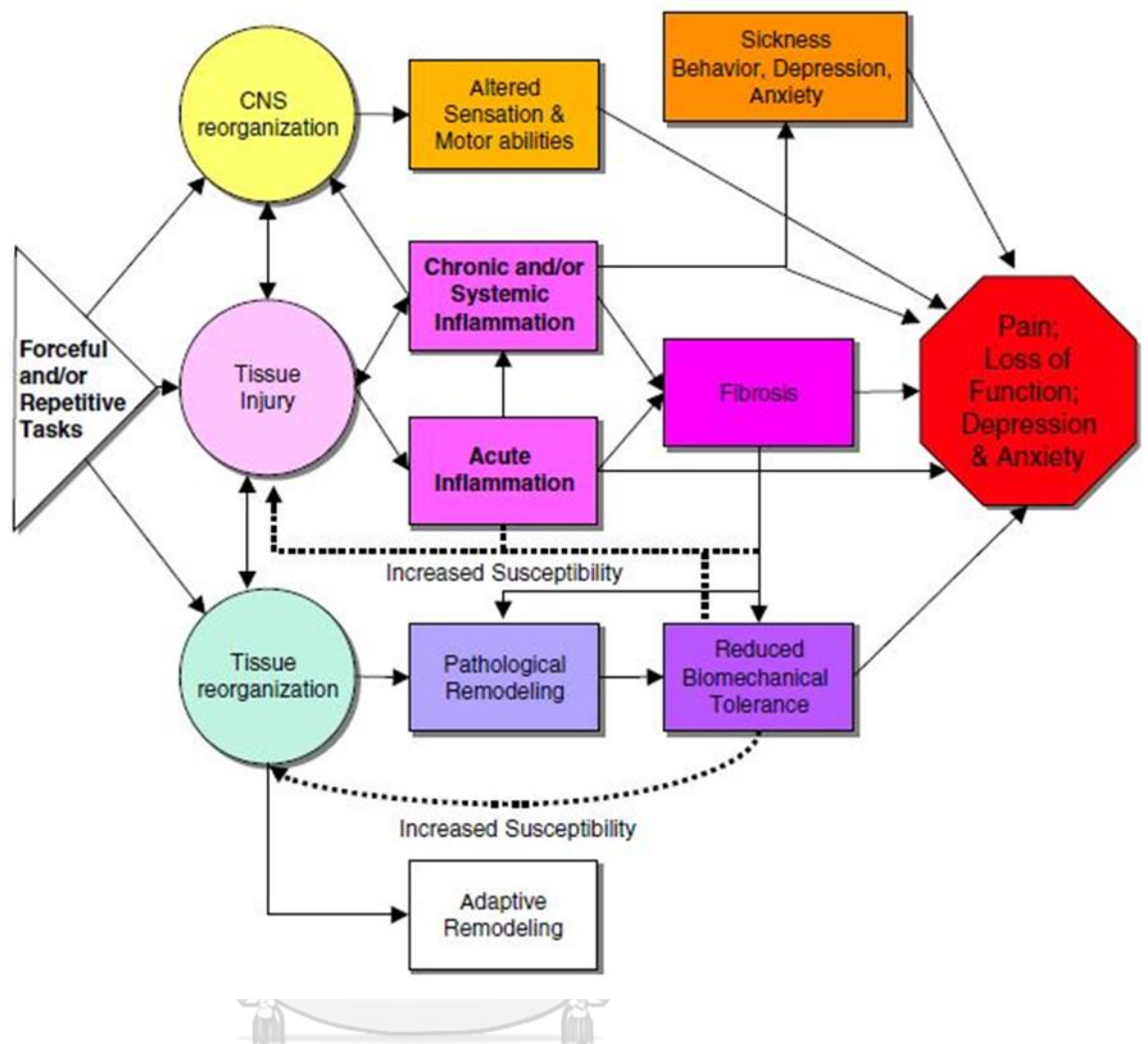


Figure 2 schematic diagram by Barr et al showing all three possible ways that lead to musculoskeletal disorders related to work by repetitive by forceful and repetitive task of hand. (Barbe et al., 2006)

A study was performed to provide epidemiological findings related to musculoskeletal disorders related to work and to summarize experimental studies about tissue pathophysiology in work related musculoskeletal disorders of hand and wrist. Epidemiologic studies related to hand and wrist musculoskeletal disorders are

reviewed and summarized which published since 1998. Pathophysiology of tissues was concerned from selected studies in response to repetitive movement of tissue loading. Results showed from selective studies that repetitive movements of hand and wrist contribute to development of musculoskeletal disorders in combination with physical or nonphysical risk factors or alone as well. Inflammation included as pathophysiological mechanism of injuries related to tissues (Barr et al., 2004).

A literature review was done on pathophysiology of muscular disorders of upper extremity. Results from literature review showed that circulation limitations and muscle cells disorders lead to upper extremity muscular disorders. Literature indicates that there may be many of possible mechanisms but no one completely explained and sufficiently supported by empirical data. Overall, all literature indicates that primary cause of upper extremity muscular disorders may be sustained muscle activity. There may be changes in blood flow, activity of muscles, morphology and accumulation of calcium in sarcoplasm which may be due to damage of muscle cells (Visser & van Dieën, 2006).

2.3 Ergonomic risk factors

Ergonomic risk factors are related to the job aspects and may impose biomechanical stress on the worker, and those risk factors as synergistic elements may cause hazards (Durmaz et al.).

Ergonomics risk factors can be defined as repetitive movements and exposure to unnatural environment and postures, tools, tasks and wrong design of work stations. In many of workplaces, ergonomics has been applied. However, ergonomic risk factors may be occurred with high risk in some specific type of tasks and jobs which includes overhead and extended tasks, repetitive movements, articular postures and working in static postures just like surgeons who require repetitive movements, standing and sitting while doing their jobs and tasks. These type of posture positions and biomechanical loads leads to musculoskeletal disorders (Zainuddin, 2014).

Firefighters mostly involved in physical activities and mostly exposed to hazards due to which various problems related to ergonomic occur. Ergonomic risk factor can play their part for developing musculoskeletal disorder. Ergonomic risks are awkward posture, pressure points, forceful exertions, static posture and repetitive motion which causes musculoskeletal disorders related to work. In Firefighters due to prolonged physical involvement and activity, musculoskeletal disorders or complaints prevalence is high (Isamudin & Mahmood, 2021)

Abbasi and colleagues (2018) did this study to evaluate relation between quality of sleep and psychological factors, demographic and ergonomics among firefighters of Qazvin. Seven stations were selected for collecting data and 118

firefighters participated in this study. Beck depression inventory, Pittsburgh sleep quality index, demographic, Nordic questionnaire were used. For occupational stress HSE questionnaire was used. Firefighters were divided into two groups. One with good sleep and other with poor sleep quality. Data were compared between these two groups. Regression analysis was used for data analyzed. Firefighters with poor sleep quality was about 59.3%. A significant correlation was seen between body mass index, shift work, musculoskeletal disorders, stress and quality of sleep by univariate analysis. Despite occupational stress, significant relationship of all other variables associated with quality of sleep by performing multivariate analysis. Conclusion was made that there is great association between poor quality of sleep and musculoskeletal disorders, high BMI and shift work (Abbasi et al., 2018).

A study performed by Gentzler and team (2010) on firefighters and emergency medical technicians about posture stress associated with repetitive bending, lifting, reaching and pulling tasks. This study was aimed to evaluate the ergonomics to identify the risks leads to musculoskeletal injuries due to extreme and awkward postures across a patient care task and two post fire tasks. The participants were from an urban United state fire department. National institute of occupational safety health, rapid upper limb assessment and rapid entire body assessment tools used for ergonomic evaluation. For rolling and lifting the hose above shoulder high to very high risk was found. Extreme risk was found while hose drainage and lifting above chest. High risk was found for emergency medical technicians' tasks which require horizontal twisting and bending while seated and for overhead reaching

equipment. So, these tasks require changes and modifications to reduce risk of musculoskeletal complaints (Gentzler & Stader, 2010).

Lim and colleagues (2014) performed a study among male firefighters working in metropolitan city in South Korea. The study was aimed to investigate the factors which were associated sleep disorders. Data was collected by Nordic musculoskeletal questionnaire, psychosocial wellbeing index short form, Pittsburgh sleep quality index, Korean occupational stress scale short form and beck depression inventory-2 questionnaires. Questionnaires were given to 730 male firefighters but 657 male firefighters were selected after exclusion of those with data missing. Logistic regression analysis was used to check relationship between these factors and sleep disorders. Sleep disorder prevalence was 48.7% among male firefighters. So, these factors were associated with sleep disorders. Better health management is required for good quality sleep among firefighters (Lim et al., 2014).

Laskar and team (2021) performed a study to among firefighters to check the prevalence of work-related musculoskeletal disorders and to find the factors which caused or behind it. Around about 152 fireworks male workers were investigated varied on age groups. 100 control participants were investigated too. Questionnaire used for location wise identification of musculoskeletal disorders was Nordic questionnaire. In Both groups strength of hand grip was also checked. Lower back was the most affected area which experienced musculoskeletal disorder related to

posture, which increased by the age and experience of work. On other parts like neck, upper back, knee, ankle, elbow and wrist, pain with stiffness also noted (Laskar et al., 2021).

Roh and colleagues (2011) conducted a study to evaluate the posture of working of firefighters for the prevention of musculoskeletal disorders. Study was done among 64 firefighters. Musculoskeletal symptoms distribution, physical burden levels was surveyed. Working postures were analyzed by using ergonomic tools such as rapid upper limb assessment, NIOSH lifting equation and Rapid entire body assessment. High risk level was found as a result of rapid entire body assessment. Immediate improvement required for working postures. Instability posture leads to increase prevalence of musculoskeletal disorders among firefighters (Roh et al., 2011).

Katsavomi and team (2014) conducted a study in firefighters. Study was aimed to check the association of work-related risk factors and low back pain and to examine what contribution exercise can do among firefighters. In Greece, questionnaire was filled out through survey. Chi square test, binary logistic regression was used as statistical analyses. Out of 3451 firefighters only 30% about 1037 reported low back pain. A significant correlation was found between work experience, job nature, job rank, age, smoking, sex and low back pain. Odds ratio was higher in rescue workers as compared to drivers, in women than men and in those who worked more than 5 years as compared to those who between 1 to 5 years. So, conclusion

made those improvements in techniques for performing job can play a vital role in minimizing the low back pain symptoms in future (Katsavouni et al., 2014).

A study performed by Vitari and colleagues (2012) to provide a solution completely or partially and contributing to improvement of situation of firefighters to minimize or prevent risk of injury due to ergonomics. Awkward postures can be enhanced in firefighters due to their functional tasks like applying techniques, performance, long time shifts, heavy equipment with intensive hands use and stressful situations. This is among other ergonomic risk factors. Study was quantitative and carried among five operational units in Brazil. Items which were analyzed were firemen profile, environment of working, level of training received, tasks performed and assessment of pain. Around 208 questionnaires were answered in total. Data was presented in tables, graphs, charts and analyzed by frequency. So conclusion made that number of injuries can be reduced by correcting ergonomics while performing tasks and other operational activities (Vitari et al., 2012).

Kodom and colleagues (2016) performed research on firefighters to evaluate how work-related musculoskeletal disorders were affected by task characteristics and their work experience. In greater Accra regional, 320 firefighters were selected for collecting data. Inferential and descriptive statistics were used to analyzed data. Ratio of work-related musculoskeletal disorders increases with task characteristics severity. However, there was no any significant correlation of increase musculoskeletal

disorders with work experience. So, it was concluded that there must my modifying or minimize in task characteristics such as shift rotation to prevent musculoskeletal disorders prevalence (Kodom-Wiredu, 2016).

A study done by Sanda and team (2018) in firefighters to identify and explore characteristics in firefighters which were hidden and predictive factors of musculoskeletal disorders in fire service Ghana. 306 firefighters participated in this study and data was collected by a questionnaire which was divided in three sections. Section 1 was demographic data; section 2 was of task characteristics and section 3 was to measure musculoskeletal disorders. Descriptive analysis was used for data analysis. So, traumas experienced several times by firefighters characterized by accidental loss, human involvement, terrible personal sensory experiences, the severity of which increase by age of task performance. So, it was concluded that characteristics of task performance which were hidden could be result in increased chance of trauma and musculoskeletal disorders (Sanda & Kodom-Wiredu, 2018).

2.4 Nordic Musculoskeletal Questionnaire

A study by Crawford (2007) to check the validity of Nordic musculoskeletal questionnaire. Validity and reliability of Nordic musculoskeletal questionnaire was checked by using a test-retest methodology. Number of different answers they found ranges from 0 to 23%. Against clinical history validity was tested and range of disagreement found by Nordic musculoskeletal questionnaire about 0 to

20%. This questionnaire was accepted as screening tool by authors. Ranges from 7 to 26% of different numbers of answers from questionnaires have been identified by further trials for annual prevalence and for weekly it was 6 to 19%. However previous studies showed that NMQ is sensitive, repeatable and useful tool for musculoskeletal disorder screening (Crawford, 2007).

Kahraman and colleagues (2016) performed a study on adaptation of Nordic musculoskeletal questionnaire culturally in Turkey for use and to identify the psychometric properties of this adapted version. This adaptation was done by translating the original version of by mother tongue translators followed by committee review. Nordic musculoskeletal questionnaire which was completed by 198 participants twice on 1 week interval was examined to check the reliability. From the same population, data was collected from 126 participants who further completed 4 questions related to body areas as explained in Nordic musculoskeletal questionnaire to check the validity. The internal consistency was perfect (Cronbach's alpha= 0.896). PABAK (prevalence adjusted bias adjusted kappa) was checked with test-retest reliability and almost all items showed perfect reliability (PABAK=0.57-0.90) indicating that there is a great construct validity of NMQ. This study conclude that Turkish version of Nordic musculoskeletal questionnaire can be used for screen musculoskeletal symptoms (Kahraman et al., 2016).

A study conducted by Phadke and team (2015) in Mumbai among traffic

police to assess work related musculoskeletal disorders by using Nordic musculoskeletal questionnaire. Study was cross sectional and data was collected thorough Nordic musculoskeletal questionnaire by interviewing them directly. Setting of study Navi Mumbai traffic police and sample size was about 270. Out of these 270 traffic police participants only 2 were females and else ones were male which clearly showed that this profession is a male dominant. 39.18 was the average age of traffic police in this study. Data was analyzed in percentage form. Results showed that back pain is the most common symptom. Decreasing in duty hours and counseling about health or offering health educational programs may be the solution for diminish musculoskeletal disorders (PHADKE et al., 2015).

Amin and colleagues (2016) conducted a study in Klang valley among nurses in public hospitals to check the prevalence of musculoskeletal disorders. Reliability of Malay version of NMQ was also evaluated in this study. 660 female nurses participated in this study from 4 different public hospitals of Klang valley. Study was cross sectional. Response rate of 77.4% was achieved with 376 nurses who completed the survey. Results indicated that neck was most prevalent site with 48.9% and second most was 47.2% in feet, 40.7% in upper back and 36.9% in upper shoulder. Less than 25% of nurses claimed that their quality of life effected by work related musculoskeletal disorders. So, it was also proven that Malay version of Nordic musculoskeletal questionnaire is a reliable tool for assessing the musculoskeletal disorders (Amin et al., 2016).

2.5 Quick Exposure Check Questionnaire

David and colleagues (2008) studied on quick exposure checklist development for assessing ergonomic risk factors related to work for musculoskeletal disorders. This tool was developed for occupational safety health practitioners for intervention in ergonomics and to evaluate risks of musculoskeletal disorders related to work. Validity was tested among 206 practitioners by doing workplace tasks. 4 main areas of body include in QEC which can be evaluated including practitioners and workers. Intra-inter reliability, usability and validity of QEC have been determined by trails which showed it is applicable for great number of working postures. Mainly this tool focuses on physical workplace factors but it also involves psychological factors evaluation. QEC has a scoring system and in 10 minutes tasks can be assessed normally and can also guide about interventions in ergonomics related to workplace (David et al., 2008).

Ispasoiu and colleagues (2021) studied in industrial area on application of quick exposure check on assessment of ergonomics. Awkward postures and high pace of works cause musculoskeletal disorders among workers in the automotive industry in Romania. In that case it was necessary to identify ergonomic risk factors which can be changed and treated. Quick exposure check is an advanced tool for ergonomic assessment and this method involves both self-reporting and observational

assessment. Transferring of metal parts manually were analyzed by researcher. Transferring of parts from conveyor of belt to trolley and vice versa. By analyzing results of these tasks positions and postures through QEC method, some parts of body found to be more affected during these tasks (Ispăsoiu et al., 2021).

A study conducted by Bidiawati and team (2015) in brick production workers to assess the ergonomic risk factors related to workers muscular disorders at workplace by using QEC while performing work tasks and working postures that can cause muscular disorders. Different tasks of brick manufacturing were assessed by QEC. Damage to back, wrist, shoulder and neck asses by quick exposure check. Tasks of mixture material and bucket fulling seemed high potential for developing work related musculoskeletal disorders with exposure level of 73.8% and 71.5%. Bending of workers neck and back while working and rotating of wrist while load lifting increases risk of workers for developing muscular disorders. Improvements were done in positions and posture by new designing of working tools such as material mixture, brick plate or brick making table. As a result of this, exposure level fall down to 48.8% and 47.7% (Bidiawati & Suryani, 2015).

Abedini and colleagues did a study in metal manufacturing factory. This study was aimed to evaluate the ergonomic risk factors of musculoskeletal disorders while working by quick exposure check method and to check musculoskeletal disorder prevalence. Study was cross sectional and carried out among 200 workers

who participated on the basis of census. Nordic musculoskeletal questionnaire and quick exposure check were used for data collection. Significance level was set to $P < 0.05$. In last 12 months prevalence of MSDs was 53.5%. Further results showed ergonomic risks were high for work related musculoskeletal disorders among participated workers. A significant correlation was found between quick exposure check risk levels and age, BMI of workers. So, conclusion made that risk level and prevalence was high among workers. Risk levels should be minimized by interventions to prevent MSDs (Abedini et al., 2012).

A study by Hassanvand and team (2018) in Iran among staff of oil refinery to evaluate ergonomic risk factors of MSDs by quick exposure check technique. Cross sectional study was performed among 86 staff members which selected from 9 units in repair and central workshop in refinery. Questionnaire Nordic musculoskeletal questionnaire and quick exposure check were used. In last 12 months, at least one musculoskeletal disorder reported by 69.8% staff members. Lumber region was most common disorder with 47.7%. On the basis of QEC method, 44.1% of job groups were in 3rd and 4th level and need corrective measures or interventions. A significant correlation was found between type of job and total quick exposure check score (Hassanvand et al., 2018).

CHAPTER 3

METHODOLOGY

Cross sectional study design was used. The data was collected from 14 fire brigade stations in Faisalabad, Pakistan. Calculated by margins of error = 8%, confidence level = 90% and population is expected to be 20000 and response redistribution is 50% sample size will be 106

Using,

$$x = Z(c/100) \sqrt{r(100-r)}$$

$$n = N x^2 / ((N-1)E^2 + x^2)$$

$$E = \sqrt{[(N - n)x^2 / n(N-1)]}$$

Where, n =sample size, E =margin of error, N =population size, r =fraction of response we are interested in, $Z(c/100)$ =critical value for confidence level (<http://www.raosoft.com/samplesize.html>)

3.1 Sample Selection Criteria: - วิทยาลัย

3.1.1 Inclusion criteria:

- Duty active firefighters (who are regular on duty)
- Age between 20-60 years
- Male firefighters
- Experience being a firefighter more than 1 year
- Who have health complaints related to work (pain or any muscular discomfort related to work)
- Who can read and write

3.1.2 Exclusion criteria:

- Who have health complaints not related to work like hypertension, diabetes etc.

Cross sectional study was conducted among firefighters of Faisalabad, Pakistan. Firefighters from different stations of Faisalabad participated in this study. There are 14 fire stations in Faisalabad district. 106 firefighters included in this study with informed consent form. Data was collected in 2 months October and November, 2023. Data was collected through google forms. Google forms were sent to emergency officer at rescue 1122 Faisalabad. He further sent google form links to firefighters. Nordic musculoskeletal questionnaire was used to evaluate prevalence of MSDs. An ergonomic risk assessment was done on 20 firefighters by analyzing their working postures using Quick exposure check (QEC) for 3 tasks i.e. holding up hose, folding the hose and lifting ladders on shoulder. A physiotherapist with 3 years of experience was the QEC observer.

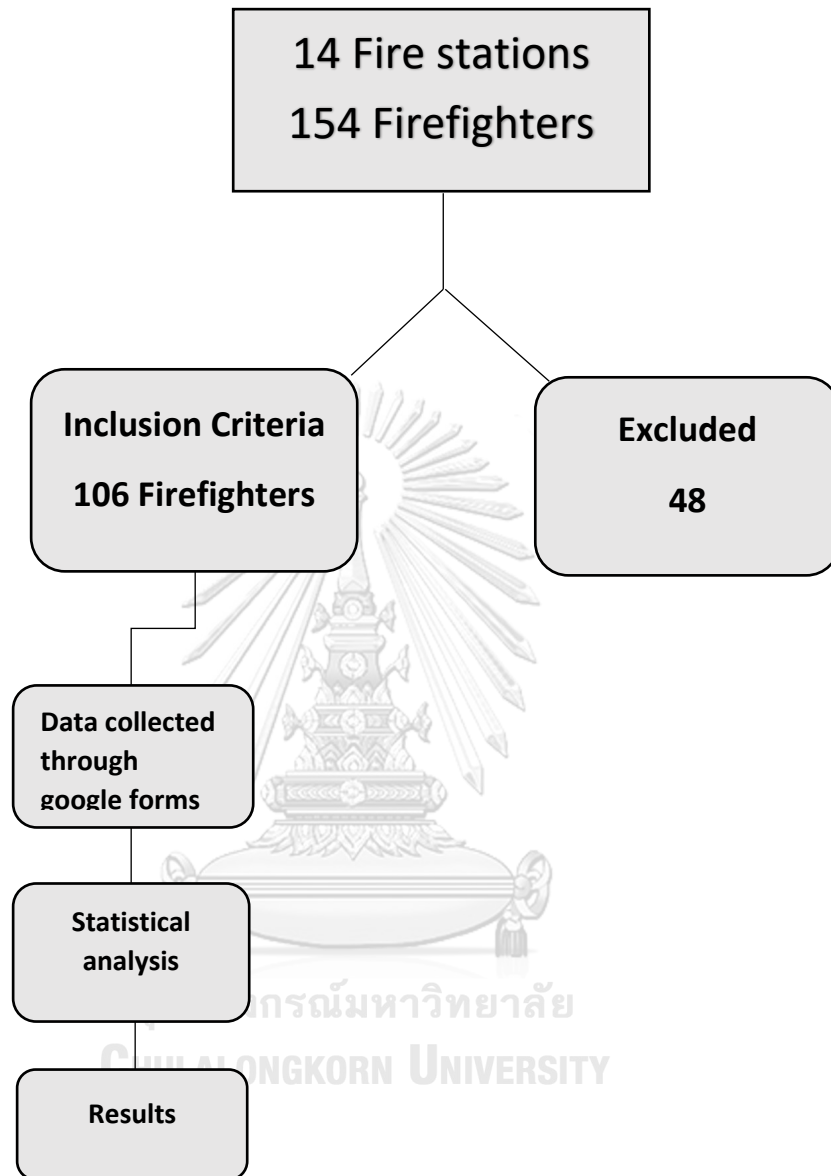


Figure 3 Flow chart of participants

Nordic musculoskeletal questionnaire was used to evaluate the prevalence of musculoskeletal disorders among firefighters. It has questions related to each body part neck, shoulder, elbows, wrist/hands, upper back, lower back, hips, knees and ankles/feet (Crawford, 2007). Quick exposure check (QEC) was used for ergonomic risk assessment. QEC has a score system which represents the level of risk. It has score values for each body part. Scores are calculated on the basis of answers given in QEC

	Level of risk			
	Low	Moderate	High	Very High
Back (static)	8-15	16-22	23-29	29-40
Back (moving)	10-20	21-30	31-40	41-56
Shoulder/arm	10-20	21-30	31-40	41-56
Wrist/hand	10-20	21-30	31-40	41-46
Neck	4-6	8-10	12-14	16-18

Table 1: QEC score chart

Statistical analysis was done using SPSS (version 29.0). Descriptive statistics were performed for age, weight, job shifts, and job positions. It was also performed to get results about pain frequency in body parts and troubles faced by firefighters in doing their job due to pain in different parts of the body. Scores of ergonomic risks of three tasks were analyzed according to the QEC score chart. The study was approved by the ethical research committee of Chulalongkorn University and the Rescue 1122 headquarters, Lahore, Pakistan provided us approval for data collection.

CHAPTER 4

RESULTS

4.1 Characteristics of the subject:

There were total 106 firefighters, 84 were firefighters and 22 were lead firefighters. 42 of them working in morning shift, 34 in evening shift and 30 at night shift respectively. Average age was 35.90 ± 5.8 years. Height is divided in 2 categories. First who in the range of 5.0 ft-5.6 ft. were 15 firemen and who in the range of 5.7 ft-6.2 ft. were 91 firemen. Average weight was 78.2 ± 8.3 kg. Sixty-five of firefighters were doing job of the fire rescue from 1-10 years and 41 of them worked from 11-20 years. Ninety-five of them worked 40-50 hrs. per week and 11 of them worked 50-60 hrs. including overtime.

Job Position				Job Shift				
Firefighter		84		Morning		42		
Lead firefighter		22		Evening		34		
				Night		30		
AGE				Height (ft)		Weight (kg)		
Range	Mean	Median	Std. Deviation	Range	Number	Mean	Median	Std. Deviation
20-60	35.90	36	5.795	5.0 ft-5.6 ft	15	78.21	78	8.346
				5.7 ft-6.2 ft	91			

Table 2: Characteristics of the subject

4.2 Prevalence of musculoskeletal disorders:

Pain experienced by firefighters in last 12 months is shown in Figure 4. Low back pain was most significant reported in 37% of firefighters. The frequency of pain at other body parts including neck, shoulder, elbows, wrist/hands, upper back, hips, knees and ankles/feet as showed in Figure 4.

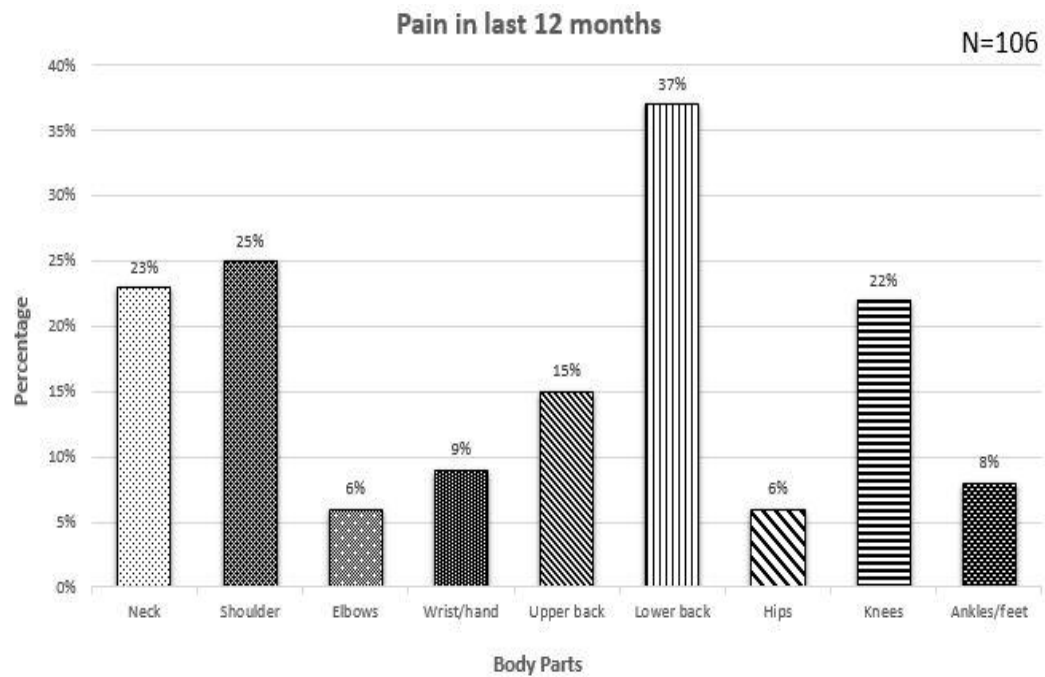


Figure 4: Pain in last 12 months

Figure 5 showed pain in body areas which refrained firefighters from doing their task in last 12 months. Low back pain was at the top for causing trouble in doing job with 28% of firefighters. Firefighters also faced hurdle in performing their job from pain in others areas such as neck pain, shoulder pain.

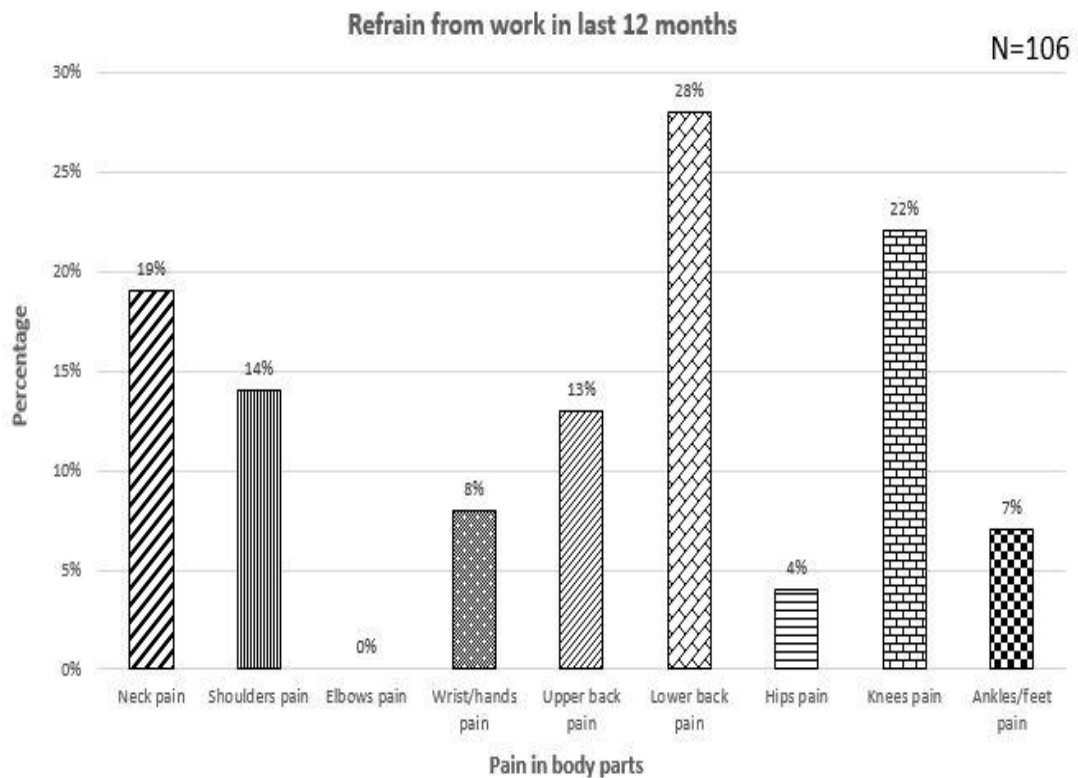


Figure 5: Pain in body area that refrain them from doing work in last 12 months

As shown in Figure 6, firefighters experienced pain in last 7 days in the neck, shoulder, wrist/hands, upper back, lower back, hips, knees and ankles/feet were about 12%, 12%, 1%, 13%, 22%, 4%, 15% and 7%.

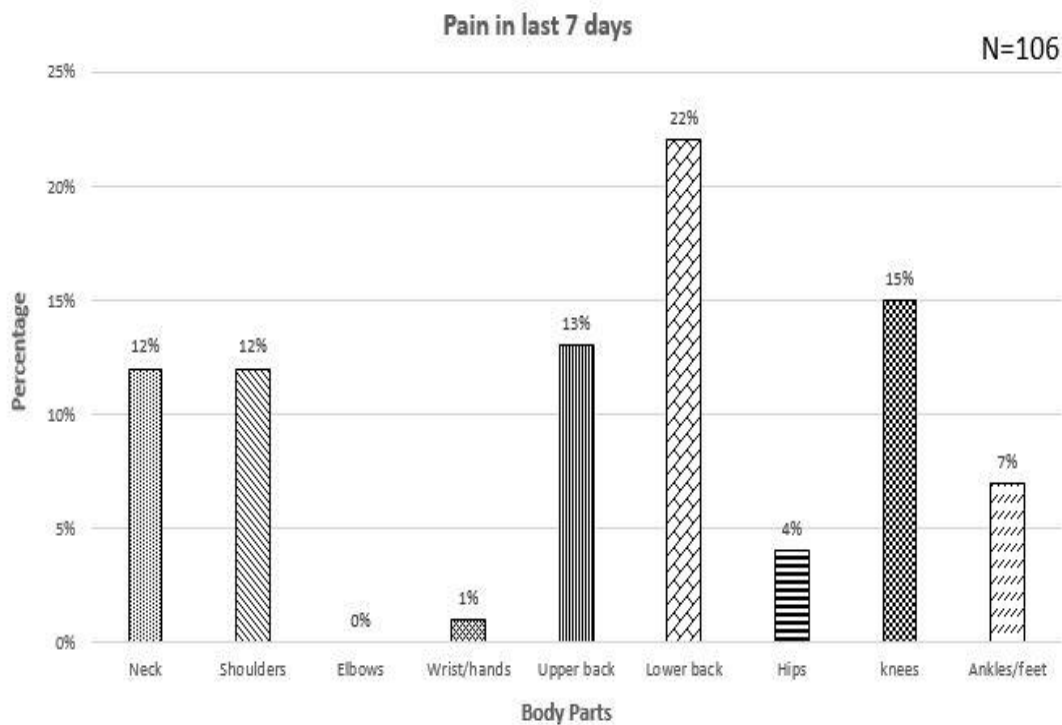


Figure 6: Pain in last 7 days

4.3 Ergonomic risk assessment

For ergonomic risk assessment, 3 tasks were performed i.e. holding up hose, folding the hose and lifting ladders on shoulder. The QEC was used to evaluate the risk score. There was a separate scoring calculated for each body part for each task.

Holding up hose task was performed by 7 firefighters and scores was shown as in Figure 7. Back was at low risk in 71% firemen and at moderate risk in 29% firefighters. Shoulder/arm was at low risk in 43% firefighters and at moderate risk in 57% firefighters. Wrist/hand was at low risk in 86% firemen and at moderate risk in 14% firefighter. Neck was at moderate risk.in all of 7 firefighters.

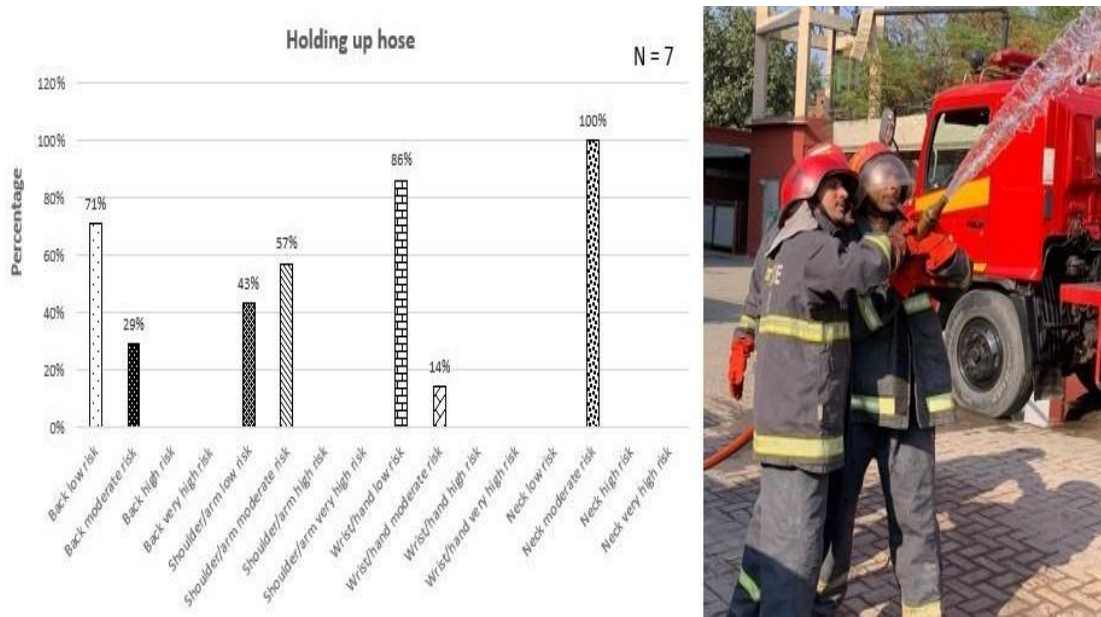


Figure 7: QEC score for holding up hose task

Folding the hose task was performed by 7 of firefighters and score was shown in Figure 8. Back was at moderate risk in 7 firefighters. Shoulder/arm was at low risk in 71% firefighters and at moderate risk in 29% firefighters. Wrist/hand was at low risk in 29% firemen and at moderate risk in 71% firefighters. Neck was at moderate risk in 71% firefighters and at high risk in 29% firefighters.



Figure 8: QEC sore of folding the hose task

Lifting ladders on shoulder was performed by 6 firefighters and score was shown in Figure 9. Back was at moderate risk in 67% firefighters and at high risk in 33% firefighters. Shoulder/arm was at moderate risk in 67% firefighters, at high risk in 17% and at very high risk in 17% firefighter. Wrist/hand was at moderate risk in 67% firefighters and at high risk in 33% firefighters. Neck was at moderate risk in 67% firefighters and at high risk 33% firefighters.

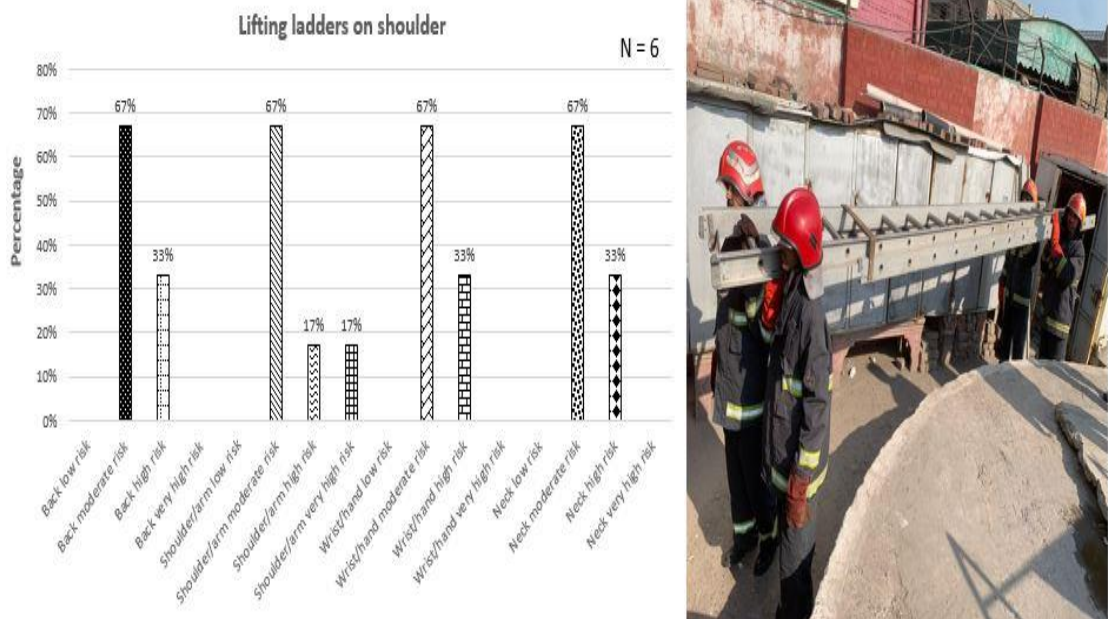
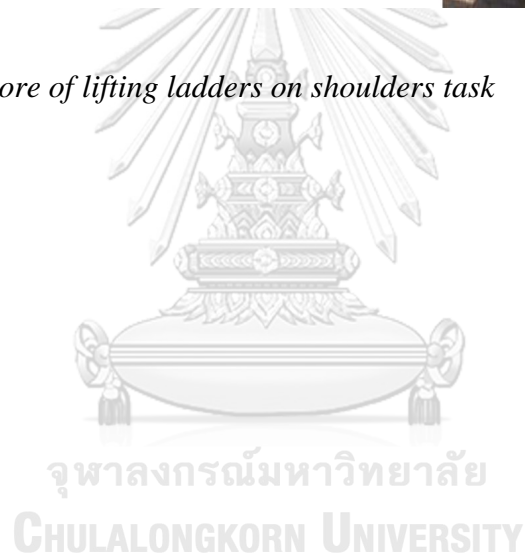


Figure 9: QEC score of lifting ladders on shoulders task



CHAPTER 5

DISCUSSION

This study was done to investigate the prevalence of musculoskeletal disorders and evaluate the ergonomic risk factors in firefighters of Faisalabad, Pakistan. As firefighters have to deal with such emergencies which includes exposure to heat and involves repetitive movements, abnormal postures while carrying out their job tasks. They also experienced some stress due to their job nature which also can cause body discomfort which lead to musculoskeletal disorders development. Firefighters schedule in Faisalabad, Pakistan as they do drilling when they start their shift and 2 to 3 times in a day to keep their selves alert or prepare for any emergency. They also do some mock up exercise to stay active to deal with any of emergency call. Frequency of emergencies are sometimes 2 to 3 times in a day or sometimes only limited to 1 call or none. Nordic musculoskeletal questionnaire (NMQ) was provided through google form for musculoskeletal disorders reporting. For ergonomic risk assessment, quick exposure check questionnaire (QEC) was used to evaluate the tasks. A physiotherapist is his presence made sure that the tasks performed by firefighters were done perfectly. Photos of tasks were taken by physiotherapist for reader's better understanding of tasks nature. Results from all responses showed that low back pain was most significant followed by neck and shoulder in firefighters during last 12 months. Low back pain, knees pain and neck pain caused trouble in firefighters from performing their job duties or work in previous last 12 months. For the pain in last 7 days experienced or reported by firefighters, low back along with knee pain was highly mentioned. (Aurangabadkar et al., 2019) studied on firefighters

of Mumbai, India to evaluate the prevalence of musculoskeletal. They used the rapid entire body assessment (REBA) for ergonomic tasks in firefighters and tasks were lifting the dummy and ladders on one side of trunk. However, our study is different from that study since we evaluated the prevalence of MSDs in last 12 months and in last 7 days along with frequency of firefighters who experienced trouble in their work from MSDs. We also choose different tasks of holding up hose, folding the hose and lifting ladders on shoulder and used the QEC tool for ergonomic risk assessment in our study. In previous study, (Bulduk et al., 2014) used (QEC) on cab drivers' to evaluate the ergonomic risk factors for developing WMSDs. The Quick Exposure Check (QEC) observational instrument, which enables practitioners and employees to evaluate four important regions of the body, was used to observe 382 cab drivers in total. The QEC score results were found to be very high for the shoulder/arm, wrist/hand, and neck, but the scores for the back were found to be high for static usage and moderate for movement. The findings also indicated that limited postures, repetitive motions, vibration, and work-related stress were occupational risk factors for WMSDs. To reduce the risk of exposure to WMSDs in cab drivers, essential ergonomic actions are required. There were 3 tasks performed in our study for ergonomic risk assessment analysis. These 3 tasks were holding up hose, folding the hose and lifting ladders on shoulder. These tasks were selected on the basis of their nature. As these tasks required repetitive motion, long time standing and carrying heavy loaded objects as well in emergency conditions and any disaster. The first task was holding up hose in standing position. Which involve movements at repetitive motion according to emergency situations or need. This involve wrist movements in term of radial deviation and ulnar deviation, isometric movements. Neck movements

also involved as a result of seeing the spots or areas which need to be encountered. Long time standing may also put pressure on back with carrying load and fighting the situation. For this task, we found wrist/hands and neck at moderate risk in many of firefighters. The second task was folding the hose. This task involved bending or flexion of back while folding the hose. Bending of neck and wrist/hand movement is also involved with same repetitive pattern. Concentric wrist radial deviators contract as well as the elbow flexors and extensors contract isometrically(Walker, 1996). Back was major at moderate risk followed by neck and wrist/hand, shoulder/arm in firefighters while performing this task. The third task was lifting ladders on shoulder. As it clearly shows lifting heavy objects on shoulder will always put pressure on your shoulders. In this task, all body parts involved as back needed to bend for lifting ladder and wrist/hand was also involved along with shoulder/arm and neck movement. So, we found all back, neck, shoulder/arm, wrist/hand at moderate to very high risk for this task. Due to prolonged standing and alternative postures, all supportive structures may get injured and cause fatigue. Repetitive task or movement without proper recovery from fatigue leads to tissue damage and damage connective tissues which results in muscular disorders(Allan, 1998). Our results showed that low back pain was highest reported in firefighters, all of three tasks low back were at moderate to very high risk for musculoskeletal disorders on the basis of task nature, duration and repetitive movements. Specially in task of lifting ladders on shoulder, all of body areas were at moderate to very high risk as ergonomic risk. These risks can be reduced by adapting proper ergonomic techniques, guidance about posture patterns and using modified tool with low weight.

5.1 Strength of study

We used validated tools to assess both musculoskeletal disorders and ergonomic risk factors, which may enhance the reliability and validity of results. Our study can help inform strategies to prevent and manage these types of injuries in population.

5.2 Study limitations

This study only reported about pain prevalence but not about severity of pain. Further study can be done by investigating the severity of pain. Moreover, this study was limited to only 1 city with small sample size. More cities can include more subjects for better results in future studies.



CHAPTER 6

CONCLUSION

The major pain reported by firefighters was the low back pain and the task of lifting ladders on shoulder was at moderate to very high risk in back, neck, shoulder and wrist/hands. Holding up hose and folding hose were at moderate to high risk in ergonomic assessment.



APPENDIX 1

CONSENT FORM

Research Participant Information Sheet and Consent Form

Title of research project Prevalence of musculoskeletal disorders and ergonomic risk factors among firefighters

Principal researcher's name Hamza Farooq Position Master's student

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10330

Home address Room 29/70, 4th floor, Siam condominium, Rama IX, Bangkok,
10310

Cell phone 062 078 8183 E-mail: ...6470019337@student.chula.ac.th

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1. Purposes

The purpose of this project is to know about the percentage of musculoskeletal disorders and ergonomic risk factors in firefighters' group of Faisalabad, Pakistan.

This study will let us know which postures can be contributing factor leads to Musculoskeletal disorders in firefighters

2. Consent

If the participant is willing to participate in study, then researcher will explain about process. If the participant doesn't understand anything, then researcher will tell him/her in his local language.

3. Participant.

Number of participants is 106 in research project. Including firefighters of age 20-60, duty active with more than 1-year experience being firefighter. Excluded those firefighters who have less than 1-year experience being firefighter, age less than 20 years and more than 60, who are not active on duty and female firefighters.

Participants will be approach at different fire stations in Faisalabad, Pakistan.

4. Screening process for eligibility

- Firefighters in age between 20-60 years will be included
- Male firefighters
- Firefighters who are active on duty. (who are regular on duty)
- Firefighters who have musculoskeletal problems related to work
- Experience being a firefighter more than 1 year.
- who can read and write

Exclusion criteria:

- Who have health complaints not related to work like hypertension, diabetes etc.

5. Procedure upon participants:

- Data will be collected through google forms

forms when its not possible to reach out to get through hard copy form.

- Firefighters will fill out form and answer questions in that form and it will

take almost 5-10 minutes for each participant.

- Pictures can be taken if possible, for tasks which I selected for ergonomic risk assessment.

6. Risk and Harms

No, there is not any risk or harm. They just need to answer questions on paper.

QEC questionnaire will be answered after the task. They have just to make their positions like in standing and kneeling only for evaluating task.

7. Benefit of the project

Benefit from this study will let us know about musculoskeletal problems and percentage of firefighters in Faisalabad, Pakistan and will also evaluate about ergonomic risk factors. Results will help us to improving posture patterns in firefighters while performing tasks and this study will provide awareness about musculoskeletal issues in Pakistani firefighters because no such study have done on Pakistani firefighters to date.

8. Confidentiality

Information related directly to you will be kept confidential Results of the study will be reported as total picture. Any information which could be able to identify you will not appear in the report.

9. Personal data after research project is completed

After project completion, personal data will be erased. Data will be published as whole study instead of your personal data

10. Compensation

There is nothing to give participants but only heartfelt thanks

11. Right to refuse

Participation to the study is voluntary and participant has the right to deny and/or withdraw from the study at any time, no need to give any reason, and there will be no bad impact upon that participant.

12. Whom to contact

if you have any question or would like to obtain more information, the researcher can be reached at all time. If the researcher has new information regarding benefit on risk/harm, participants will be informed as soon as possible. Participants can be contacted through their cell numbers which they can give in filling out forms.

13. Participant rights

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Group I, Chulalongkorn University (RECCU) Jamjuree 1 Bldg., 254 Phyathai Rd.,

Patumwan

district, Bangkok 10330, Thailand, Tel./Fax. 0-2218-3202, 0-2218-3049 E-mail:

eccu@chula.ac.th”

APPENDIX 2
GENERAL QUESTIONS

Name: _____ Age: _____

Height: _____ Weight: _____

Job Shift: _____ Job Title: _____



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

APPENDIX 3

NORDIC MUSCULOSKELETAL QUESTIONNAIRE

[Questions](#) [Responses](#) **106** [Settings](#)

Musculoskeletal Discomfort Form

Form description

Consent Form

Research Participant Information Sheet and Consent Form

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 Home address Room 29/70, 4th floor, Siam condominium, Rama IX, Bangkok, 10310
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Job Position موقع *

Short answer text

.....

Job Shift *

- Morning
- Evening
- Night

Questions

Responses

106

Settings

Age *

Short answer text

Height (ft, In) *

Short answer text

Weight (KG) *

Short answer text

How long Have you been doing this job ? * آپ کب سے یہ کام کر رہے ہیں؟

Short answer text

How many hours do you work each week ? * آپ ہر ہفتے کتنے گھنٹے کام کرتے ہیں؟

Short answer text

TO BE ANSWERED BY EVERYONE. اس کا جواب ہر ایک کو دینا ہوگا.

Description (optional)

Have you at anytime during the last 12 months had pain in:

کیا آپ کو پچھلے 12 مہینوں میں کسی وقت درد ہوا ہے:

Description (optional)

Neck میں گردن میں *

No

Yes

Shoulders میں کندھوں میں *

No

Yes, right shoulder دائیں کندھے

Yes, left shoulder بائیں کندھے

Yes, both shoulders دونوں کندھے

Elbows *

No

Yes, right elbow

Yes, left elbow

Yes, both elbows

Wrist/Hands **کلائی/ہاتھ** *

- No
- Yes, right wrist/hand
- Yes, left wrist/hand
- Yes, in both

Upper back **اوپری پیٹھ** *

- No
- Yes

Lower back **کمر کے نچلے حصے** *

- No
- Yes

Hips **کولہوں میں** *

- No
- Yes

Knees میں گھٹتوں *^{*}

- No
- Yes

Feet میں پاؤں *^{*}

- No
- Yes

TO BE ANSWERED BY THOSE WHO HAVE HAD TROUBLE

ان لوگوں کی طرف سے جواب دیا جائے جن کو پریشانی ہوئی ہے۔

Description (optional)

Have you at any time during the last 12 months been prevented from doing your normal work because of the trouble ?

کیا آپ کو پچھلے 12 مہینوں کے دوران کسی بھی وقت درد کی وجہ سے اپنا معمول کا کام کرنے سے روکا گیا ہے؟

Description (optional)

Neck میں گردن *^{*}

- No
- Yes

Shoulders کنڈھوں میں *

No

Yes

Elbows کہنیوں میں *

No

Yes

Wrist/ Hands مٹھوں / ہاتھوں میں *

No

Yes

Upper back اوپری پیٹھ میں *

No

Yes

Lower back نیچے حصے میں *

No

Yes

Hips میں کولہوں میں *

No

Yes

Knees میں گھٹنوں میں *

No

Yes

Feet میں پاؤں میں *

No

Yes

Have you had trouble at any time during the last 7 days ?

کیا آپ کو بچھڑے 7 دنوں میں کسی بھی وقت پریشانی ہوئی ہے؟

Description (optional)

Neck میں گردن میں *

No

Yes

<p>Shoulders * کندھوں میں</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Yes</p>
<p>Elbows * کتیبوں میں</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Yes</p>
<p>Wrist/hands * کلائی / ہاتھوں میں</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Yes</p>
<p>Upper back * اوپری بیٹھ میں</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Yes</p>
<p>Lower back * بیٹھ کے تجنے حصے میں</p> <p><input type="radio"/> No</p> <p><input type="radio"/> Yes</p>

APPENDIX 4

QUICK EXPOSURE CHECK QUESTIONNAIRE

[Questions](#) [Responses](#) **20** [Settings](#)

Quick Exposure Check

Form description

Consent form

Research Participant Information Sheet and Consent Form

Title of research project Prevalence of musculoskeletal disorders and ergonomic risk factors among firefighters

Principal researcher's name Hamza Farooq Position Master's student
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- Experience being a firefighter more than 1 year.
- who can read and write

Exclusion criteria:

- Who have health complaints not related to work like hypertension, diabetes etc.

5. Procedure upon participants:

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Job Title عبدہ *

Short answer text

Task کام *

- Holding up hose
- Folding the hose
- Lifting ladders on shoulders

OBSERVER ASSESSMENT

Description (optional)

When performing the task, is the back ? *

- Almost neutral
- Moderately flexed or twisted or side bent
- Excessively flexed or twisted or side bent

Select only one of the following tasks ***Either:****For seated or standing stationary tasks. Does the back remain in a static position most of the time?**

- Yes
- No

OR ***For lifting, pushing/pulling and carrying tasks. is the movement of back ?**

- Infrequent (around 3 times per minute or less)
- Frequent (around 8 times per minute)
- Very frequent (around 12 times per minute or more)

When the task is performed, are the hands? *

- At or below the waist height
- At about chest height
- At or above shoulder height

Is the shoulder/arm movement? *

- infrequent (some intermittent movement)
- Frequent (Regular movement with some pauses)
- Very frequent (almost continuous movement)

Is the task performed with? *

- An almost straight wrist?
- A deviated or bent wrist?

Are similar motion patterns repeated? *

- 10 times per minute or less
- 11-20 times per minute
- more than 20 times per minute

When performing the task, is the head/neck bent or twisted? *

- No
- Yes, occasionally
- Yes, continuously

WORKERS ASSESSMENT

I'm

Is the maximum weight handled manually by you in this task ? *

کیا اس کام میں آپ کے ذریعہ زیادہ سے زیادہ وزن دستی طور پر سنبھالا جاتا ہے؟

- 5kg or less
- 6-10 kg
- 11-20 kg
- more than 20kg

On average, how much time do you spend per day on this task ? *

اوسطاً، آپ اس کام پر روزانہ کتنا وقت صرف کرتے ہیں؟

- Less than 2 hours
- 2-4 hours
- more than 4 hours

- 2-4 hours
- more than 4 hours

When performing this task, is the maximum force level exerted by one hand? *

اس کام کو انجام دیتے وقت، کیا ایک ہاتھ سے زیادہ سے زیادہ قوت کا استعمال کیا جاتا ہے؟

- less than 1kg
- 1-4kg
- more than 4kg

Is the visual demand of this task ? *

کیا اس کام کا بصری مطالبہ ہے؟

- Low
- High

At work do you drive a vehicle for? *

کیا آپ کام پر گاڑی چلاتے ہیں؟

- less than one hour per day or never
- between 1-4 hours per day
- more than 4 hours per day

At work do you use vibrating tools for? *

کیا آپ کام پر وائبریشننگ ٹولز استعمال کرتے ہیں؟

- less than one hour per day or never
- between 1-4 hours per day
- more than 4 hours per day

Do you have difficulty keeping up this work? *

کیا آپ کو اس کام کو جاری رکھنے میں دشواری ہوتی ہے؟

- Never
- sometimes
- often

In general how do you find this job ? *

عام طور پر آپ کو یہ کام کیسا لگتا ہے؟

- Not at all stressful
- mildly stressful
- moderate stressful
- very stressful

Interpreting the scores

Exposure scores for body areas

The total score for each body area is determined from the interactions between the exposure levels for the relevant risk factors (see table below), and their subsequent addition.

It is important to take note of which interactions contribute most to the overall score for each body area.

The exposure scores for the back, shoulder/arm, wrist/hand and neck have been categorised into 4 exposure categories: Low, Moderate, High or Very High. Even if the exposure score is Low, it is important to note that one or two interactions may be contributing disproportionately to the score (i.e. a score of 8 or more). For Moderate, High and Very High scores, there are likely to be several interactions that should be identified and reduced. It is also possible that one or two interactions are at the highest levels (i.e. 10 or 12) of exposure. These should be addressed urgently to reduce the level of exposure for these factors.

These interactions should be monitored and reviewed as injury to the body could occur if exposure continues.

Where scores are Moderate or High, or Very High, the level of exposure should be reduced.

Important Risk Factors

Back	Wrist/hand	Neck	Shoulder/arm
• load weight	• force	• duration	• load weight
• duration	• duration	• posture	• duration
• frequency of movement	• frequency of movement	• visual demand	• task height
• posture	• posture		• frequency of movement

Exposure Level

Score	Low	Moderate	High	Very High
Back (static)	8-15	16-22	23-29	29-40
Back (moving)	10-20	21-30	31-40	41-56
Shoulder/ arm	10-20	21-30	31-40	41-56
Wrist/ hand	10-20	21-30	31-40	41-46
Neck	4-6	8-10	12-14	16-18

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