

Prevalence of Musculoskeletal Disorders and Ergonomic Risk Factors among Firefighters

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ABSTRACT

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.

Aim: To investigate 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 evaluate 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.

INTRODUCTION

The term "musculoskeletal disorder (MSDs)" refers to inflammatory conditions or impairments that affect the body's structure, including muscles, joints, tendons, ligaments, bones, nerves, and supporting blood vessels. These conditions or impairments cause pain and functional impairment¹. Firefighting is a physically hard and dangerous career that necessitates a certain degree of fitness to carry out essential work responsibilities². Firefighters are government professionals who carry out emergency rescues, prevent and extinguish fires, and respond to disasters in a recovery capacity. Additionally, they are subjected to physical hazards including heat, noise, toxic gases, smoke, carbon monoxide, and diesel fumes³. Workers who deal with fireworks often have MSDs⁴. Thus Firefighting is one of the most dangerous and demanding professions there are⁵. The physical demands of rescue missions and sudden movements might strain a firefighter's musculoskeletal system⁶. Workplace accidents cause major financial and health costs, as well as missed productivity⁷.

Moreover, the majority of disabilities and missed workdays are caused by occupational musculoskeletal problems⁸. There is widespread agreement that working as a firefighter is perilous by nature⁹. During firefighting operations, firefighters are subjected to physical dangers, injuries, and accidents. It is thought that mechanical elements have an impact on musculoskeletal discomfort¹⁰. Furthermore, firefighters engage in activities that include significant levels of physical strain, extreme temperatures, and negative health impacts from breathing poisonous gases. Many of these risk factors are to blame for chronic respiratory, musculoskeletal, and psychological issues¹¹. The intense physical demands of firefighters' jobs lead to high incidence of work-related injuries¹². The type of job that firefighters do might subject them to a lot of speed, monotonous, repetitive duties, and occupational musculoskeletal diseases¹³.

Thus Firefighters have a higher risk of musculoskeletal injuries than other occupations^{14,15,16}. In addition, firefighters experience a lot of muscular discomfort at work¹⁷. Because they frequently confront circumstances demanding extreme activity, often in an unanticipated manner. Firefighters are frequently exposed to the dangers of low back pain (LBP)¹⁸. They do several dangerous work responsibilities at the scene of a fire, making them

a profession at high risk for back injuries¹⁹. The majority of injuries sustained by firefighters while working on the fire ground are still musculoskeletal in nature²⁰.

The amount of ergonomic risk factor experienced by firefighters as a result of their profession is determined via an ergonomic assessment. Repetitive motion of joints, awkward posture of body, violent exertion, pressure points, and static postures while performing tasks are ergonomic risk factors for musculoskeletal condition. They had to roll the fire hose till done, bending forward with unnatural posture. Due to their prolonged uncomfortable body posture, this may result in back discomfort²¹. Firefighters work is distinguished by their high social responsibility and the variety of hazards they face while performing life-saving and fire-fighting tasks²².

The fire department is one of the world's most demanding and dangerous professions²³. Firefighters do a variety of hazardous activities that need their physical participation in warm environments. Therefore, firefighters are at a significant risk of getting musculoskeletal disorders when carrying out jobs, handling heavy equipment, and wearing personal protective equipment. Since there hasn't been any research on firefighters in Pakistan yet, the aim of this study was to evaluate the prevalence of musculoskeletal disorders and ergonomic risk factors among those who work as firemen in Faisalabad, Pakistan.

METHODOLOGY

Subject: Firefighters from different fire stations of Faisalabad, Pakistan participated in this study.

Inclusion and exclusion criteria: The inclusion criteria were that firefighters age between 20-60 years, male, who are regular on duty, and have work experience at least 1 year can read and write and have health complaints related to work. The exclusion criteria were that firefighters who work less than 1-year, not regular on duty, age out of range 20-60 years and who have health complaints not related to work such as hypertension, diabetes etc.

Tools: 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/feet²⁴.

Quick exposure check (QEC) was used for ergonomic risk assessment. QEC have score system which represent the level of risk. It has score values for each body part. Scores are calculated on the basis of answers given in QEC (Table 1).

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Procedure: Cross sectional study was conducted among firefighters of Faisalabad, Pakistan. Firefighters from different stations of Faisalabad participated in this study. 106 firefighters included in this study with informed consent form. 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. All these tasks were performed under supervision of a physiotherapist. Physiotherapist rated the posture during tasks and filled out in QEC observer's assessment section.

Statistical Analysis: Statistical analysis was done using SPSS version 29.0. Descriptive statistics were performed to for age, weight, job shifts, and job positions. It was also performed to get results about pain frequency in body parts and troubled faced by firefighters in doing their job due to pain in different parts of body. Score of ergonomic risks of three tasks were analyzed according to the QEC score chart.

Ethical approval: 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.

RESULTS

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.

Prevalence of musculoskeletal disorders: Pain experienced by firefighters in last 12 months is shown in Figure 1. Low back pain was most significant reported in 37% of firefighters. The percentage of pain at other body parts including neck, shoulder, elbows, wrist/hands, upper back, hips, knees and ankles/feet as showed in Figure 1.

Figure 1: Pain in last 12 months

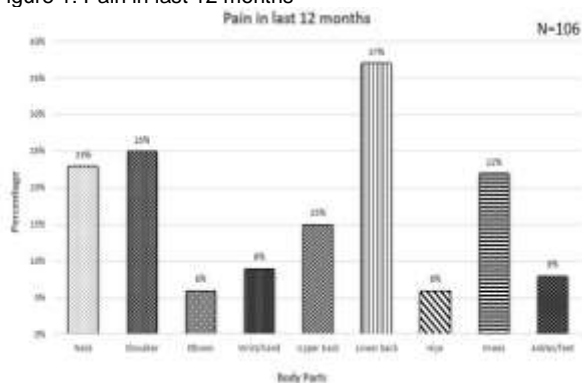
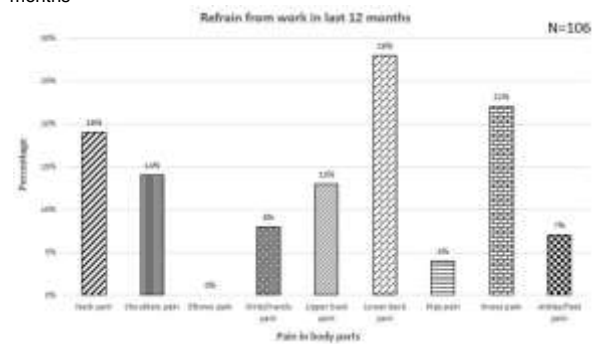


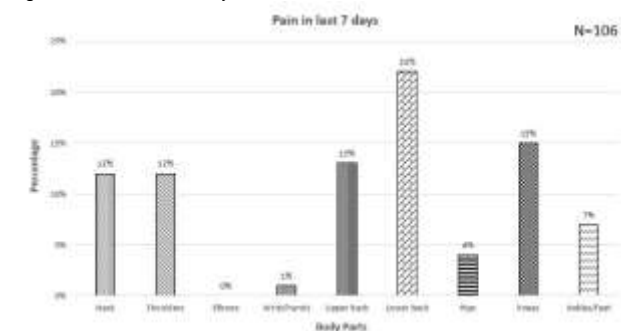
Figure 2 showed pain in body areas which refrained firefighters from doing their task in last 12 months. Low back pain was at the top for causing trouble in doing job with 28% of firefighters. Firefighters also faced hurdle in performing their job from pain in others areas such as neck pain, shoulder pain (Figure 2).

Figure 2: Pain in body area that refrain them from doing work in last 12 months



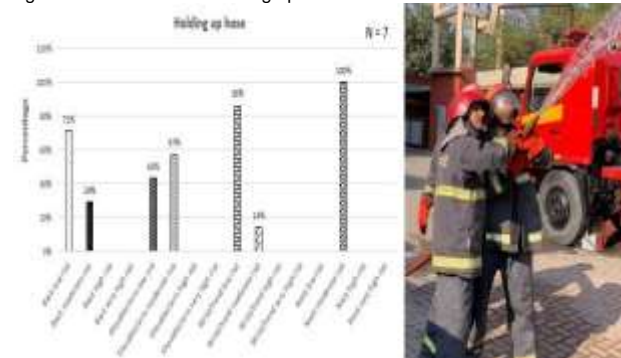
As shown in Figure 3, firefighters experienced pain in last 7 days in the neck, shoulder, wrist/hands, upper back, lower back, hips, knees and ankles/feet were about 12%, 12%, 1%, 13%, 22%, 4%, 15% and 7% respectively.

Figure 3: Pain in last 7 days



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 4. Back was at low risk in 71% of firemen and at moderate risk in 29% of firefighters. Shoulder/arm was at low risk in 43% firefighters and at moderate risk in 57% of firefighters. Wrist/hand was at low risk in 86% firemen and at moderate risk in 14% of firefighter. Neck was at moderate risk in all of 7 firefighters.

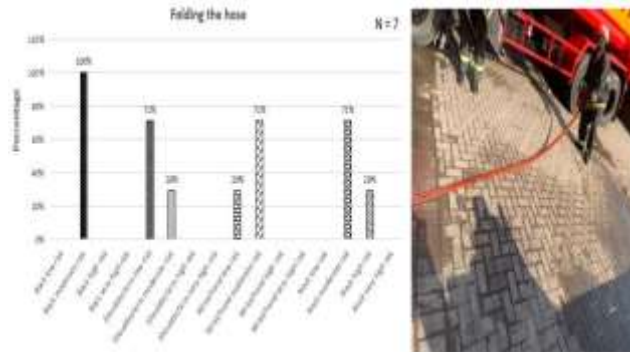
Figure 4: QEC score for holding up hose task



Folding the hose task was performed by 7 of firefighters and score was shown in Figure 5. Back was at moderate risk in 7 firefighters. Shoulder/arm was at low risk in 71% firefighters and at moderate risk in 29% of firefighters. Wrist/hand was at low risk in 29% firemen and at moderate risk in 71% of firefighters. Neck was at

moderate risk in 71% firefighters and at high risk in 29% firefighters.

Figure 5: QEC sore of folding the hose task



Lifting ladders on shoulder was performed by 6 firefighters and score was shown in Figure 6. 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% of firefighters.

Figure 6: QEC score of lifting ladders on shoulders task



Table 1. QEC score chart

	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

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.

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.

Sheetal et.al¹² 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 al²⁵ used (QEC) on cab drivers' to evaluate theergonomic risk factors for developing WMDSs. 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 WMDSs. To reduce the risk of exposure to WMDSs 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 isometrically²⁶. 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 disorders²⁷.

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.

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 cites can be included in more subjects for better results in future studies.

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.

Authorship and contribution Declaration: Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.
4. All authors agree to be responsible for all aspects of their research work

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REFERENCES

1. Azmi NLAM, Masuri MG. Work-related musculoskeletal disorder (WMSDs) and functional status of firefighters in Klang Valley. *Healthscope: The Official Research Book of Faculty of Health Sciences, UiTM*. 2019;2.
2. Saremi M, Noorizade N, Rahimi E. Assessment of mental workload, work ability and musculoskeletal disorders of firefighters. *Journal of Community Health Research*. 2019;8(3):139-47.
3. Kim MG, Kim K-S, Ryoo J-H, Yoo S-W. Relationship between occupational stress and work-related musculoskeletal disorders in Korean male firefighters. *Annals of occupational and environmental medicine*. 2013;25(1):1-7.
4. Laskar P, Ganguly S, Hossain ZM. Ergonomic risk factors and Work-Related Musculoskeletal Disorders among Fireworks workers in West Bengal, India: A cross sectional study. *bioRxiv*. 2022:2021.06.07.447237.
5. Sepidarkish M, Safiri S, Hosseini SH, Pakzad R. Prevalence of occupational stress and its correlates among firefighters, Tehran, Iran, 2013. *Journal of Research in Clinical Medicine*. 2014;2(4):177-82.
6. RAS F, Ferraz M, Machado L, Oliveira L, Gondo F, Quemelo P. Symptoms of Musculoskeletal Disorders in Firefighter Worker in Brazil.
7. Negm A, MacDermid J, Sinden K, D'Amico R, Lomotan M, MacIntyre NJ. Prevalence and distribution of musculoskeletal disorders in firefighters are influenced by age and length of service. *Journal of Military, Veteran and Family Health*. 2017;3(2):33-41.
8. Katsavouni F, Bebetos E, Antoniou P, Malliou P, Beneka A. Work-related risk factors for low back pain in firefighters. Is exercise helpful? *Sport Sciences for Health*. 2014;10(1):17-22.
9. Nazari G, Osifeso TA, MacDermid JC. Distribution of number, location of pain and comorbidities, and determinants of work limitations among firefighters. *Rehabilitation research and practice*. 2020;2020.
10. Abbasi M, Rajabi M, Yazdi Z, Shafikhani AA. Factors affecting sleep quality in firefighters. *Sleep and Hypnosis*. 2018.
11. Katsavouni F, Bebetos E, Malliou P, Beneka A. The relationship between burnout, PTSD symptoms and injuries in firefighters. *Occupational medicine*. 2016;66(1):32-7.
12. Aurangabadkar S, Deo M, Kadam S. Prevalence Of Work Related Musculoskeletal Disorders In Fire Fighters. *Int J Physiother Res*. 2019;7(6):3320-25.
13. Sanda M-A, Kodom-Wiredu JK, editors. *Visibilization of Hidden Characteristics of Firefighting Tasks and Factors Predictive of Firefighters' Work-Related Musculoskeletal Disorders*. International Conference on Applied Human Factors and Ergonomics; 2018: Springer.
14. Gentzler M, Stader S. Posture stress on firefighters and emergency medical technicians (EMTs) associated with repetitive reaching, bending, lifting, and pulling tasks. *Work*. 2010;37(3):227-39.
15. Abrard S, Bertrand M, De Valence T, Schaupt T. Physiological, cognitive and neuromuscular effects of heat exposure on firefighters after a live training scenario. *International Journal of Occupational Safety and Ergonomics*. 2019.
16. Abbasi M, Jaliloghadr S, Soltanabadi M, Yazdi Z. Prevalence of musculoskeletal disorders in firefighters and its association with insomnia. *Policy and Practice in Health and Safety*. 2020;18(1):34-40.
17. Jahnke SA, Poston WSC, Haddock CK, Jitnarin N. Injury among a population based sample of career firefighters in the central USA. *Injury prevention*. 2013;19(6):393-8.
18. Kim MG, Ahn Y-S. Associations between lower back pain and job types in South Korean male firefighters. *International Journal of Occupational Safety and Ergonomics*. 2021;27(2):570-7.
19. Damrongsak M, Prapanjaroensin A, Brown KC. Predictors of back pain in firefighters. *Workplace health & safety*. 2018;66(2):61-9.
20. Nazari G, MacDermid JC, Sinden K, D'Amico R. Prevalence of musculoskeletal symptoms among Canadian firefighters. *Work*. 2020;67(1):185-91.
21. Isamudin A, Mahmood S. Design of An Ergonomic Portable Fire Hose Roller: A Simulation Study. *Progress in Engineering Application and Technology*. 2021;2(2):1016-25.
22. Takeyama H, Itani T, Tachi N, Sakamura O, Murata K, Inoue T, et al. Effects of shift schedules on fatigue and physiological functions among firefighters during night duty. *Ergonomics*. 2005;48(1):1-11.
23. Kodom-Wiredu JK. *Work-related Musculoskeletal Disorders among Firefighters: Do Task Characteristics and Work Experience Matter?* : University of Ghana; 2016.
24. Crawford JO. The Nordic musculoskeletal questionnaire. *Occupational medicine*. 2007;57(4):300-1.
25. Bulduk EÖ, Bulduk S, Süren T, Ovalı F. Assessing exposure to risk factors for work-related musculoskeletal disorders using Quick Exposure Check (QEC) in taxi drivers. *International Journal of Industrial Ergonomics*. 2014;44(6):817-20.
26. Walker J. *Cartilage of human joints and related structures. Athletic injuries and rehabilitation*. 1996:120-51.
27. Allan DA. Structure and physiology of joints and their relationship to repetitive strain injuries. *Clinical Orthopaedics and Related Research*. 1998;351:32-8.

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