

Dose-Response Association between Musculoskeletal Disorders and Physical Factors among Construction Workers

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Abstract: Background: Musculoskeletal disorders (MSDs) are a variety of inflammatory and degenerative diseases that affect muscles, tendons, ligaments, joints, peripheral nerves and related blood vessels. These contain syndromes like tendon inflammation and associated conditions (tenosynovitis, epicondylitis, and bursitis) that is most commonly seen in the construction workers with prolonged working hours. Objective: The purpose of the study was to find the dose-response association between MSDs & physical factors among construction workers and to determine the association between their pain severity and working duration. Methodology: A cross-sectional study of 317 construction workers. Workers were randomly selected from different areas of Multan. Nordic questionnaire and NPRS were the data collection tools along with the questionnaire derived from previous studies. Results: No significant association was found between the physical factors and MSDs. 49.6% workers experienced mild pain with working duration of 8 hrs. 8.3% workers whose work duration was 10 hours, experienced severe pain. Conclusion: Physical burden factors don't have any strong predictor role in MSDs of different regions of body among construction workers. Working duration has significant association with pain severity.

Key Words: Construction Workers; Dose-Response Association; Musculoskeletal Disorders (MSDs); Pain.

1. Introduction

Musculoskeletal disorders (MSDs) comprise a wide variety of inflammatory and degenerative diseases that affect the muscles, tendons, ligaments, joints, peripheral nerves and their related aiding blood vessels. Areas of body most commonly affected are low back, neck, shoulder, forearm and hand and now lower extremity also. MSDs related to the upper extremity are common in manual occupations [1].

Construction workers are at increased prospects of developing work related MSDs of back and upper and lower limbs. [2] Many researchers have found these MSDs to be associated with both psychosocial and physical factors. [3] According to some studies, the principal contributing elements to MSDs were those related to working environment like abnormal postures such as stooping, kneeling due to small or confined space, lifting heavy tools, neck being bent or shoulders being raised for long periods of time, strain on neck due to cumbersome weight of hard hat and welding mask. [4]

In disorganized regions, the laborers have to manually handle a wide range of materials like bricks, soil, sand, stone chips, packets of cement, mixers, planks of wood, slabs of concrete. They also have to manage different tools such as spades and trowels manually when they have to dig, mix and fill the substances in canisters. All these tasks and operating heavy machinery; make their work both physically challenging and ergonomically risky. [2]

Work related musculoskeletal disorders WRMSDs are also common in painters who work in painting workshops. They are unaware of good posture and perform their activities with awkward posture.[5] These disorders in painters can also be caused by inappropriate tool designs and instruments and working circumstances. [6]

Apart from lifting heavy objects, bending, kneeling and stooping postures; working with hands above their shoulders level is a necessary part of their electrical work and puts electricians at danger of developing shoulder problems. Most commonly, they suffer from hands, wrists and back symptoms.[7]

There exists a relation between occurrence of musculoskeletal disorders and the intensity of and time spent in all these physical factors like twisted or stooping posture, lifting heavy burden, hands above shoulders, kneeling and sleeplessness. This relation is the dose response association. [8]

Objective: The aims of this study are

- To find out the association between the dose of the physical factors exposure and the response of different areas of the body of a construction worker to these doses.
- To determine the association between pain severity and working duration.

2. Literature Review

A previous cross sectional study was based on work related injuries among old aged workers. Multidimensional analysis was made according to age, gender, employment status, industry and occupations by targeting 40-79 persons who died due to occupational injuries. Total population involved in study were 10,000 workers. This study was published in 2018. High risk groups were: male workers by sex, daily workers by status of work, craft and related trade workers by occupations, mining by industries. Prevalence rate was high in skilled agriculture (fishery & forestry). Major causative factors for injuries were negligence, failure of object identifications, inappropriate working platform, and dismantlement of temporary equipment, Mobile cranes and conveyer belts. Preventive strategies were taken which were risk factor identification, safety measures, supervision, job training, consideration of age, gender, provide work place of less than 10 workers and understanding of ability of age groups. Specialized predisposing factors for injuries in old age were weak mental health and cognitive function. Database of 7993 persons that died from occupational injuries [9]. Three analyses were done demonstrating each demographic and occupational characteristics, analyzed in depth of occupation and high risk group. Different causative factors had been introduced in male (building structure, surface machine and equipment transportation) and in female (same as male but machine and equipment risk came first). Some common risk factors were negligence, failure of identification of objects, inappropriate use of protective clothes. Daily worker fall rate that lead to injury was 50-60 % and fishery, skilled agriculture & forestry had high incidence rate followed by craft and related trade workers. [10]

A cross sectional survey was conducted on ergonomic risk factors & musculoskeletal disorders. Research was published in 2010. Author selected sample arbitrarily from 12 construction companies. Response rate was 62.7 %. Varying degrees of MSDs occur in workers. High level of discomfort was with low back than (ankle, head & so on). To eliminate or reduce risk, specific training programs were elected with worker training & contractor level resources. [11]

Another investigation was published in 2014. Major aim of their study was to observe the effect of working postures on MSDs in sand workers. About 50 sand core workers (carbon dioxide and chemical sand core workers) of west Bengal of India were recruited in this study. Study was made with the key elements of age, height, BMI and clinical examination. By questionnaire assessment of posture, level of discomfort by discomfort level scale, risk level scale and statistical analysis for magnitude and direction with correlation between these two variables were explored. Result of the study was that musculoskeletal problems were

basically caused by awkward postures leads to pain in low back (100%), hand (40%), shoulder (30%), wrist (20%) and neck (20%).[12]

A study was carried out to estimate the interaction of bio-mechanical & morphological factors on shoulder workload in industrial paint workers and to determine activity related MSDs in automobile industry. It was an observational study. Assessment was based on questionnaire, examination & EMG. Study population included 29 paint area workers aged 37.7-8.2 years. Multifactorial linear analysis revealed that some characteristics belong to increased workload on upper limb. Causative factors include awkward posture, demanding force implies different effects as same work provides different MSK loads. [13]

3. Methodology

3.1. Sample Design

This was a cross sectional survey with a sample size of 317 calculated from online Epitool software. The sampling technique used was non probability convenient sampling. The time duration of the study was 5 months starting in October 2019 and ending in February 2020.

The data was collected from construction workers (laborers, carpenters, welders, electricians and painters) of different areas of Multan.

3.1.1. Inclusion Criteria

Male construction workers (laborers, carpenters, welders, electricians and painters), working in Multan and engaging in lifting heavy weights, working in different abnormal postures, standing and sitting in different positions and keeping arms at different angles.

- Age between 17 and 57 years.
- Workers working for more than 8 hours per day.
- Working in the profession for last 2 years.

3.1.2. Exclusion Criteria

- Older adults.
- Workers with congenital deformities.
- Physically disabled workers.
- Patients who had medical conditions (liver, kidney disease, deep venous thrombosis etc.)
- Workers with known autoimmune diseases malignancy, arthritis or gout.
- Workers with these co-morbidities: diabetes, cardiovascular diseases.
- History of recent injury or trauma. (In the time duration of past one month).
- Persons already taking treatment/ medicine for pain in any region of body.

3.2. Outcome Measurement Tools

- Questionnaire derived from previous studies.
- Nordic Questionnaire
- Numeric Pain Rating Scale.

3.3. Data Analysis

To evaluate the dose-response association between physical factors and musculoskeletal disorders, the working activities were measured for several days at many working sites. In Demographic data, age and occupation were documented. Pain intensity (response), working hours and physical factors (dose) were assessed by using Nordic Questionnaire, numeric pain rating scale and questionnaire used by previous studies.

Data analysis was done on SPSS Version 18.0. Working hours was the quantitative variable while pain intensity was categorized into four groups that were none, mild, moderate and severe pain respectively, denoted by 1,2,3 and 4; and it was the qualitative variable along with physical factors (work related physical dose) and musculoskeletal disorders. These were all the variables of data obtained for this study. The age of participants was also categorized into four groups of 17 to 27 years, 28 to 37 years, 38 to 47 years and 48 to 57 years.

Descriptive statistics was used to evaluate valid percentage, mean and standard deviation values of data. Multiple Logistic regression analysis was used to calculate the odd ratios for physical factors, Nordic

Questionnaire and age. The odd ratios were used to predict which physical factor was how much responsible. Pierson chi square test was used to calculate the association of working hours and numeric pain rating scale.

4. Results

The data was collected from 317 participants ranging in age from 17 to 57 years.

When assessing the physical factors and checking how often the workers were subjected to these factors, most (48.3%) workers said that they often worked in stooping or twisted posture. While 22.7% individuals said that they never worked in hands above the shoulder position.

Out of the 317 subjects asked about any trouble (ache, pain, discomfort or numbness) in different body regions through Nordic questionnaire, maximum responses (41.0%) were of shoulder pain while 37.5% construction workers had neck pain, 28.4% had elbows trouble 30.9% had wrist/hands pain, 22.7% had Upper Back pain, 36.9% had lower back discomfort, 13.6% had ache in Hips/thighs/buttocks, 23.7% had knees pain and only 12.6% had ankles/feet pain. Maximum workers didn't have discomfort in any of these regions.

Pearson Chi square test revealed that out of the 3 working hour categories, majority (49.6%) subjects reported mild pain with 8-hour work duration while majority individuals with severe pain were only 8.3% and they belonged to the 10 hour working duration category. All others belonged to other categories of pain.

Multiple logistic regression analysis gave different Odds Ratios and Confidence intervals regarding the physical factors and Nordic questionnaire.

When analyzing the effect of different physical factors on different body areas, it was found that most of the workers who often spent time in a specific position, did not have pain in any body area. Still, for some of them, every physical factor affected a specific body part more than others. For instance, out of the workers who often worked in stooping \ twisted posture, hands above shoulders position and those with issues of sleeplessness; most workers didn't have any pain but out of those who did have pain, most complained of pain in the shoulders. Meanwhile among the ones who worked often in kneeling position, most of those with pain, had pain in the lower back.

Table 1. Distribution of physical factors

	Reply alternatives (%)					Total
	Missing values	Rarely	Sometimes	Often	Never	
Lifting heavy burdens	.3	35.6	17.7	28.7	17.7	100
Stooping or twisted posture	0	15.5	16.4	48.3	19.9	100
Hands above shoulders	.3	25.6	22.7	28.7	22.7	100
Kneeling	.6	27.0	26.0	26.3	20.6	100
Sleeplessness	4.4	38.2	25.2	13.2	18.9	100

Table 2. Distribution of Nordic Questionnaire

	Reply alternatives (%)			Total
	Missing replies	No	Yes	
Neck	.7	61.8	37.5	100
Shoulders	.6	58.4	41.0	100
Elbows	.6	71.0	28.4	100
Wrist/hands	0	69.1	30.9	100
Upper back	.3	77.0	22.7	100
Lower back	.6	62.5	36.9	100
Hips/thighs/buttocks	.3	86.1	13.6	100
Knees	.3	76.0	23.7	100
Ankles/feet	.9	86.4	12.6	100

Table 3. Association of working hours and numeric pain rating scale

	Numeric pain rating scale (%)				Total
	None	Mild	Moderate	Severe	
8 hours	22.0	49.6	23.6	4.7	100
10 hours	20.0	43.3	28.3	8.3	100
12 hours	21.6	45.2	25.5	7.7	100

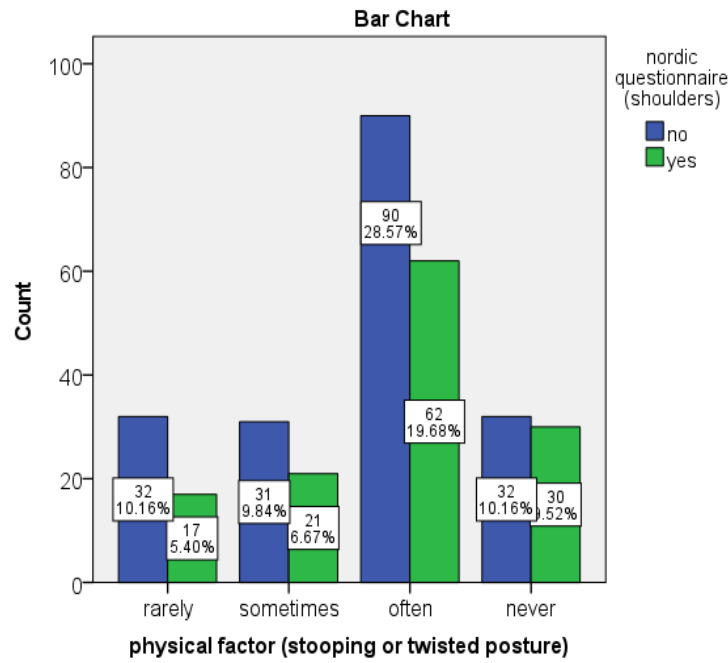


Figure 1. Graph of effect (pain) of Stooping/ twisted posture on Shoulders

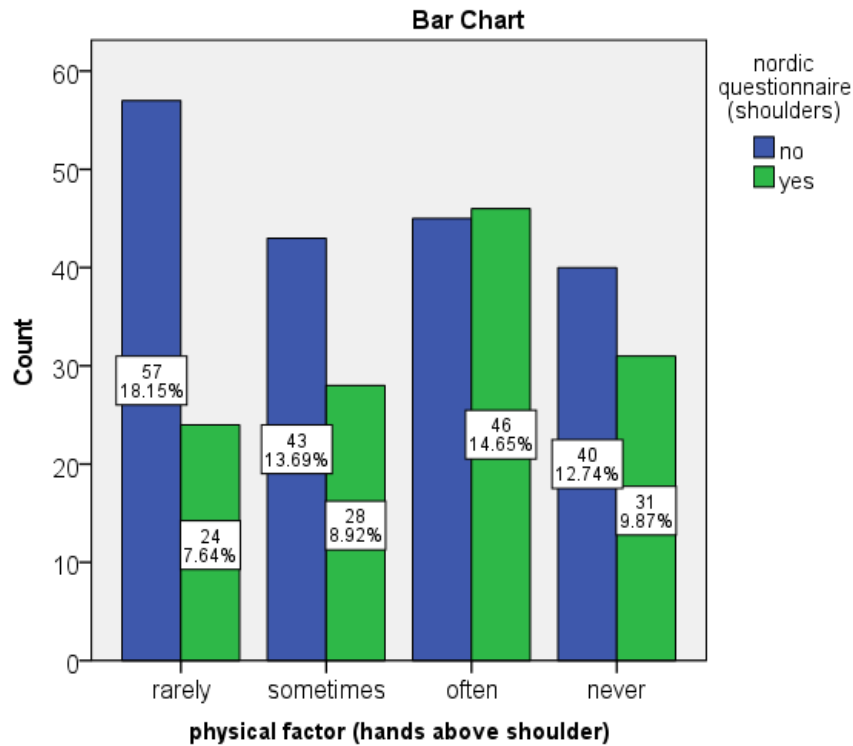


Figure 2. Graph of effect (pain) of Hands above shoulders position on Shoulders.

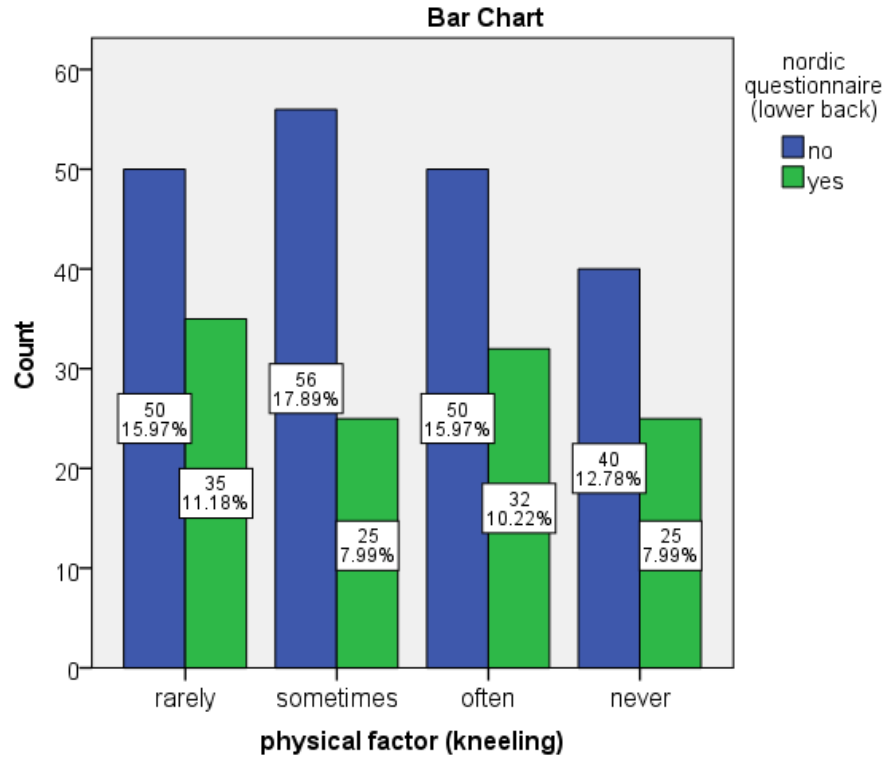


Figure 3. Graph of effect (pain) of Kneeling on Lower back

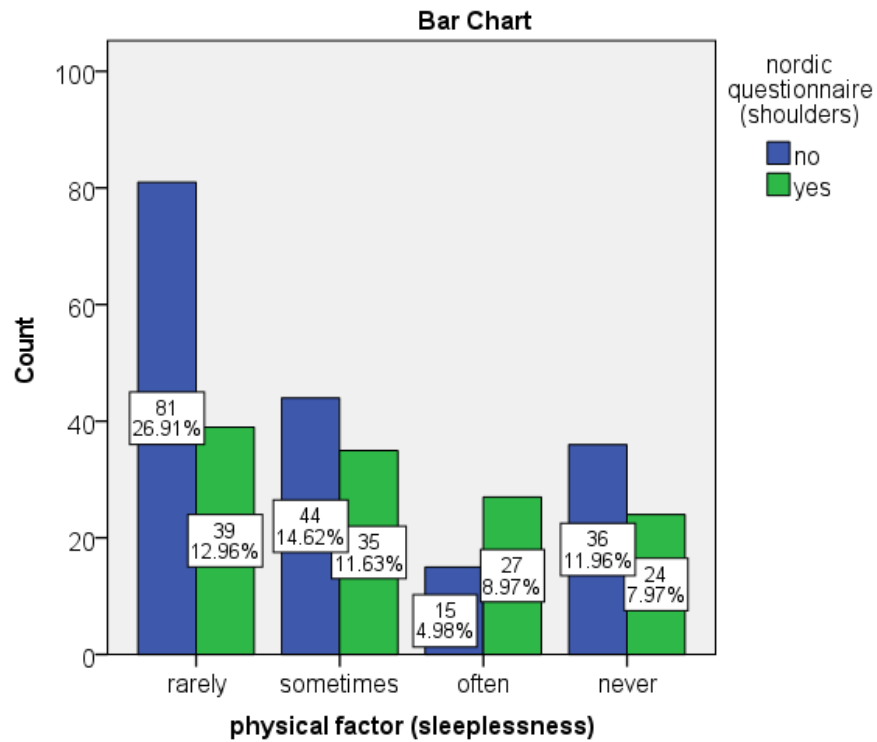


Figure 4. Graph of effect (pain) of Sleeplessness on Shoulders.

4.1. Discussion

Paul Bowen *et al.*, conducted research with the purpose of finding the role of after-hours work related contact in work-to-family conflict and sleep problems experienced by construction workers. It involved 630 participants (architects, engineers and construction workers). That study evaluated demographic characteristics, work exposure, job autonomy and job pressure and sleep problems etc. Mean age group of participants was 45 to 49 years. 82 percent males and 49 percent of children were involved in the study. They found that greater job pressure, work contact, sleep problems, working for more hours in a week had negative impact on the quality of relationship with partner [14] [15] [20]. While in recent study, we have described that in construction workers, working durations of greater than 8 hours have a big impact on severe pain in MSDs.

A cross sectional study conducted by Subhashis Sahu *et al.*, evaluated work related MSDs among laborers. Population selected were both males (140) and females (90). Study acquired information about pain. Work posture was examined by REBA (rapid entire body assessment). Body parts discomfort (BPD) was intended to assess the intensity of discomfort. It was concluded that loads lifted by them were more than NIOSH (National Institute for Occupational Safety and Health) recommended weight limit. Output of the study was that low back pain was high in females and males [2]. While recent research describes the MSDs among construction workers due to physical factors and working hours. One of the assessed physical factors in present study is also lifting of heavy weights. These MSDs involve discomfort symptoms in different body parts inquired by using Nordic Questionnaire.

Anas ali *et al.*, conducted research on the topic of WRMSDs among workers in Indian saw mills. Pain was found to be most commonly occurring in low back. Causative factors included lifting heavy loads, using dangerous tools & improper biomechanics. They found that all these factors lead to decreased work productivity mostly in males. Use of ergonomic measures reduced symptoms and improved effectiveness [16-19]. While according to present research, physical factors like stooping or twisted posture & lifting heavy burdens all cause discomfort in some, not all construction workers and kneeling is found to be more associated with problems of lower back.

5. Conclusion

In conclusion, this study established that there is no significant association between physical factors (dose) and MSDs (response) in construction workers of Multan. Some of the workers working often in stooping or twisted posture, hands above shoulder position and having less sleep; have pain in the shoulders. Some of the workers lifting heavy burdens and working more while kneeling, have discomfort in the knees and low back respectively. Working dose of 12 hours has significant association with severe pain while working dose of 10 hours has association with mild pain.

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