Prevalence of musculoskeletal disorders and occupational risk factors among building painters in South India

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Abstract. The main objective of this study is to find out the prevalence of musculoskeletal disorders (MSDs) and risks among building painters in South India. Cross-sectional data were collected from 120 male building painters in South India using a modified Nordic Musculoskeletal Questionnaire (NMQ) survey. The question includes demographic information, psychological factors, medical history, work-related information, MSDs symptoms and severity of MSDs. The statistical analyses reported the highest prevalence of MSDs among building painters was reported as 70.8%. The highest prevalence rate has been found in the shoulder region (69.5%) and neck region (65.4%). It is also evident that the chief painters experienced the highest discomfort (72.0%) than assistant painters (68.4%). The repetitive task, awkward postures, forceful exertions and work height above shoulder level were reported as highly contributing factors of MSDs among building painters. The building painters who participated in this research were found to exhibit both MSDs and ergonomic hazards. Results suggest that further studies are needed to establish different preventive measures and ergonomics interventions to reduce the risks of MSDs among building painters.

1. Introduction

The predominant prevalent of ergonomic-related injuries are musculoskeletal either from repetition, overload, awkward positions or some combination. Most probably injuries could be a reason affecting workers performance [1]. Barbara et al., [2] reported that work-related upper extremity musculoskeletal disorders are associated with repeated trauma and it was a major cause of lost work in many hand-intensive industries [3]. The physical risk factors that have been associated with at least Work-related Musculoskeletal disorders (WMSDs) include repetitive/longed activities, forceful exertion, awkward/static posture, vibration, localized mechanical stress, cold temperatures, and the evaluation states that any upper extremity complaint should begin at the neck and upper back and then proceed down to the fingers [4]. According to Johanning [5], repetitive or static awkward body posture resulting from excessive bending (forward and lateral) and twisting (trunk rotation or torsion) will increase the spinal stress and disproportionate loading to spinal structures.
Working conditions and working methods have been demonstrated to be contributing factors in the development of musculoskeletal disorders in the shoulder [6-10]. House painters represent a group of construction workers with a high frequency of neck and shoulder complaints and concomitant high risks for early retirements [11]. The task of wall painting produces considerable risk to the workers, both male and female, primarily in the development of upper extremity musculoskeletal disorders [12]. In this case, building painters were exposed to work with arms elevated above the shoulder and in an awkward posture. Insufficient data is available and limited research works were carried out among building painters to evaluate the WMSDs. However, Stenlund et al., [11] have also determined the joint moments and force distribution during ceiling work by house painters and reported that supraspinatus tendonitis is a common shoulder injury incurred by them. Similarly, Patricia et al., [12] investigated shoulder muscle loading and exerted forces during wall painting tasks and suggested to avoid painting at extreme heights (low or high) to reduce fatigue and potential musculoskeletal shoulder injury risks. Gunnar et al., [13] reported that a higher prevalence of symptoms occurs at the right shoulder, elbow and hand/wrist among spray painters due to upper-arm abduction work exposure.

Painting work is listed in industries with a high prevalence of musculoskeletal disorders of multiple body parts [14]. The painting workshops of the furniture industry reported that most problems were originated from inappropriate hand tools, awkward working postures and unsuitable work organization [15]. Painting on high working height imposed greater muscular demands compared to middle and low heights. Work height influences shoulder muscle fatigue during wall painting [12]. The NMQ and statistical analysis methods provide quite correct and appropriate validation [16]. The purpose of this study was to find out the prevalence of musculoskeletal disorders, occupational risk factors and sources of discomfort among building painters in South India.

2. Subjects and methods

2.1. Subjects
Male building painters (120 out of 126) from Chennai, Tamilnadu, India, were formed the population of this study and the effective response rate was measured as 95%. The respondents were under the different age groups from 20 to 55. Subjects were involved for investigation are chief painters (n=82) and assistant painters (n=38). All of them were full-time workers and has been working at least 6 hours per day. All participants were informed regarding the nature of study, objective and outcome before the survey.

2.2 Methods
This cross-sectional study through a modified Nordic Musculoskeletal Questionnaire (NMQ) survey and personal interview among 120 male building painters. Data from a questionnaire survey were used to evaluate the risk factors, psychosocial factors, working conditions, working environment and physical discomfort at different anatomical sites. This survey fulfilled the requirements of this study which includes socio-demographic data, occupational characteristics and musculoskeletal symptoms. The frequency of discomfort, severity, and intensity of disorders were measured by a 4-point Likert scale and the body discomfort chart which displays the various responses as follows: 1 “Never”, 2 “Often”, 3 “Moderate”, and 4 “Extreme Pain”. The ergonomic risk factors were also observed by direct observation. All statistical analysis was performed with Statistical Package for Social Sciences (SPSS version 21.0) software tool. All the subjects were made fully aware of the experimental details and signed informed consent has been
obtained as approved by the ethical guideline of the institution.

3. Results

3.1 Demographic Characteristics of the Respondent

Descriptive statistics for socio-demographic characteristics were presented in Table 1. Data from the survey revealed that the age of the respondent was more or equally distributed between ≤ 25 and 26-40 age groups and with the mean age of 29.5 ± 6.7 (range 20-55), mean working experience as 6.8 years, BMI status of 26.7% was underweight, 69.1% was normal and 4.2% was overweight. Most of them had primary school education (51.7%) and it was noted that very few only did their high school education (5.8%). It was determined that 18.3% of the participants had been working for more than 10 years and 35.8% of them had been working for less than 5 years. The average time of working was 6 hours per day. Notably, 74.0% of the study populations were married and 83.3% of them having smoking habits.

Table 1. Descriptive statistics on general characteristics of the study population (N=120).

| Demographic factors | Chief painters | Assistant painters | Total |
|---------------------|----------------|--------------------|-------|
|                     | n (%)          | n (%)              | N (%) |
| Age (years)         |                |                    |       |
| ≤ 25                | 29 35.4        | 20 52.6            | 49 40.8 |
| 26-40               | 44 53.6        | 16 42.1            | 60 50.0 |
| ≥41                 | 9 11.0         | 2 5.3              | 11 9.2  |
| Education           |                |                    |       |
| Illiterate          | 0 0.0          | 2 5.3              | 2 1.7  |
| Primary             | 41 50.0        | 21 55.2            | 62 51.7 |
| Intermediate        | 36 43.9        | 13 34.2            | 49 40.8 |
| High school         | 5 6.1          | 2 5.3              | 7 5.8  |
| Marital status      |                |                    |       |
| Married             | 67 81.7        | 22 57.9            | 89 74.0 |
| Single              | 15 18.3        | 16 42.1            | 31 26.0 |
| Physical and mental health |        |                    |       |
| Cigarette smoking   |                |                    |       |
| No                  | 11 13.4        | 9 23.7             | 20 16.7 |
| Yes                 | 71 86.6        | 29 76.3            | 100 83.3 |
| BMI                 |                |                    |       |
| Underweight         | 24 29.3        | 8 21.0             | 32 26.7 |
| Normal              | 55 67.0        | 28 73.7            | 83 69.1 |
| Overweight          | 3 3.7          | 2 5.3              | 5 4.2  |
| Current Health status |             |                    |       |
| Good                | 57 69.5        | 23 60.5            | 80 66.7 |
| Average             | 17 20.7        | 12 31.6            | 29 24.1 |
| Bad                 | 8 9.8          | 3 7.9              | 11 9.2  |
| Stress level during work |        |                    |       |
| Low                 | 16 19.5        | 7 18.4             | 23 19.2 |
When it comes to the physical and mental health of the workers, 52.5% of them reported high-stress levels during work and 72.5% of the workers were getting tired after the work. It clearly states that the workers were psychologically affected due to the working condition and nature of work. In addition to that various work-related risk factors like repetitive work (76.7%), awkward posture (85.8%), forceful exertions (69.2%) and work height above shoulder level (82.5%) show the highest prevalence of which contributes discomfort in anatomical sites of the workers.

### 3.2 Discomfort in different anatomical sites

Painting in a multi-story building is typical, risky, time-consuming and highly hand intensive work. From the direct observation and personal interview, it was found that the majority of the painting tasks in the building were done with standing/hanging postures, highly repetitive and forceful exertions. So painters were intended to work for long duration in prolonged standing, which causes discomfort in body regions. It reduces the blood circulation, causes muscle fatigue and tiredness. But only a few tasks were carried out through sitting posture and notably, squatting posture was highly eliminated during building painting.

Table 2 shows the prevalence of discomfort among various categories of painting workers. Chief painters have reported a high risk of discomfort (72.0%) than assistant painters (68.4%). It

|                      | Moderate | 29.3 | 10 | 26.3 | 34 | 28.3 |
|----------------------|----------|------|----|------|----|------|
| Getting tired at the | High     | 51.2 | 21 | 55.3 | 63 | 52.5 |
| end of the work      |          |      |    |      |    |      |
| No                   | 17       | 20.7 | 16 | 42.1 | 33 | 27.5 |
| Yes                  | 65       | 79.3 | 22 | 57.9 | 87 | 72.5 |

| Work-related factors | Total work experience (years) | 52.5% | 45.8% | 48.5% | 35.8% | 36.8% |
|----------------------|-------------------------------|-------|-------|-------|-------|-------|
| ≤ 5                  | 29                            | 35.4  | 14    | 43    | 35.8  |
| 5.1-10               | 33                            | 40.2  | 22    | 57.9  | 45.8  |
| ≥10                  | 20                            | 24.4  | 2     | 5.3   | 18.3  |

| Micro Breaks during work | No | 30.5 | 18 | 47.4 | 43 | 35.8 |
|--------------------------|----|------|----|------|----|------|
| Yes                      | 57 | 69.5 | 20 | 52.6 | 77 | 64.2 |

| Repetitive work | No | 15.9 | 15 | 39.5 | 28 | 23.3 |
|-----------------|----|------|----|------|----|------|
| Yes             | 69 | 84.1 | 23 | 60.5 | 92 | 76.7 |

| Awkward posture | No | 7.3  | 11 | 28.9 | 17 | 14.2 |
|-----------------|----|------|----|------|----|------|
| Yes             | 76 | 92.7 | 27 | 71.1 | 103| 85.8 |

| Forceful exertions | No | 25.6 | 16 | 42.1 | 37 | 30.8 |
|--------------------|----|------|----|------|----|------|
| Yes                | 61 | 74.4 | 22 | 57.9 | 83 | 69.2 |

| Work height above shoulder level | No | 9.8  | 13 | 34.2 | 21 | 17.5 |
|----------------------------------|----|------|----|------|----|------|
| Yes                              | 74 | 90.2 | 25 | 65.8 | 99 | 82.5 |
was observed that 70.8% of workers were reported to have MSDs with discomfort at least in one anatomical site. This leads to absenteeism and long-term leave among building painters workers in the construction industry. Mostly due to improper working conditions different anatomical sites like lower back, shoulder, fingers/wrist, neck, upper back, legs, and thighs were getting affected.

Table 2. Prevalence of discomfort among various working categories in painters.

| Reported discomfort | Category | Total |
|---------------------|----------|-------|
|                     | Chief painters | Assistant painters |
|                     | n=82 | % | n=38 | % |
| Yes                 | 59  | 72.0 | 26  | 68.4 |
| No                  | 23  | 28.0 | 12  | 31.6 |

Figure 1. shows the distribution of work-related MSDs in the different body regions. From the survey result, it was determined that the highest prevalence rate of discomfort was reported in the shoulder region (69.5%) and neck region (65.4%). It was followed by lower back (60.3%), finger/wrist (57.8%), upper back (42.4%), knee/foot (41.3%), elbow/forearm (38.0%), thigh (20.7%) and chest (18.3%).

Figure 1. Reported MSDs in different body region among building painters (N=120) during the past12 months
3.3 Evaluation of Ergonomic risk factors

The primary workload was distributed between the workers such
   a) Paint preparation and painting work was mainly done by chief painters and
      assisted by assistant painters.
   b) Workplace setup and removing old paint was done by assistant painters.

The various working tasks of building painters were.
   1. Scrubbing/removal of old paints
   2. Workplace Setup
   3. Paint preparation
   4. Painting work and
   5. Handling/transportation of paints and accessories

These tasks were carried out by the workers without any proper engineering control, ergonomic tools, and prescribed instructions. Those tasks were observed as a source of ergonomic risk factors that contribute to the MSDs and discomfort in body regions. Table 3 describes the various tasks and their ergonomic risk factors in painting work.

Table 3. Ergonomic risk factors for various tasks at building painting in South India.

| S.No. | Major tasks in painting work                  | Ergonomic risk factors                                                                 |
|-------|----------------------------------------------|---------------------------------------------------------------------------------------|
| 1     | Scrubbing/removal of old paints               | Excessive grip force                                                                  |
|       |                                              | Forceful exertions                                                                    |
|       |                                              | Contact stress                                                                        |
|       |                                              | Prolonged standing                                                                    |
|       |                                              | Highly repetitive                                                                      |
|       |                                              | Awkward posture                                                                       |
|       |                                              | Work height above shoulder level                                                      |
| 2     | Workplace Setup                               | Forceful exertions                                                                    |
|       |                                              | Bending/twisting trunk                                                                |
|       |                                              | Awkward posture                                                                       |
|       |                                              | Work height above shoulder level                                                      |
| 3     | Paint preparation                             | Chemical hazards                                                                      |
|       |                                              | Bending/twisting trunk                                                                |
|       |                                              | Respiration Problem                                                                  |
|       |                                              | Skin Problem                                                                          |
|       |                                              | Awkward posture                                                                       |
| 4     | Painting work                                 | Repetitive motion                                                                    |
|       |                                              | Bending/twisting the trunk                                                            |
|       |                                              | Awkward postures                                                                      |
|       |                                              | Prolonged standing/hanging                                                            |
|       |                                              | Forceful exertions                                                                    |
|       |                                              | Work height above shoulder level                                                      |
|       |                                              | Physical injuries like slips, cuts and accidents                                      |
| 5     | Handling/transportation of paints and accessories | Heavy lifting/pulling                                      |
|       |                                              | Manual materials handling                                                              |
|       |                                              | Physical injuries like slips, cuts and accidents                                      |
4. Conclusion

This current study evaluated the ergonomic risk factors, sources of discomfort, and levels of discomfort in body regions among the building painters in South India. Using questionnaire various factors like psychosocial variables, work-related variables, health-related and working environment were observed to quantify the risk factors that contribute to MSDs. It was found that identified working tasks associated with various ergonomic risks like repetitive motion, heavy lifting/pulling, prolonged standing/hanging, forceful exertion, contact stress, grip force, awkward posture, and excessive force. These ergonomic risk factors cause discomfort largely in the shoulder and neck region during the past 12 months. Chief painters were identified as they were at high risk of MSDs than assistant painters. It is concluded that various ergonomic risk factors were investigated and reported among building painters in South India. This finding recommends the ergonomic intervention, structure engineering control on working conditions and administrative controls reduce the exposure of ergonomics risk factors.

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