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Musculoskeletal risk assessment among the male workers engaged in craft sectors of Jaipur, India

Ashish Kumar Singh, Makkhan Lal Meena and Himanshu Chaudhary
A. Department of Mechanical Engineering
Malaviya National Institute of Technology
Jaipur, Rajasthan 302017, India
singh.mechanical@yahoo.com, mlmeenamnit@gmail.com, hchaudhary.mech@mnit.ac.in

Abstract

This study investigates the musculoskeletal problems in four craft sectors in the Jaipur, India, namely carpet washing, trimming, alignment and wood carving. A field study was conducted in 13 workshops of several handicraft manufacturers, and 122 male respondents were randomly selected for the survey. The data about pain occurrence at different body and hand regions among the participants were collected using a questionnaire. Mean perceived exertion among the handicraft workers during respective craft tasks was estimated according to Borg's rated perceived exertion (RPE) scale The highest prevalence of symptoms in the body regions was reported for the last 12 months were the Wrist, Lower back, Shoulders. Whereas, metacarpal, thenar eminence, and hypothenar were the most prominent hand regions of discomfort. These discomfort regions could be due to the poor workstation and hand tool design, and awkward working postures. Furthermore, the study revealed that the mean scores of the RPE were significantly higher with higher age and experience. It can be postulated that the work system including hand tools should be redesigned that may reduce the symptoms of musculoskeletal disorders. Health habits also play a role in RPE, albeit to a moderate degree.

Keywords
Handicrafts; Musculoskeletal disorders; Ergonomics; Rated perceived exertion; Health habits.

1. Introduction

Musculoskeletal disorders (MSDs) are the most common problem among the workers employed in the handicraft industry which are related to injuries of the muscles, nerves, tendons, joints, cartilage, and supporting structures of the upper and lower limbs, neck, and lower back (Salve, 2015). These disorders are caused by the sudden exertion or prolonged exposure to physical factors such as repetition, force, vibration, noise, or awkward posture (Bernard, 1997; Singh et al., in press; Singh et al., 2018a). This study investigates the problems encountered during handcrafting work and proposes solutions to mitigate the risks due to the physical factors involved in these craft tasks. This study assesses the ergonomic aspects at the grass-root level and proposing the insight to develop a better design.

The handicraft manufacturing processes may be dynamic, repetitive or sedentary (Singh et al., 2018b). The craft workers may require prolonged repetitive, awkward postures. Handicraft work is much more difficult and extremely labour intensive as compared to other informal jobs (Singh et al., washing). Several available literature reports that there are risk factors are present, for developing the cumulative trauma disorders, at the workplace of handicraft manufacturing (Singh et al., 2018c; Das et al., 2018; Singh et al., 2018b).

In countries like India, informal sectors are the primary source of new employment and the occupational problems among workers in these sectors need more focus. The prevalence of various MSDs was not evident in literature for the workers engaged in the targeted handicraft workers in the present study. Therefore, it sought useful to take up the issues of the ergonomic study of handicraft operatives, with an objective to determine the prevalence of MSDs while crafting work. This study hypothesizes that there would be significant association of age, experience and health habits on perceived exertion. The research aimed to propose certain workstation guidelines which could

be beneficial for designing new workstation that may improve the working conditions and reduce symptoms of MSDs to effecive sustainability.

2. Material and Methods

2.1 Participants

The study was conducted within the urban area of Jaipur. All 122 male respondents, aged between 19 and 50 (mean 31.9; SD 7.65) were selected for the survey from 13 workshops of several handicraft manufacturers. These workshops were situated within the urban and rural areas of Jaipur in Sadwa, Maanbagh, Khore and Ramgarh regions. The experimental subjects were divided into three groups according to the categories of perceived exertion (0-3 for light exertion, 4-7 for moderate exertion and 8-10 for extreme exertion) (Figure 1a). The average work experience of the participants in the present occupation was 10.2 ± 6.8 years. These craft professions are most sought after male workers because it requires high physical strength.

2.2 Questionnaire Study

Modified Nordic Musculoskeletal Questionnaire (Kuorinka et al., 1987) was used to collect the required information from the experimental group. The checklist comprised three parts: (a) general information, i.e. age, demographic characteristics, working hours, experience, education, marital status, health habits, etc.; (b) Body part discomfort interview i.e. pain/discomfort at different body sites, palm and finger regions, perceptual effort rating on Borg scale during wiping (Borg, 1982);

The questionnaire was translated from English to Hindi for the ease of study. Each washer-man got verbal explanation about Borg scale before the survey. The 0-10 scale over 6-20 scale was used as it is easy to understand by the workers having low literacy rate. As opined by Borg (1982), the 0-10 scale is simple and easy to understand by the lay of population that is not familiar with technical terminologies. Moreover, the 6-20 scale is used in simple applied studies like exercise testing that do not include subjective symptoms. In the present study, body and palmar pain are reported in detail in results and discussion section. Additionally, chemicals used during washing may cause breathing and tingle/irritation on the skin that is reported in the discussion section. Therefore, we sought to use the new 0-10 scale to quantify the perception of physical exertion instead of 6-20 scale.

Self-enumeration was difficult due to less understanding and low literacy rate among the participants. The main benefit of the interviewer-assisted over self-enumeration data collection method is that by personalizing the interview, survey population with low literacy rates can be covered and response rate and quality of data could be increased. Generally, the response rate for self-enumeration surveys is less than 70% (Fellegi, 2003). Therefore, interview assistance was provided to the respondent to complete the questionnaire.

2.3 Physical Parameters

Physical parameters such as height and weight were measured by Holtain Harpenden Stadiometer (Made in Britain) and Accusure Digital Weighing Machine (Model GBS710). The Body Surface Area (BSA) and Body Mass Index (BMI) of the subjects were computed from the data collected using standard equations (Mosteller, 1987).

2.4 Sample Characteristics and Statistical Analysis

Shapiro-Wilk's test (Shaipro and Wilk, 1965; Razali and Wah, 2011) after a visual inspection of their histograms, normal Q-Q plots and box plots showed that the experience, level of smoking and drinking were not normally distributed for the group categories of perceived exertion. Whereas, the age was normally distributed for the group categories of perceived exertion. The results clearly showed that most of the dependent variables were not normally distributed for the categories of independent variables. So, we opted the non-parametric approach for the statistical analysis.

Kruskal-Wallis H test was conducted to test the Hypothesis H1 (a) "significant difference in the rating of perceived exertion (RPE) and health habits (smoking and drinking)". It was performed to test the Hypothesis H1 (b) "significantly high perceived exertion with higher age and experience of the workers". Kruskal-Wallis H test is a non-parametric alternative to one-way ANOVA test and used when ANOVA's distributional assumptions are not met. All of these data were analyzed using the SPSS version 22.0.

3. Results and Discussion

During the study, 122 male handicraft workers were asked to participate. Table 1 shows the demographic description and general information related to work. The demographic description of mean BMI was 22.4 ± 1.7 (normal) (WHO, 2000); mean BSA was 1.65 ± 0.10 m2 (normal). The daily hours spent by the participants was 9.2 ± 0.74 hours with rest of 45-60 minutes each day, and weekly workload was 63.5 ± 5.04 hours (7 days working). It was observed that 86.7% of participants were having education below secondary. It was reported that 90% of them use the right hand as their dominant hand. 63.3% of the participants had health habits (smoking and drinking) at varying levels either light, medium or heavy.

Table 1. Demographic statistics and personal characteristics of the study population (N=122)

Characteristics of samples		Washer-men (n=30)	Wood Carver (n=30)	Carpet Trimmer (n=32)	Alignment Workers (n=30)	Overall (N=122)	Kruskal-Wallis *p* value
		Mean ± SD					
Age of subject (years)		32.8 ± 8.15	31.4 ± 7.26	33.5 ± 7.37	30.1 ± 7.81	31.9 ± 7.65	0.119
Weight of subject (Kg)		59.63 ± 5.44	62.51 ± 5.81	61.72 ± 5.09	60.84 ± 6.09	60.84 ± 6.10	0.258
Stature of subject (cm)		163.37 ± 4.06	165.53 ± 5.19	163.81 ± 4.88	164.68 ± 5.11	164.12 ± 5.09	0.184
BMI index		22.32 ± 1.66	22.59 ± 1.69	22.44 ± 1.68	22.38 ± 1.70	22.4 ± 1.70	0.684
BSA index		1.64 ± 0.09	1.66 ± 0.10	1.64 ± 0.11	1.65 ± 0.10	1.65 ± 0.10	0.329
Experience (years)		12.01 ± 7.19	9.23 ± 6.80	10.20 ± 6.51	9.22 ± 6.62	10.2 ± 6.8	0.112
Daily workload (hour)		9.1 ± 0.71	8.9 ± 0.68	9.3 ± 0.78	9.3 ± 0.79	9.2 ± 0.74	0.214
Weekly Workload (hour)		63.7 ± 4.98	61.2 ± 4.81	63.9 ± 5.14	63.9 ± 5.19	63.5 ± 5.04	0.221
	Category	Frequency (%)					
Education	Illiterate	33.3	50	53.33	60	49.23	
	Primary education	53.3	36.67	40	23.33	38.35	
	Secondary education	13.3	13.33	6.67	16.67	12.40	
Marital Status	Unmarried	3.3	6.67	3.3	3.33	4.14	
	Married	96.7	93.33	96.7	96.67	95.86	
Hand Dominance	Right Hand	90	100	96.67	96.67	95.85	
	Left Hand	10	0	3.33	3.33	4.15	
Level of Smoking	No	36.7	50	60	46.67	48.53	
	Light (<15 cigarettes)	16.7	40	36.67	43.33	34.22	
	Medium (15-25 cigarettes)	30	6.67	3.33	6.67	11.53	
	Heavy (>25 cigarettes)	16.7	3.33	0	3.33	5.74	

Level of Drinking	No	30	60	66.67	43.33	50.27
	Light (<125 ml)	10	33.33	33.33	26.67	25.96
	Medium (125-250 ml)	36.7	6.67	0	30	18.04
	Heavy (> 250 ml)	23.3	0	0	0	5.73

Figure 1a depicts the mean perceived exertion among the handicraft workers during respective craft tasks according to Borg's rated perceived exertion (RPE) scale (Borg, 1982). The mean perceived exertion among the workers was 6.8 ± 3.3. 51.6% of the participants complain of extreme physical exertion while working with the hand tools; 28.7% feel moderate physical exertion; 19.7% feel the light physical exertion (Figure 1b). Table 2 shows the association of experience and age with the perceived exertion. The treatments/grouping category was the subjective rating of perceived exertion while the age and experience were considered under these treatments from the questionnaire.

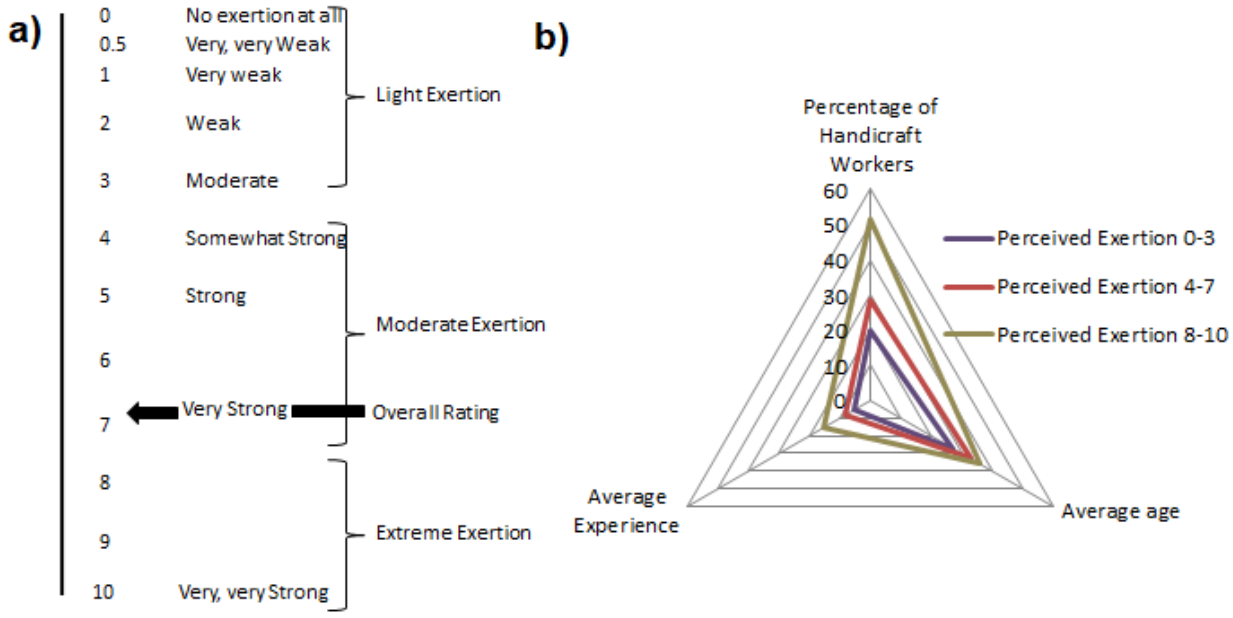

Figure 1. a) Mean perceived exertion among the handicraft workers; b) Spider diagram for perceived exertion w.r.t age and experience

The results of the Kruskal-Wallis test were significant, $\chi 2$ (0.05, 2) = 12.519, pointing out that the mean score of the perceived exertion were significantly higher with greater experience. The perceptual effort rating increased marginally with higher age ($\chi 2$ (0.05, 2) = 9.515). There was no evidence of a significant difference of health habits (smoking) on the categories in perceived exertion ($\chi 2$ (0.05, 2) = 2.296). It was observed that there was a strong evidence of a significant difference of health habits (drinking) on the categories in perceived exertion ($\chi 2$ (0.05, 2) = 14.114) (Table 2).

Table 2. Kruskal Wallis Sum Rank test for test fields (experience, age, health habits) by perceived exertion

	Feeling of perceived exertion					
Test Fields	Mean Rank (0-3)	Mean Rank (4-7)	Mean Rank (8-10)	χ^2	*df*	*p*
Experience (years)	11.82	9.15	23.11	12.519	2	<0.000*
Age (years)	10.42	9.55	21.15	9.515	2	0.004*
Level of Smoking	9.81	16.49	18.14	2.296	2	0.215
Level of Drinking	6.71	13.55	20.08	14.114	2	<0.000*

Notes. Light exertion – Mean Rank (0-3), Moderate exertion – Mean Rank (4-7), Extreme exertion – Mean Rank (8-10)
*($p<0.01$)

Somewhat surprisingly, there was a no evidence of a statistically significant effect of smoking on the categories in perceived exertion. Nonetheless, there was a pronounced trend for the inebriate workers to feel more exertion. Most of the participants smoke and drink at varying levels, which could be the important factors in the musculoskeletal health of the handicraft workers. The inferences from the present research suggest that alcohol consumption has a direct effect on the musculoskeletal system. It was also evident from the previous literature that the effect of alcohol is not only limited to people who drink excessively, albeit small daily consumption causes weakening in skeletal system (Turner, 2000; Drug Rehab Florida, 2013; Hodges et al., 1986; Burke et al., 2007).

This study presents the evidence of the prevalence of MSDs among the workers in handicraft industries. In addition to that, the study suggests that the perceived physical exertion may be influenced by the age and experience of the workers, albeit to a moderate degree. The average age and experience of participants complaining of feeling extreme physical exertion were 35.69 years and 15.12 years which were relatively higher compared to participants feeling moderate or low physical exertion. Also, Kruskal-Wallis test showed that the variations were too great to be explained by chance alone. There was strong evidence of statistical difference in age and experience on the categories in perceived exertion.

Figure 2 shows the results of the questionnaire, revealed that the frequency of most commonly affected body regions among the handicraft workers in the past 12 months was wrist, lower back, shoulders, elbows, leg/Calf muscle, and hips/thigh. The sole of the foot is other most affected body region among the washer-man. Figure 3 shows the results of the questionnaire, revealed that the frequency of most commonly affected palmar surface regions among the handicraft operatives in the past 12 months were metacarpal, thenar eminence, and hypothenar.

The results from this longitudinal study were in line to some previous studies (Singh et al., 2017; Singh et al., 2018c) showing wrist, lower back, metacarpal, and thenar eminence were the most affected body regions during craft work. The high exertion of force against the hand tool with bare hands requires hard gripping on the tool handle. The palmer regions were therefore exposed to shear stress for long periods.

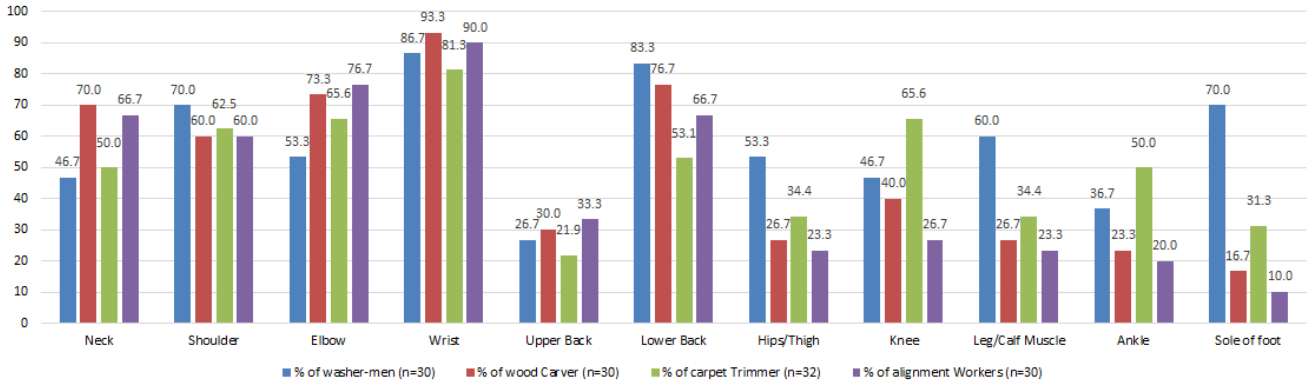

Figure 2. Frequency of reported symptoms in different body regions among male workers in last 12 months

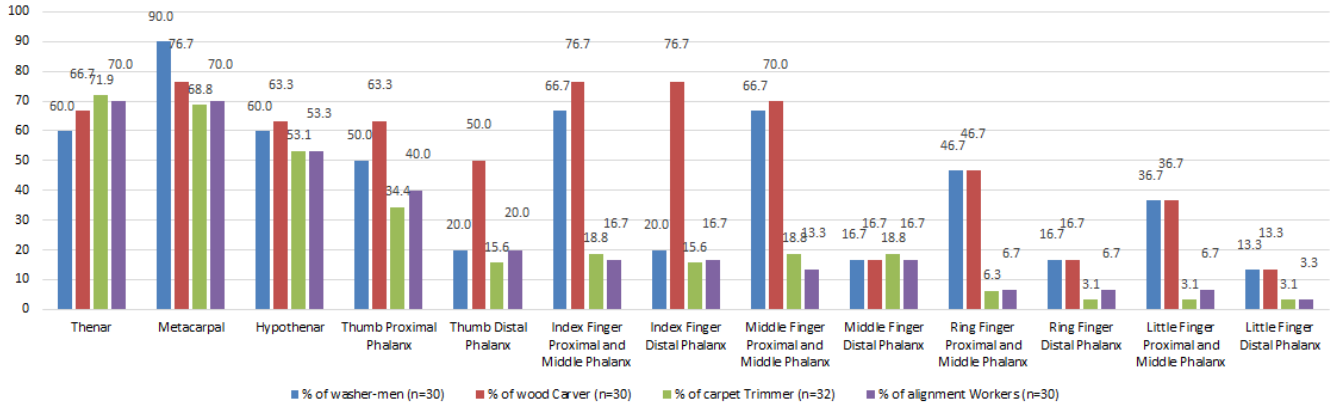

Figure 3. Frequency of reported symptoms in different palmar surface regions among male workers in last 12 months

4. Conclusion

Overall, it can be concluded that there was risk of discomfort in different body and hand regions among the handicraft workers. The findings in this study can lead to the need for attention as well as investigation of current hand tools and workstation, leading improvement in working posture and efficiency of the worker. The other major contributions of the paper was proposing the effect of age, experience and health habits on rated perceived exertion on the workers engaged in craft activities. It must be borne in mind that this study was only conducted on a small exposed group of workers. The future work includes to design/redesign the hand tool interventions focusing on the inferences drawn from this study.

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Biographies

Ashish Kumar Singh is a Research Fellow in Department of Mechanical Engineering in Malaviya National Institute of Technology (MNIT), Jaipur. He graduated in Mechanical Engineering from University of Rajasthan, Jaipur. He obtained his Master's in Quality Management from Birla Institute of Technology and Science (BITS), Pilani. His research areas are public health, ergonomics, work system design, human response to vibration, and noise exposure. He has published more than 10 research papers in various peer-reviewed international journals and conferences.

Dr. M.L. Meena is an Associate Professor in Department of Mechanical Engineering in Malaviya National Institute of Technology (MNIT), Jaipur. He graduated in Mechanical Engineering from University of Rajasthan, Jaipur in the year 2005. He obtained his Master's in Manufacturing System Engineering from Malaviya National Institute of Technology Jaipur. He earned his PhD from MNIT, Jaipur. He has published 73 research papers in various national and international journals and conferences. His research areas are quality, ergonomics and productivity engineering. He has ten years of teaching and research experience.

Dr. Himanshu Chaudhary is Professor in Department of Mechanical Engineering in Malaviya National Institute of Technology (MNIT), Jaipur. He graduated in Mechanical Engineering from Engineering College, Kota. He obtained his Master's in Solids Mechanics & Design from IIT Kanpur. He earned his Doctorate in Machine Design from IIT Delhi. He is actively working in the field of Kinematics and Dynamics of Machinery. He is more interested in Dynamic and balancing of Multibody Systems such as closed loop mechanisms and manipulators. He has published in about 50 journal and conference papers and a book "Dynamics and Balancing of Multibody Systems" by Springer (2009). He is the reviewer of several international journals and his current activities include studies and design of agricultural machinery