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Assessment of Work-Related Musculoskeletal Disorders and Postural Risks in West Bengal's Furniture Manufacturing Carpenters Using RULA and REBA

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Abstract: Wooden furniture making is among one of the most common and predominant but unorganized industries and engages a large number of carpenters, mostly belonging to lower socio-economic backgrounds. There is a significant research gap in the assessment of Musculoskeletal Disorders (MSD) and in addressing the related issues occurring in these industries in West Bengal. This article discusses postural strain among 12 carpenters (25-65 years) using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA). The scores from these two recognized posture analysis tests revealed the need for some changes to alleviate discomfort and reduce risk. The study's findings suggested that providing a proper workplace with adjustable workbenches would be beneficial. Introducing short rest breaks during tasks can help delay the onset of fatigue. Among the limitations of the study is the small sample size of only 12 carpenters. This hinders the generalization of findings to a larger population. The absence of control groups also limits statistical analysis. Further research with a larger sample size and control groups can extend the study's purpose and provide a more robust assessment of WMSD in carpenters during furniture manufacturing.

Keywords: Musculoskeletal Disorders, Postural load, Carpenter, Working posture analysis, Body part discomfort

Introduction

Among the various types of construction works, carpentry can be considered among the most versatile ones [1]. Not just in the rural and urban areas of West Bengal but all over the world there is a large number of wooden furniture making industries. Carpenters in the developing countries like India belong to the lower socioeconomic background who mainly works in a daily wage system mostly under informal and unorganized sector.

A carpenter is a skilled artisan who specializes in working with woods to fabricate, install, and maintain buildings, furniture and various other objects. They play a crucial role in the design, construction, installation, and repair of wooden structures, fixtures, furniture, and other items [2]. Carpenters usually use woodworking skills to make the various wooden furniture starting from simple chairs, tables to elaborate beds, cabinets, dressers, etc. To make these furniture they need to perform a wide range of activities like making sketches of proposed designs including dimensions, measurements, cutting and shaping of the woods or other specified materials (e.g., plastic, fiber glass) joining the woods,

weaving fabric to the furniture etc. They use a diverse range of hand tools like saws, hammers, chisels, screwdrivers as well as they operate many types of machinery or power tools like table saws, sanders, routers and others to create a complete furniture. Even though they perform with high woodworking skills, being unaware of occupational safety and health problems, the carpenters often expose themselves to various hazardous conditions like repeated motion, working in awkward posture, manual material handling, heat, cold, dust, chemicals, biological agents etc. and eventually suffer from serious health problems among which the musculoskeletal disorders are mostly predominant [3]. Although the work experience and age are significantly associated with the condition of WMSDs, it is largely the awkward, extreme and repetitive postures or prolonged period of static postures which are adopted by the carpenters during their different steps of furniture-making activities which impose the greater risk for WMSDs development. Moreover, working under unorganized sectors and being self-driven by the daily wage system, furniture makers in West Bengal are often forced to perform strenuous physical activities as fast as they can, on a regular basis. The consequences of these disorders not only affect the individual worker's health, well-being and productivity but also have broader implications for the industry and society as a whole.

Therefore, this study is conducted to assess the prevalence and impact of WMSDs among carpenters involved in furniture manufacturing in West Bengal. By investigating the ergonomic factors, work practices and occupational hazards in the carpentry profession, this project intends to identify potential risk factors contributing to the development of WMSDs during their several daily activities in a furniture making task in accordance with their mostly used body parts (especially the upper extremities).

Materials & Methods

With the permission of the Institutional Human Ethical Committee, the original study was conducted on a total 12 male carpenters (aged between 25-65 years). Subjects were selected mainly from different unorganized units in West Bengal. Their activities were both observed directly (in order to record certain physical parameters) and videotaped for about 15-30 minutes during the furniture manufacturing processes (for later work study analysis purpose).

Subject selection

Various carpenters of small-scale establishments were approached for assessment. A meeting was arranged where the purpose of the study was discussed with the carpenters and then their participation requested. Initially 20 subjects were considered for this study but eventually 12 were assessed due to non-cooperation and feeling of indisposition.

Inclusion and exclusion criteria

For the current study, it was made sure that all the 12 individuals had a minimum of two years' experience in carpentry tasks. All of those who were selected had given their permission to videotape their activities during work and they also agreed to cooperate in providing information regarding their work activities. It was carefully noted that all the workers chosen for this study were in their best physical conditions. Anyone who reported himself as unfit or was found to be taking days off during a regular work week were excluded from the current study. Only the workers who had a minimum of two years of working experience were considered for the present study.

Demographic data collection

Height (cm) – Heights of the subjects was recorded using the anthropometric rod. Body Weight (kg) - The body weights of the selected subjects were measured with the help of the weighing machine. Body Mass Index (BMI) - The BMI (in metric units) as a measure of body fat was calculated from the recorded height and body-weight values by using the

formula: BMI [kg/m^2] = Weight (kg) / Height^2 (in meters) [4]. Body Surface Area (BSA) was calculated using the formula proposed by Du Bois & Du Bois [5]: BSA [m^2] = Weight [kg]$^{0.425}$ x Height [cm]$^{0.725}$ x 0.007184.

Parameters recorded

The original study recorded multiple parameters for a detailed assessment of the WMSDs among the carpenters during furniture making. The main study not only obtained its data from questionnaire analysis but also it took the help of different tools like The Assessment of Repetitive Tasks (ART); Quick Exposure Checklist (QEC) [6]. Work study was also done using the Two Handed Process Chart. But the present article will particularly focus on the postural strain that was imposed from adopting various awkward postures during their particular tasks. Postural Strain Analysis was recorded with the help of two popular posture analysis methods namely Rapid Upper Limb Assessment (RULA) [7] for the specific analysis of upper extremity discomfort and Rapid Entire Body Assessment (REBA) [8] for the analysis of whole body postural strain.

Results & Discussion

Table 1 depicts the average age group of the selected carpenters is 46±8.93 (29-62) years with a mean work experience of 20.83±8.0 (6-38) years. This indicates that most of the subjects belong to middle age. Their mean BMI value was found to be 23.35 ± 2.11 (20.58– 28.63) kg/m^2 which according to Nutritional Trends in India will be considered normal. [Normal range = 18.5 kg/m^2- 24.99 kg/m^2] (Nutritional Trends in India, 1993). The normal BMI signifies that the subjects are not suffering from under nutrition and it possibly does not cause any occupational hazards among them.

Table 1. Physiological characteristics of the carpenters.

Age (years)	**46 ± 8.93 (29-62)**
Work Experience (years)	20.83 ± 8 (6-38)
Height (cm)	162 ± 7.18 (155.2-175)
Weight (kg)	62 ± 9.40 (53-85)
BMI (kg/m^2)	23.35 ± 2.11 (20.58-28.63)
BSA(m^2)	1.66 ± 0.15 (1.5-1.98)

The following Table 2 and Table 3 represent the proper posture analysis done by both RULA and REBA methods respectively.

Table 2 depicts the different postures which cause mainly upper extremity discomfort and therefore it was analyzed using the RULA method. The average RULA scores for these 4 different tasks are found to be 3.5, 4.5, 4, 3 which suggests further investigation and change in posture may be required.

Table 2. Analysis of Working Postures by RULA Method.

Activity Name	Performed by Total Number of Subjects	Working Posture	Stick Diagram	Average RULA Score
Cutting with Handsaw	2	 	 	3.5
Hammering	4	   	   	4.5
Planing	1			4
Furniture Leg Making	1			3

Table 3 shows the working postures involving the entire body. Therefore, these postures were analyzed by using the REBA method and the obtained REBA scores for 9 different tasks performed by nine different individuals were found to be 3, 4, 5, 4, 3, 4, 3, 5, 5. These scores suggest that most of these tasks impose a certain amount of risk on the workers' body for which further investigation and change in the posture is required. In similar research, Biswas, et al. [3] also found that most of the postures adopted by the carpenters were incorrect which required additional investigation as well as adjustments.

Table 3. Analysis of Working Posture by REBA Method.

Activity Name	Performed by Total Number of Subjects	Working Posture	Stick Diagram	Average REBA Score
Cutting with Handsaw	1			3
Hammering	1			4
Wood Curving	1			5
Making Wooden Moldings	1			4
Planing	1			3
Sanding with Sand Paper	1			4
Sanding with Electric Sander	1			3
Joining Wooden Rail	1			5
Cutting with Electric Saw	1			5

Conclusion

The present study was conducted on a group of carpenters working in small scale establishments who mainly construct furniture with the help of simple tools. The physical characteristics in accordance to weight, height, BMI and BSA of the subjects were found to be normal.

RULA was mainly utilized for the subjects whose upper body was mainly involved in their daily activities. REBA is utilized for the subjects whose entire body was actively involved during their tasks. In case of sitting work the RULA scores varied between 3 and 4 which mean that some investigation may be required to implement some degree of change. In case of REBA the scores varied from three to five which means some of them lie in the low risk category and others are in medium risk criteria for which some amount of changes may be needed.

Limitation of the Study: As this study was conducted with the cooperation of only 12 carpenters, i) this limits the ability to generalize the findings to a larger population of carpenters. ii) Furthermore, since the responses obtained were from a small group of individuals, the results cannot be considered as reliable as it could have been if the study involved a large group of workers. iii) And lastly, as the study did not include control groups, there is a lack of statistical analysis between such groups which could enhance the knowledge. With a greater subject number and in presence of a control group, further research studies can extend this study's purpose as well as bring a new approach to fulfil the aim of the study to assess the WMSD of carpenters during furniture manufacturing.

Ethical approval

The study was approved by the Institutional Human Ethical Committee (Ref. No. IHEC/SSM/P80/2019 dated 27.02.2019; Department of Physiology, University of Calcutta).

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