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Original Research Article

Postural strain of spinner and casting workers of a small-scale aluminium utensil making factory

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ABSTRACT

Background: Small scale establishments often neglect the worker safety and comfort which impacts both productivity and workers' safety. Various studies have been conducted in such small-scale establishments but not much has been done on aluminium utensil manufacturing factories. Spinning and casting are two important processes for manufacturing of aluminium utensils. But not much has been studied to assess the hazards of the involved workers. The present study is an attempt to explore this previously unnoticed area.
Methods: The study was conducted in different small scale aluminium utensil factories in West Bengal. Sixteen spinners and seventeen casting workers were evaluated for this study. The analysis of posture was done by rapid upper limb assessment (RULA), rapid entire body assessment (REBA) and Ovako working posture analysis system (OWAS). The body parts discomfort was assessed by using Cornell musculoskeletal discomfort questionnaire and Nordic questionnaire was also used to assess the pain they experience.
Results: All the casting workers are experiencing postural load beyond the recommended limit whereas in case of spinner, five workers experienced less postural load due to favorable work conditions. Casting workers mainly suffered from low back, neck, right shoulder pain whereas spinners suffered from wrist and finger pain followed by lower extremity pain.
Conclusions: Both group of workers are experiencing postural load and discomfort. In case of casting workers, the prevalence was high and immediate interventions are needed. The discomfort is particularly high during the end of shifts.

Keywords: Nordic questionnaire, Postural load, Body part discomfort, Cornell musculoskeletal discomfort questionnaire, Musculoskeletal pain

INTRODUCTION

The concept of ergonomics in workplace design is ignored in most of the industries. This problem is very much prevalent around the world, including India. The problem of workplace design should be thought of at the blueprint stage involving an ergonomist along with process engineers, and production engineers. The workplace design is basically governed by the two main dimensions, i.e., clearance and reach, where clearance will be focused on taller individuals and reach for shorter. Lacing of which force the workmen to assume awkward posture, poor posture, and bad posture. Assuming those posture by the workmen are either due to inadequate workspace or due to lack of awareness of the workmen. In most of the unorganized sectors in India, the workers are forced to work in low wage where their work effort is maximum but occupational safety is highly neglected.[1]

In the context of workplace studied involving different activities, workmen suffer from postural stress. Many studies in the past have been conducted in different workplaces, including India. No such studies have been reported the postural problem of spinners and casting workers of aluminium utensil making industries in our country. Hence a study has been undertaken to highlight the problem of postural stress and its impact on health and productivity.

As the study in this particular field is scarce, studies in similar workplaces may provide useful insight to the problems regarding poor working postures. A study conducted on the foundry workers of West Bengal showed that the workers have to experience high workload and a lot of thermal load which in the long term may have some detrimental effects on their health.[2] Another study on welders have revealed that along with the welding type, the work duration and work table are one of the key factors which contribute to the body part discomfort of workers.[3] The casting works have to carry a lot of weight during their daily tasks which is comparable to manual material handling. Implementation of hand drawn carts and occupational training may help to mitigate the postural load related to manual material handling tasks.[4] Low back pain is a prevalent problem in manual material handling tasks and it amounts up to a lot of time loss in production as well.[5] Low back pain has been found to be the root cause of absenteeism, productivity loss and results in a lot of healthcare expenses.[6] That is why it is important to implement preventive measures to reduce the risks of low back pain in various workplaces. Proper evaluation of the workplace is very important to achieve this and redesigning or adjusting the workplace has proven to be and effective measure to reduce the low back pain among the workers.[7] Ergonomic interventions have been proven to raise the wellbeing of the workers and reduce absenteeism and accidents in the workplaces which in turn increases the productivity and boost the economy.[8] Despite all these benefits, ergonomic interventions are often neglected and there is a very limited acceptance and applicability of them especially in unorganized small scale sectors.[9] For these reasons expensive intervention methods may not be always feasible to implement so sustainability should be of outmost priority.[10]

METHODS

The present investigation was conducted in various small scale aluminium utensil making industries around West Bengal. The duration of the study was from August 2018 to December 2019. Around 33 (16 spinners and 17 casting) workers were assessed. To conduct the study the subject selection was done randomly to eliminate any bias. It was essential to explain the purpose of the study to the management as well as the workers to ensure appropriate participation. To achieve this, a meeting was organized where the idea and objective of the study was explained to the management as well as the workers. In addition to that a proper explanation to how various data will be collected and what they will have to do during that process. A video recording of their work activities as well as still photographs were taken. The photographs were then analyzed with the help of rapid upper limb assessment (RULA), rapid entire body assessment (REBA) and Ovako working posture analysis system (OWAS) to assess the postural abnormalities of those workers. The study of posture analysis was based on a total of 165 observations (5 observation per subject). To assess the discomfort of the workers the Cornell musculoskeletal discomfort questionnaire (CMDQ) was used. In addition to that, Nordic questionnaire was utilized to assess in which areas they experience the most pain and if they have any absenteeism due to that.

Discomfort assessment

CMDQ was actually developed by Dr. Alan Hedge and the students of Cornell University in 1999.[11] This questionnaire focuses all the relevant body parts and provides a detailed idea where and how frequent the discomfort is. Each worker was individually assessed and their response were noted down. An average of the responses was calculated according to category and the results were entered into ErgoFellow 3.0 software and the graphs were generated.

Postural analysis

The posture analysis was mainly done by OWAS, RULA and REBA. Multiple still snapshots and photographs of a worker were taken while they were engaged in their daily activities. Later on, the posture of the workers was assessed from those stills.

OWAS

OWAS was invented by Karhu et al in 1977 for assessing the poor work posture of steel factory workers in Finland.[12] This tool mainly analyzes the posture abnormalities of the back arms and legs. In the present study photographs and videos were used to record the posture of the workers. Multiple readings were taken and afterwards OWAS analysis was done to assess their postural load scores.

RULA

RULA is used to assess the posture of the upper limb while at work. This method was developed by McAtamney et al in 1993.[13] In similar way the photographs and videos were recorded at different angles and multiple times. Based on those recordings, RULA was done to assess the posture scores of the workers.

REBA

Hignett et al developed REBA in 2000. This method is particularly helpful to assess static, dynamic and also rapid changes of postures.[14] The video data were particularly

helpful in this case to properly assign the scores of the workers.

Inclusion and exclusion criteria

There were certain individuals who did not agree to participate in the study. In addition to that some individuals had to respond to some urgent matters due to which their record had to be stopped abruptly and they were excluded. Individuals with musculoskeletal disorders and injuries were also excluded from this study. In the end 33 subjects were analyzed and 7 refused any participation. Rest of all the willing subjects were included in this study.

RESULTS

Table 1 shows the physical characteristics of the workers involved in casting and spinning activities. It can be observed that their personal profiles including age, height, weight, BMI and BSA represent the average Eastern Indian population data as reported in National Institute of Nutrition, Hyderabad 1965.

Table 1: Demographic data of the spinners (n=16) and casting workers (n=17). Values are presented as mean±SD (range).

Parameters	Spinners	Casting
Height (cm)	161.34±7.23 (152.40-180.34)	163.43±3.49 (157.48-167.64)
Weight (kg)	60.13±9.72 (42-77)	56.24±7.57 (45-72)
Age (years)	34.88±11.42 (19-58)	36.12±13.41 (19-61)
Experience (years)	12.13±9.72 (1-33)	9.38±7.18 (0.17-20)
BMI (kg/m^2)	23.01±2.83 (18.08-30.07)	21.01±2.32 (17.79-25.62)
BSA (m^2)	1.63±0.15 (1.35-1.90)	1.60±0.11 (1.42-1.81)

Figure 1 a, b, and c represent the average OWAS, REBA and RULA scores of the casting workers and spinners. Each of the scores are averaged after taking a total of 5 readings of the workers in various angles. The solid marks at different scores actually signify the values beyond which ergonomic interventions are required to be undertaken. It is also observed that almost all the casting workers exceed the level where ergonomic interventions were required except in one case considering OWAS foot score.

The same figures also include the scores of the spinners. The figures illustrate that 11 out of the 16 workers surpassed the level beyond which interventions are required. Rest of the five remaining workers did not cross that mark indicating no interventions were required for them. This was true in all three ergonomic tools.

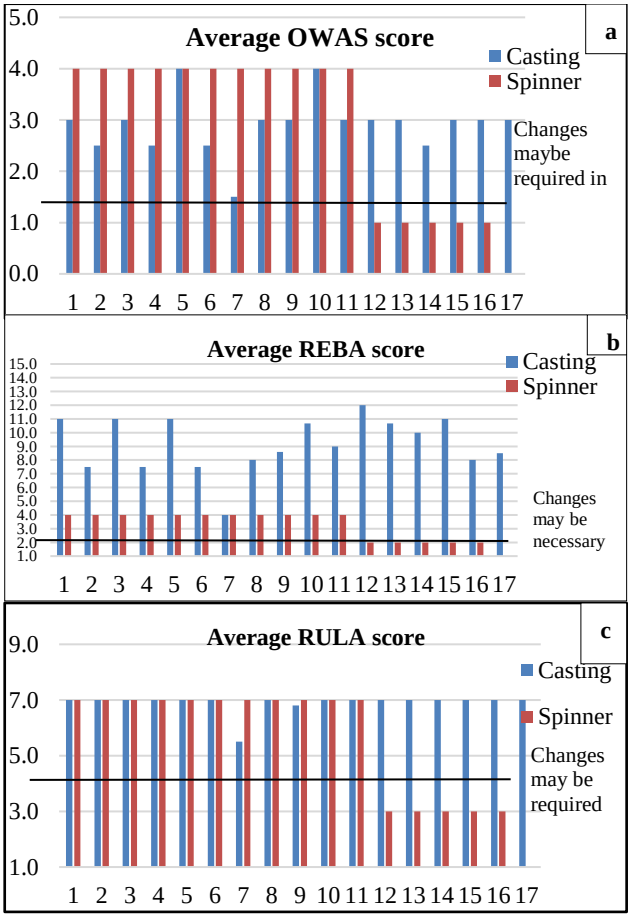

Figure 1: Average OWAS scores of each worker of both categories (a) OWAS, (b) REBA, and (c) RULA.

Figure 2a shows the evolution of discomfort of casting workers in different body part throughout the working hours. It can be observed that in most of the cases the discomfort value is highest at the end of the shift and lowest at the beginning of the shift. The casting workers experience most of the discomfort in the neck, trapeze, lumbar, shoulder, upper arm, elbow, forearm, wrist, hands and foot. Figure 2b shows the same data of the spinners. In this case, most of the discomfort lies in the shoulders, wrists and hands. Apart from that a lot of discomfort is also observed in trapeze and the lower extremities too. The Nordic questionnaire data demonstrates that both groups suffer from work related complaints in the different parts of their body. Figure 4a shows the average Nordic questionnaire answers of the casting workers. Most of the discomfort are observed in the neck, right shoulder, right wrist/hand and lower back. Some of the discomforts are also observed in the lower extremities. In case of work interruption, around 52.94% of the total population were somehow interrupted during their daily work in the last 1 year. Figure 4b shows the Nordic questionnaire results expressed in percentage of all the spinners. Most of the discomfort is observed in the neck, right shoulder, right wrist and lower back. Around 43.75% of the population were unable to work due to their discomfort.

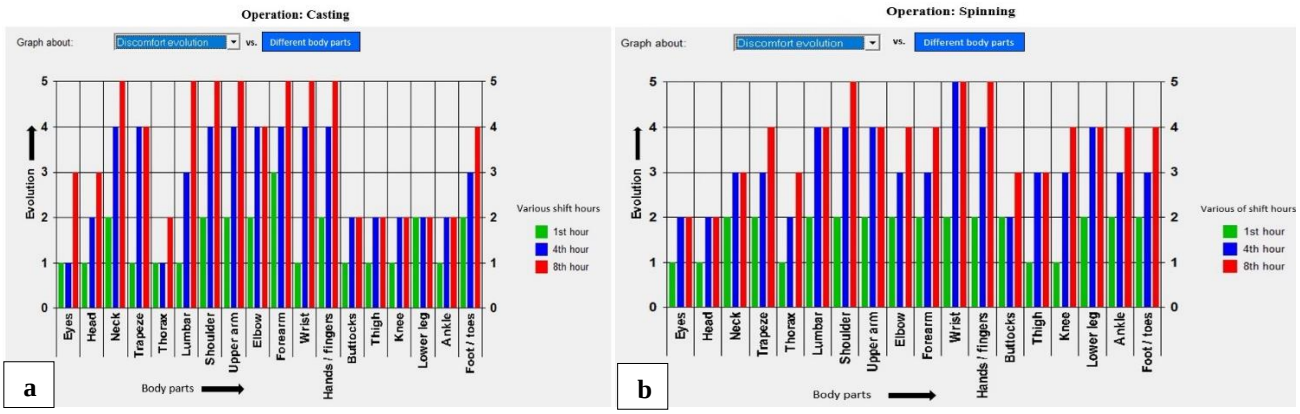

Figure 2: Average discomfort score of different body parts of casting workers during various working hours

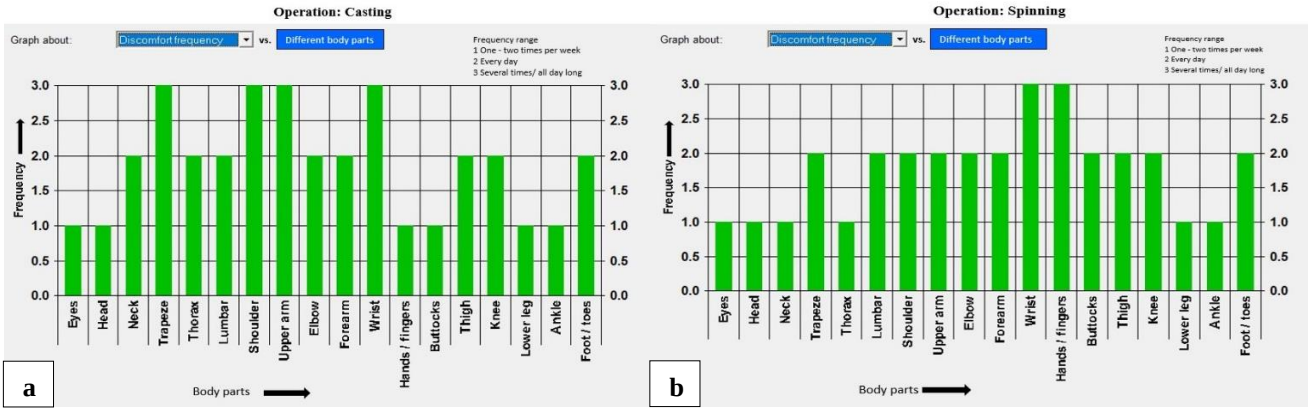

Figure 3: Average discomfort frequency of different body parts of (a) casting workers, and (b) spinners.

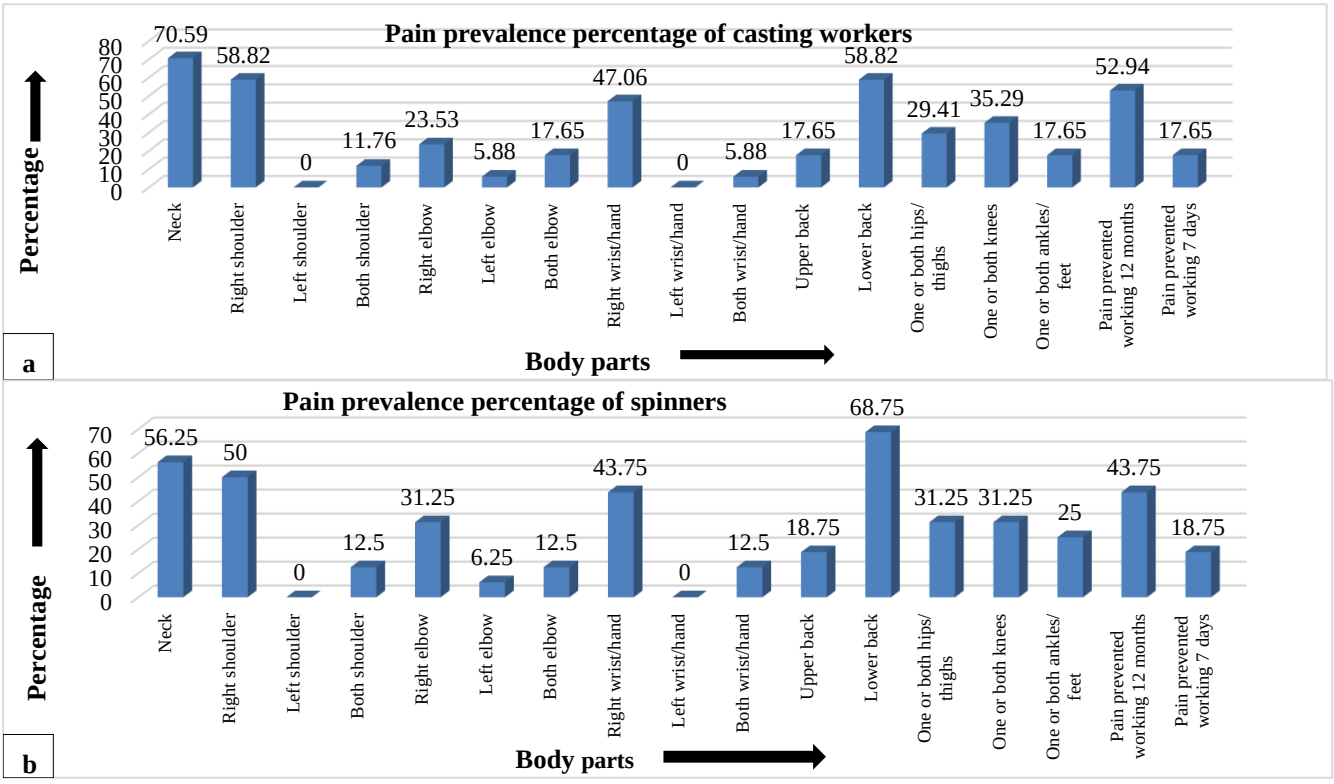

Figure 4: Average Nordic questionnaire response of (a) casting workers and (b) spinners.

DISCUSSION

RULA analysis mainly indicated that the majority of the subjects were in category 4 and this percentage was higher in case of casting workers. In case of OWAS, the majority of the distribution was again in category 4 with spinners having the overall higher number in category 4 and casting workers in category 3. REBA showed that most of the spinners were in category 2 and 4 whereas casting workers were in category 4 and 5. It should be noted that the five spinners who didn't need any interventions were working under favorable conditions. Their postures were well maintained without any awkward bending and slouching and the workplace was well suited according to their body dimensions resulting in low postural load. A proper workplace should have proper working height of the table, normal and maximum clearance and the workers should attain a proper working posture.[15] The findings in case of the 5 workers corroborated with this study and they actually experienced less postural load compared to other workers of same category.

The body part discomfort questionnaire revealed that the casting workers have a lot of discomfort in their upper body area especially neck, trapeze and shoulder area. The possible reason may be due to the fact that casting workers have to handle a lot of heavy weight during their day's work. Most of their weight bearing is carrying the raw materials (scrap aluminium) to the furnace and also while carrying the molten metal to the casts and pouring them. The shift ends are the busiest time during their daily work as there is a pressure to complete the day's target. That's why during that time they have to do the most strenuous activities which in turn results in more discomfort in the associated body areas while at the ending hours of the shift. The spinners have to use specific tools to shape the aluminium sheets into utensils. While doing that they have to exert a lot of force on the sheets while spinning them on the machine. For this reason, most of the discomfort is observed in their shoulders and the upper extremities. In addition to that the workers have to either stand or sit in a fixed posture for a long duration due to which some discomfort is also observed in the lower extremities. Again, during the shift end the high work pressure to fulfil the target results in more discomfort during shift ends.

Casting workers have to carry a lot of loads sometimes over their heads while loading the furnace. These are mostly scrap aluminium which are to be melted. After melting they have to carry the molten aluminium to the casts where they pour the molten metal. For this reason, most of the discomfort experienced by them are in the neck, right shoulder and lower back. They also have to operate the tongs to stir the molten metal and filter out the sludge. During these tasks they have to exert a lot of force on their hands and shoulders. These also result in a lot of discomfort in these associated body parts. Often times the spinners have to slouch a little while working which results in a lot of neck and low back discomfort. Their daily work involves a lot of movement of hands and wrist. Due to that high percentage of discomfort is observed. Some amount of discomfort is also observed in the lower extremities as they have to sit/stand for prolonged duration without much movement. This finding corroborates with the literature because it has been found that prolonged standing without intervals or rest lead to muscle fatigue and discomfort in the lower extremities and some forms of interventions are necessary to mitigate this particular risk.[16]

CONCLUSION

The present study was conducted on two groups of aluminium utensil makers, namely casting and spinners. The postural load of two groups of workers were high indicating immediate intervention were required to be taken. The percentage prevalence of postural load was concluded to be cent percentage in case of casting workers whereas around 31% of spinners did not show the symptoms where ergonomic interventions were required. The findings of pain and discomfort based on Nordic questionnaire showed that casting and spinners suffered more from low back pain followed by neck, right shoulder and less in wrist and elbow. The finding of discomfort survey using Cornell Questionnaire of both group of workers indicated that they have varying degrees of pain and dissatisfaction. The discomfort level was profound at the shift ends.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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