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Health Status of Grinders in Different Foundries in West Bengal

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Abstract

The most significant operation to produce products in manufacturing sector in West Bengal is grinding. There is always a need of high human involvement to successfully plan and execute it. The body postures of the grinders are not correct and scientific in different grinding units. Prolonged working hours exceed the capacity of the grinder's causes' uneasiness, elevated risk of chronic pain, increase heart rate and developed body stresses. Prolonged working hours exceed the physical capacity of the workers that causes' body discomfort, physical fatigue, joints pain, sprain of ligaments in different soft tissues. Work related musculoskeletal disorders (WRMSD), body fatigue and strain injuries are very common health problems of grinders in different micro, small & medium scale grinding units in West Bengal. The productivity and cost benefits of this unit are highly related with the physical capabilities and physical comfort of the grinders. The data of musculoskeletal disorder of workers was collected, evaluated and validated by using RULA and Discomfort Questionnaire. It was observed that lack of Ergonomic planning and unergonomic body postures increase the muscular stresses & muscular disorders which affect the health status of grinders. The significant reduction of body stresses and correct body postures were required to improve the quality of work and health status of the grinders.

Keywords: Discomfort feelings, health status, posture analysis, RULA, Stress analysis.

Introduction

Suitable working environment, appropriate occupational hygiene and proper postural methods of the workers are very much neglected in different foundries in West Bengal, India. The most essential part of manufacturing the products is grinding. Health and safety of workers are the most important issues in this unit now a days. High productivity as well as maximum turnover is the highest interest of these units. Target oriented work put some pressure on the workers that also increase their muscular and body stresses. Grinders are very much involved and also do their work in very bad work postures in this unit. The grinding is performed on kneeling posture and the grinder has to sit and perform the operation on a fixed jig & fixture on the ground continuously (Hignett et al., 2000 ; Karhu et al., 1977). Uncomfortable as well as unergonomic work postures create pain in the different joints, ligaments and muscles among grinders. If no ergonomics alertness taken among grinders, more rapidly work-related diseases will come and musculoskeletal system will be collapsed. The Work Related Musculoskeletal Disorders (WRMDs) occurred due to unscientific work-stations design and negligence of Ergonomics measures (Aaras et al., 2007 ; Metgud et al., 2008). Proper ergonomically design of work - station can increase the productivity, integration, workers comfort, worker variety and security & safety up to a certain extent. Work postures as well as physical load of grinders can be measured and evaluated by using RULA method (Rongo et al., 2004). There is a particular attention to the neck, trunk and upper limbs of the workers body for postural and whole body load calculation (Metgud et al., 2008). The objective of this research work was to investigate occupational health of grinders engaged in different grinding units in West Bengal. Higher score of RULA indicates that posture was not granted for occupational health and safety of the grinders (Markku et al., 1993 ; Ali et al., 2011). NIOSH's discomfort survey method was used for mapping the different areas of pain, dissatisfactions during the grinding operation. High intensity of postural stresses also indicates that body posture was not safe. Product quality and efficiency of the grinders will be reduced and body fatigue, muscular pain should be increased if no Ergonomic intervention among grinders is taken. Proper planning and scientific body postures of grinders can reduce these problems and improve the health condition of the grinders (Varmazyar et al., 2009 ; Widanarko et al., 2012). The appropriate Ergonomics guidance and awareness programs amongst workers are essential to overcome work related musculoskeletal problems that will help to improve health and physical capabilities of the grinders and finally the quality of jobs (Wearsted et al., 1991).

Materials and Methods

The research work was done in different small scale grinding units in West Bengal. The snap shot of 20 workers in different grinding units were obtained and evaluated with the help of RULA. NIOSH's discomfort survey method was used for mapping the different areas of pain, dissatisfactions during the operation. Heart rate and postural stresses were also noticed.

Postural Assessment

Different techniques were applied for analysis of body postures of grinders. This tool can be used to assess a variety of tasks, in any sitting position where body posture is static, dynamic or rapidly changing. This method is the quick survey method for use in Ergonomic interventions of work places where MSDs are reported. This assessment method can accesses bio-mechanical and postural loading of the workers body.

RULA Analysis

This method was developed by Lynn Mc Atamney and E Nigel Corlett in 1993. It helps to examine Ergonomics especially upper limbs of the workers body in the work places. Musculoskeletal loads of the workers can be evaluated due to body postures, motion-repetition and force. No special equipments and tools were required for this assessment. An action was generated by using a coding system which indicates the level of intervention necessary to decrease the risk of injury due to physical loading of the workers (Sing et al., 2012 ; Jones et al., 2010). This method accomplished these goals by providing a 'Grand Score' that can be categorized by Action Levels. Upper score indicating urgent changes to be made in the body posture for reducing muscular fatigues and also for improvement of job quality.

Questionnaires and Interview Technique

The Questionnaires consist of questions pertaining to different problems related to this particular operation. Daily activity of the worker, discomfort level of different body parts, working and resting periods were plotted and calculated. NIOSH body discomfort survey was used for mapping and plotting different areas of pain of the body parts with its intensity. Body discomfort level can also be calculated with the help of this method.

CAD Model of Human Body

Figure-1 indicates the actual work posture of the grinder. 3D model of human body was developed with the help of solid works software (Fig. 2). The model was exposed to ANSYS for analysis of stresses. The upper part of the grinder's body was directly involved with the grinding operation. The upper part of the body i.e., trunk, clavicles, upper arm, fore arm, neck and hands were connected by anatomically motivated restricted articulations. These are pelvis, neck, sterno clavicular joints, shoulders, elbow and wrists. The upper part of the body provides twenty (20) degree of freedom: DOF for each neck joint is three, three for each shoulder, three for pelvis, two for each elbow and two for each wrist.

Body Stress Calculation

Body discomfort and injuries are associated with different joints of the human body. To get accurate results, the distribution of stresses in different body parts, muscles and joints in a specific work posture and particular work load is required. It is important and also necessary to develop realistic model to understand the performance of human body. The muscles stress during the grinding was studied in details by developing a 3D model in Solid Works software and analysis of body stress and muscles is done in ANSYS-R17.0 software. The FEM analysis was done in ANSYS-R17.0 software to get von Mises stresses at particular load and work posture.

Fig. 1. Actual work posture of grinder.

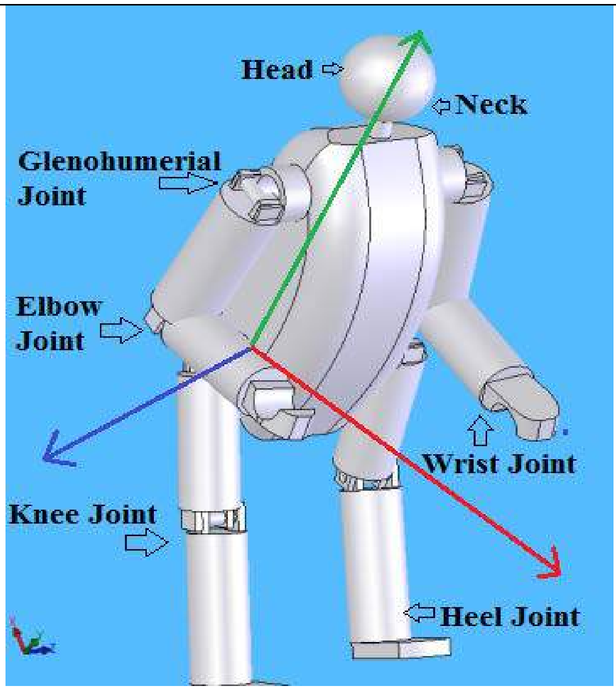

Fig. 2. CAD model of grinder with different joints.

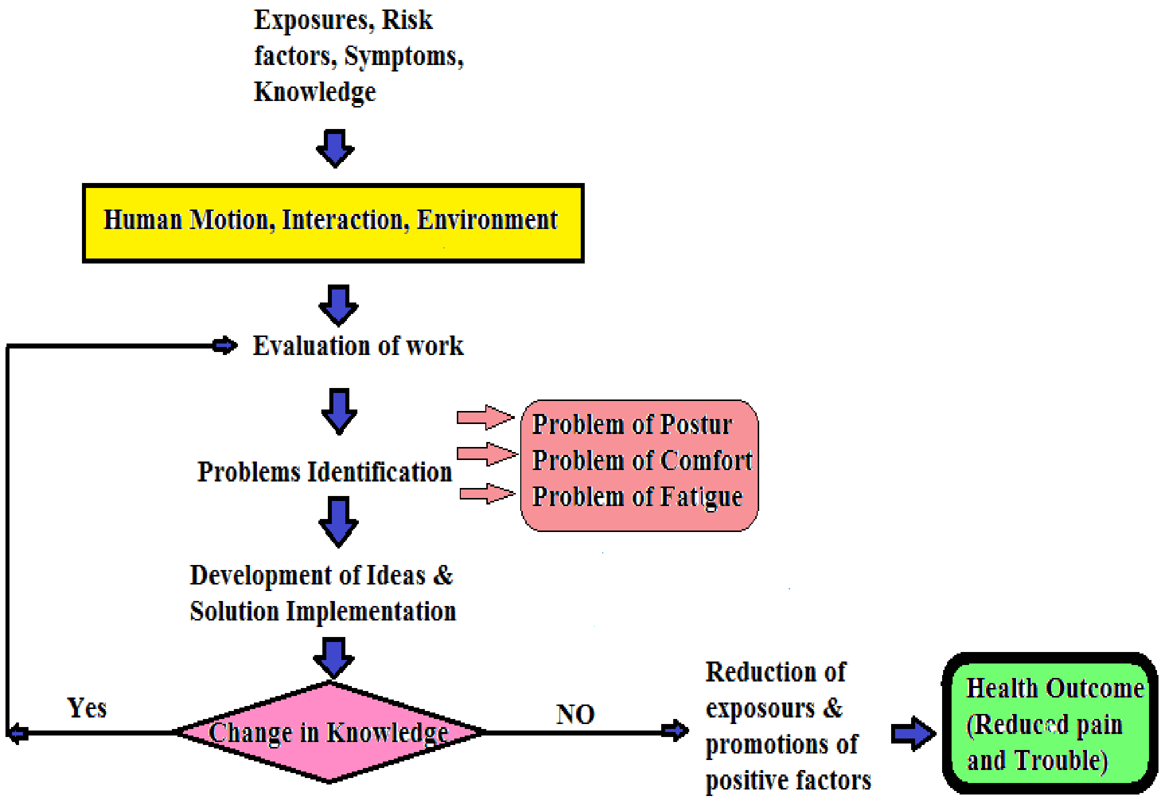

Fig. 3. Flow chart of health outcome of grinders.

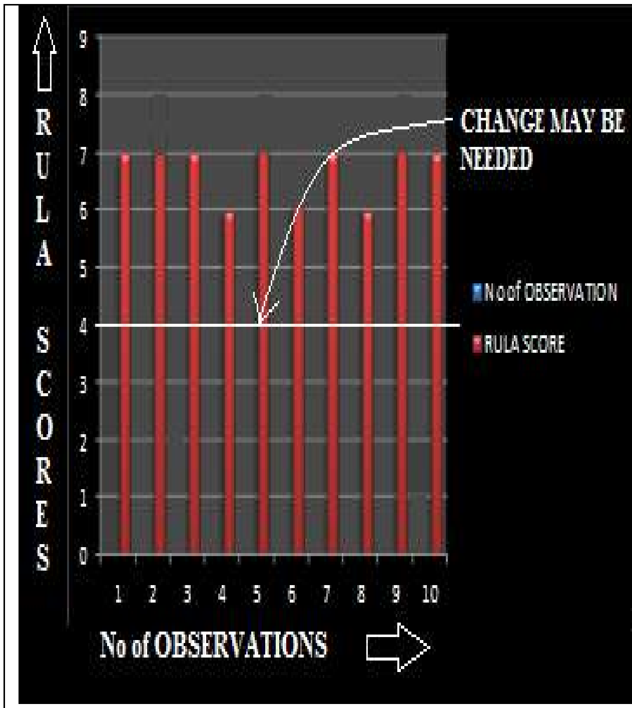

Fig. 4. RULA Score of grinders.

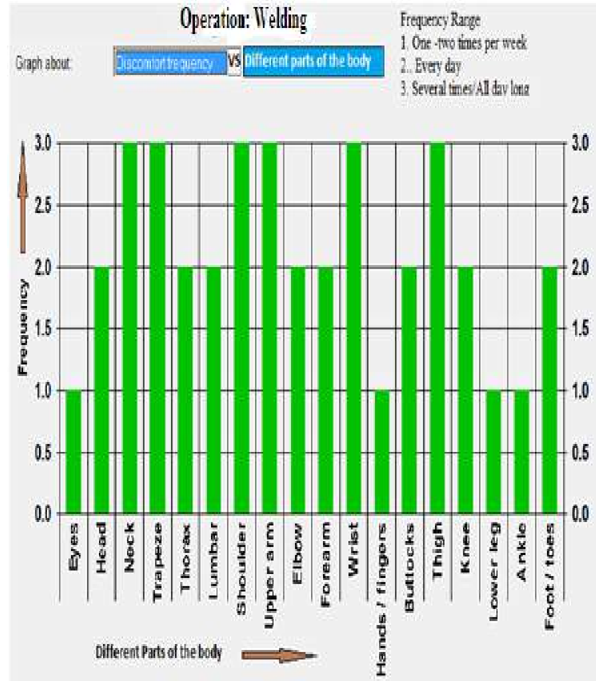

Fig. 5. Discomfort Frequency in different body parts of grinders.

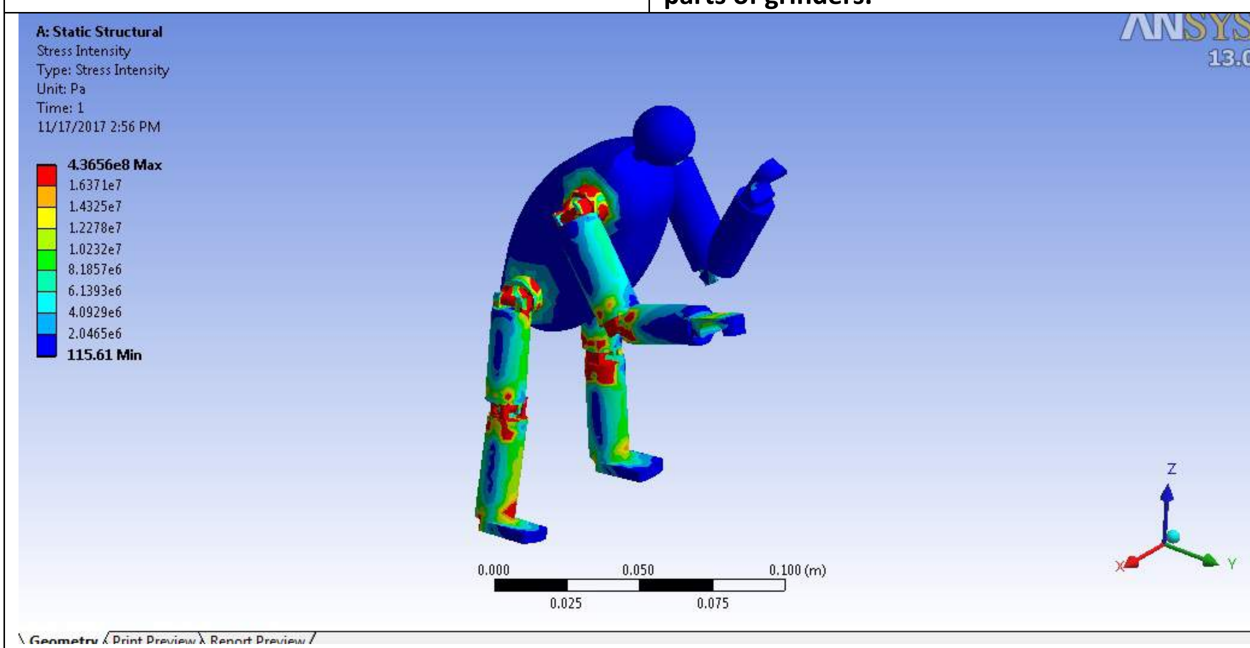

Fig. 6. Stress intensity distribution patterns of grinder.

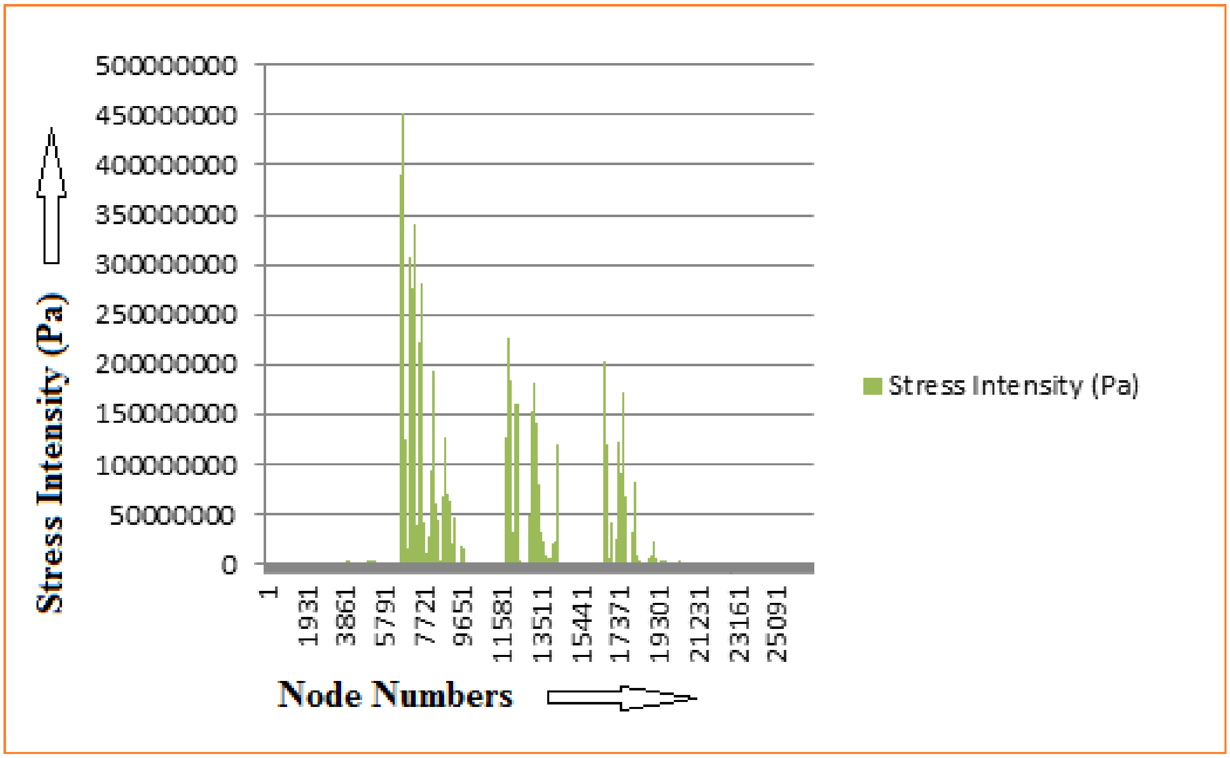

Fig. 7. Stress intensity Vs node number.

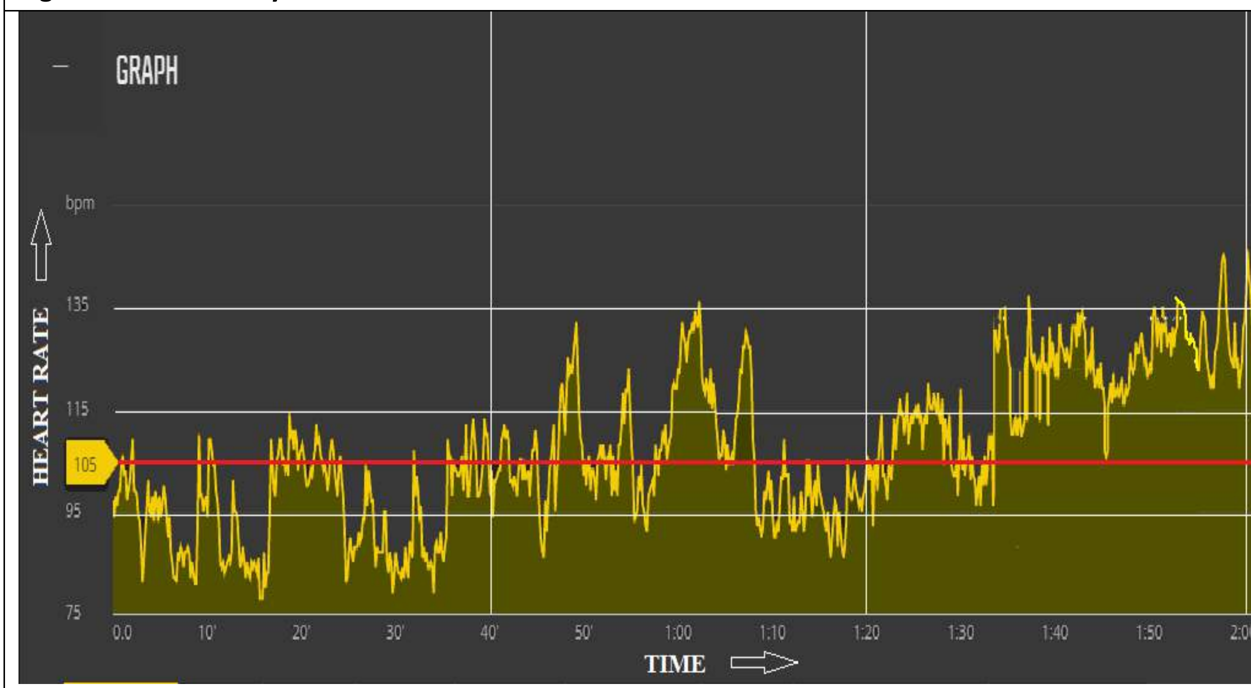

Fig. 8. Heart rate Vs Time during grinding operation.

Heart Rate Analysis

To get accurate results, the heart rate in a specific work posture and particular work load is required. The heart rate of grinders during grinding was taken with the help of heart rate monitor and also analyzed.

Framework and Flow Chart

Occupational safety & health are the major concerns in small scale units to improve the productivity and job quality. Some of the common problems are improper design, mismatch between worker abilities and job demand and adverse environment.

It has been noticed that human factors improve the productivities, workers health, safety and job satisfaction. From this frame work and flow chart (Fig. 3), it is clear that ergonomically designed work stations can reduce muscular problems, physical fatigue and will improve workers health. Proper Ergonomic knowledge, planning and awareness can also reduce physical and mental stresses.

Results and discussion

The result of RULA score indicates that the working postures of most of the workers were above the line indicated in the figure-4. Immediate change of Ergonomic intervention was needed of the grinders. The result of this study revealed that the grinding workers were engaged in manual handling jobs, leading to various muscular disorders primarily affecting the upper part of the body.

Software Ergo-Fellow was used for plotting the different areas of pain, dissatisfactions of the grinder's body during grinding operation. Figure-5 indicates the discomfort frequency in different body parts of the grinders.

More than 80% of the grinders were got affected in their wrist, hand, trapeze and neck due to unsuitable position of electrode holder, body posture and unergonomic man machine interface. A poor posture contributes to stress and stress donates to poor posture. When the body is stressed, the muscle of human body tense up. The different joints and muscles of human body are the most affected parts due to poor posture. Sitting in a slouched position in the shop floor for an extend period of time put a great deal of stresses of upper as well as lower body specially if the grinders body is not supported. Poor work posture increases body stresses and other physical problems as well. Human body is designed to stand strong and erect, effortlessly. Poor posture leads to back pain during grinding in long period of time.

Table 1. Demographic data of the grinding workers (n=10).

Variables	Workers (SD)
Mean Age (years)	25.4(±4.62)
Height (cm)	167.35(± 3.35)
Mean working experience (years)	5±2

The three-dimensional finite element model consists of 13810 elements which are connected through 25837 nodes. The stress contour map revealed that the maximum intensity of stress varied from $4.3656x10^8$ P_a to $1.6371x10^7$ P_a for particular work posture and load (Fig. 6). Node numbers 6460 to 7600, 13919, 17371 marks is highly stressed denoted by red colours. Stress intensity vs node number is also shown in the figure-7.

Figure-8 indicates heart rate in bpm of the worker with respect to time in minutes. In the last 40 minutes the heart rate increased markedly for being in awkward work posture for a long time. The rate in the 1st working zone is within the acceptable range which exceeded beyond the severe level due to inappropriate body posture.

Conclusions

The optimization for postural prediction, heart rate analysis, stresses in different body parts, discomfort of different joints were presented in this research work. It can be concluded that MSDs were present in the activities carried out in grinding units where major number of workers were involved in bad body postures. This research work also shows that the poor working conditions enhance the body stresses and discomfort level of grinders. The higher heart rate also indicates the poor health condition of grinders. Poor environmental conditions, specially noise and heat were common in grinding units. The analysis indicates that immediate change in body posture was needed for healthy working environment. The modified and redesigned workstation may reduce the score RULA, body stresses, level of body discomfort and increase the quality of work.

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