Original Article

Ergonomic interventions to improve work environment in garment manufacturing units

Abstract

The work environment in the garment manufacturing units is unhealthy and unsafe for the workers, resulting in several health problems. Analysis of garment manufacturing units using a combination of techniques revealed that the congested work area, improper ventilation, dust, unergonomic workstations, excessive noise and non-use of personal protective equipment were the major constraints faced by the workers in these units. Based on the study, interventions to improve the work environment, safety aspects and work methods have been suggested which could be adopted on a wider scale.

Key words: Garment manufacturing units, guidelines, safety aspects, work environment

INTRODUCTION

In India, the readymade garment industry had its beginning during the first half of the 20th century and has witnessed impressive growth during the last four decades. It is reported to be the second highest contributor to India's export basket, after 'gems and jewelry.'^[1] There are around 70,000 garment manufacturing units in the country providing employment to more than 3 million persons.^[2]

The work environment in a majority of these units is unsafe and unhealthy. These include poorly designed workstations, unsuitable furniture, lack of ventilation, inappropriate lighting, excessive noise, insufficient protection from dangerous chemicals, insufficient safety measures in fire emergencies and lack of personal protective equipment. People working in such poor or substandard environment are prone to occupational diseases.

Empirical evidences suggest that the workers in the garment units suffer from work-related musculoskeletal disorders such as carpal tunnel syndrome, forearm tendinitis, epicondylitis, bicapital tendinitis, lower back pain, neck pain, shoulder pain and osteoarthritis of the knees.^[3-7] Mismatch between man and machine is one of the major factors contributing to musculoskeletal problems. This may be mainly due to the attempts made by the workers to 'fit the man to

the job' rather than to 'fit the job to the man'. The recent efforts in this area are directed to fitting the job to the man by eliminating mismatch between the man and the machine and redesigning the work environment to the optimum comfort levels of the workers. The present study aims at suggesting interventions to provide better work environment in the garment manufacturing units, which is the outcome of the in depth analysis of work and work environment.

MATERIALS AND METHODS

The study was conducted in 18 garment manufacturing units located in Madurai city. A total of 216 workers from these 18 garment manufacturing units formed the study sample. Various methods like interview with the workers; analysis of work environment; hazard identification and risk assessment; and quantification techniques were used to collect information about the work, work environment and workers' health problems. By the combination of these techniques, several gaps were identified in the work environment and facilities provided to the workers. Based on the study, ergonomic interventions have been suggested which will eventually help to improve the work environment and also to overcome the health problems.

RESULTS AND DISCUSSIONS

The results of the study revealed that there had been several gaps in work environment, tools and equipment that affect the health and safety of workers at the work site. Table 4 P. Parimalam. N. Kamalamma*, A. K. Ganguli** Department of Family Resource Management, Home Science College and Research Institute. Tamil Nadu Agricultural University, Madurai, *Department of Home Science, Gandhigram Rural Institute (Deemed University), Gandhigram, **Occupational Health Services, Bharat Heavy Electricals Limited, Tiruchirapalli, India

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presents the gaps identified in the work environment.

The mean heights of the tables used for cutting, sorting, checking and ironing were 99.5, 92.3, 89.9 and 92.3 cm respectively. The furniture used in the garment manufacturing units was either above or below the recommended levels and the strained posture had to be maintained throughout the work day, which could have been responsible for the development of pain in the shoulders, the upper arm and the forearm. The high stool (mean height 59.5 cm) forced the workers to bend their trunk and head toward the table to have a clear view of the point of operation. As a result of excessive bending, a majority of workers complained of pain in the lower back, the mid back, the shoulders and the neck. The stools used by the operators were not padded for their comfort when seated for long hours. None of the work stools had a backrest to provide support to the back.

The mean levels of illumination in the cutting and stitching sections were of 259.88 and 236.05 lx respectively. This was found to be low when compared to the standard levels recommended by Grandjean,^[8] and Ghosal,^[9] which are 750 and 400 lx respectively. Due to improper selection of lighting fixtures and their placements, the efforts made to improve the levels of illumination had failed to give the desired results at the point of operation.

Continuous exposure to high levels of noise over a period of time would result in noise-induced loss of hearing among the workers in this section. Improper maintenance of the machines also added to the mechanical noise. Excessive dust was reported as a problem by 27% of the workers in the cutting section. The occupational health survey revealed a high rate (85.2%) of prevalence of breathing difficulty and 22% of the workers in the cutting section suffered from asthma. Due to continuous use of steam iron, the finishing section was found

Table 1: Gaps identified in work environment

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Areas	Gaps identified	Supportive findings	
Furniture			
Cutting table	Work height too high	Complaints of postural	
Sorting table	Work height too high	discomfort and pain in	
Inspection table	Work height too low	shoulders, neck and hands	
Ironing table	Work height too low		
Sewing machine operators stool	Too high		
Workspace/environment			
Inadequate lighting	Low level of lighting	Complaints of visual strain and blurred vision	
Excessive noise	Noise level exceeds 90dB(A)	Worker's complaints	
Dust	Increased level in cutting section	Complaints of respiratory problems	
Hot and humid work place Heat	Humidity 23 to 57% Heat exposure	Workers complaints Identified as risk factor by hazard identification and risk assessment	

to be hot and humid. The humidity levels in the units ranged from 23 to 57%, with the highest levels recorded for the finishing section. The workers' response to questions regarding temperature also supported this view [Table 1].

Table 2 summarizes the gaps in the design and usage of tools and equipment and also in safety aspects at work site. Cases of accidental injury to fingers while working with the handheld cutting machine and the band knife cutting machine were reported by 52% of the workers in the cutting section. Though there were inbuilt blade guards for these machines, they were too small and inadequate to provide safety to the fingers placed on top of the fabric for holding the fabric layers in position. Some of the operators did not care to use blade guards while operating the machines. This has led to accidental injuries and cuts on fingertips in a few cases.

Continuous use of cutting shears has led to swelling of fingers and cornifications of the skin of the fingers. Many of the workers in the cutting section used to wrap the handles of the shears with a piece of cloth/cotton to reduce the friction of the metallic handle on the muscles and the resultant pain.

Lack of task lighting (local lighting) was an important deficiency noticed in the sewing machine. The workers complained of headache and occurrence of accidents like needle-piercing because of the visual strain caused by insufficient light at the point of operation. The hazard identification and risk analysis indicated insufficient illumination as a risk for the sewing machine operators.

Lack of general safety measures like absence of first aid kits and lack of safety devices like fire extinguishers, alarms and emergency exits were other serious deficiencies in the workplace. Lack of these safety devices results in the workers getting trapped inside the units under emergency situations. None of the cutting machine operators used any personal protective equipment like metallic gloves for safeguarding the hands from possible mechanical injuries. The risk of cuts in fingers can be easily avoided with this simple device.

Table	2:	Gaps	identified	in	equipment	and	tools
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Areas	Identified gaps	Supportive findings
Equipment and tools		
Blade guard of the	Defects in design of	Fifty per cent of workers
cutting machine	blade guard, non use of blade guards	reported accidental cuts
Shears used for fabric	Handles heavy and	Swollen fingers and
cutting	strenuous to use for long	commications
Sewing machine	Absence of task lighting	Postural discomfort
Safety at work site		
General safety measure	Absence of general safety measures	Observed gaps
Personal protective equipment	Absence of personal protective devices	Observation and reported incidences

Suggestions to improve work environment

The suggestions that have emerged from the present study have been formulated as guidelines. These guidelines would not only be of use for improving the work environment in existing units from the health and safety point of view but would also be invaluable for entrepreneurs starting new units.

The dimensions suggested for various tables used in readymade garment units are given in Table 3. As multiple tasks like pattern laying, pattern marking and cutting are carried out on the same table, a height-adjustable wooden platform is suggested as an adjunct to the cutting table for adjusting the work height for various operations. The wooden platform will also help in preventing electrical shocks while operating electrical instruments.

The inspection table should have a forward inclination of 12° towards the worker to enable the workers to have a clear view of the garment being examined and to maintain postural stability while at work. The table top can be covered with a rough cloth to prevent slipping of the garments. The use of wooden platforms to stand on while ironing should be insisted on. The recommended dimensions of the sewing machine operator's work seat height should be 41.5 cm for women and 43 cm for men to attain a 105° trunk-thigh angle while operating the sewing pedal. The seat should be padded or wire-netted to provide comfort to the worker.

A minimum lighting level of 400 lx is recommended for all the three sections of the readymade garment manufacturing units. For sewing operations, additional task lighting is to be provided in the machine in such a way that the visibility of the needlepoints will be optimum. Lighting in the sewing section is to be planned functionally and the lights fixed at appropriate points to ensure optimum lighting at the work site.

Noise control at the source can be ensured by regular maintenance, lubrication and replacement of parts that produce noise in the embroidery machines. Use of earplugs/ earmuffs by workers in the embroidery section can be made obligatory. Workers exposed to high noise levels should be provided with ear protection or their working periods rotated so that they remain within the permissible limit of 4 hours' exposure to 95.0 dB (A).

Provision of local exhaust ventilation that uses suction, based on the principle of a vacuum cleaner, is to be encouraged in the cutting and stitching sections to remove dust from the air. The dust particles can be sucked through the ventilation duct provided in all the three sections of the readymade garment units. Workers in the cutting and the stitching sections should be encouraged to use dust protectors in the form of fine-mesh cloth material worn over the face and the nose, similar to operation theater staff, while at work, especially when knitted materials are used for garment making. A gap of 4-5 feet between rows of machines will minimize the workers' exposure to heat from the sewing machine motor.

The blade guards of the cutting machines are to be redesigned. These guards can be designed either as enclosure guards or as interlocking guards. Enclosure guards will cover the entire blade. Interlocking guards will allow the machine to function only after the blade guards are lowered. Tools like shears used for fabric cutting need to be redesigned. The handles should be made of flexible polyethylene materials, which even after prolonged and regular use give a comfortable feel.

Every unit should have at least the minimum first aid facilities and access to trained personnel to provide emergency medical care. First aid facilities and trained personnel are important components of health and safety arrangement. Safety measures should be checked periodically for ensuring their utility during emergency situations. Use of personal protective equipment (PPE) like earplugs, earmuffs and dust masks should be made mandatory wherever threat to workers' health and safety is anticipated. All workers using PPE should be trained in their use and maintenance. While purchasing PPE, items that have been designed in accordance with recognized standards set by relevant institutions should be bought - ISIapproved if existing.

CONCLUSION

These interventions made in the units would help to improve the work environment of the garment manufacturing units and in addition would also be of use to units seeking certification under international standards like OHSAS 18001 or national standards like IS 18001:2000. However, compromises are often necessary in actual practice; and



Parameters	Cutting table	Sorting table	Checking table	Ironing
Length	Variable depending upon the size of the room and the length of the lay	180 cm (6ft)	180 cm (6ft)	120 cm (4ft)
Width	120 cm (4ft) The maximum width of fabric	120 cm (4ft)	120 cm (4ft)	90 cm (3ft) The maximum reach of a worker
Height for men Height for women	117.3 cm 108.9 cm	112.3 cm 103.9 cm	117.3 cm 108.9 cm	102.3 cm 93 cm

these guidelines, which are normative, will be of relevance in reducing the strain of work.

REFERENCES

- 1. Uchikawa S. Indian Textile Industry, State Policy, Liberalization and Growth. Manohar Publications: New Delhi; 1998.
- 2. Awasthi M, Singh A. Global competitiveness hinges on product quality. The Textile Magazine 2003;44:42-3.
- 3. Courtney TK, *et al.* The impact of a chair as an ergonomic intervention in conventional trouser manufacturing. Georgia Inst Technol: Atlanta; 1990.
- Blader S, Barck-Holst U, Danielsson S, Ferhm E, Kalpamaa M, Leijon M, *et al.* Neck and shoulder complaints among sewing machine operators: A study concerning frequency, symptomatology and dysfunction. Appl Ergon 1991;22:251-7.
- Nag A. Women in industry Repetitive work and postural stress. *In*: Nag PK, (Ed). Ergonomics and work design - Emerging issues in organizational sciences. New Age International Pvt. Ltd: New

Delhi; 1996.

- Delleman NJ, Dul J. Ergonomic guidelines for adjustment and redesign of sewing machine workplaces. *In*: Haslegrave CM, Wilson JR, Corlett EN, Manenica I, (editors), Work design in practice. Taylor and Francis: London; 1990.
- Parimalam PN, Kamalamma, Ganguli AK. Hazard identification and risk assessment in garment manufacturing units. Proceedings of conference on humanizing wok and work environment. Mumbai, India: 2004. p. 93-7.
- 8. Grandjean E. Fitting the task to the man An ergonomic approach. Taylor and Francis: London; 1985.
- Ghosal S, Chakrabarthi D. An ergonomic study on the ready-made garment workers at Ahmedabad for improvement of health, safety, efficiency at work and productivity. National Institute of Design: Ahmedabad; 1987.

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