Musculoskeletal Disorders and Poor Product Quality: Do they Have Same Risk Factors?

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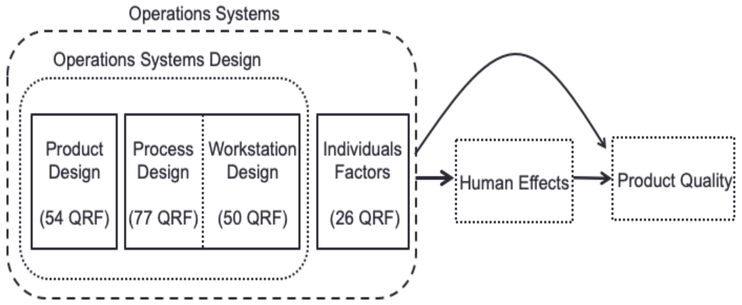
Abstract

An earlier review identified 207 human factors (HF) related risk factors for product quality (QRF). In this study, we investigate whether these QRF are also risk factors for musculoskeletal disorders (MSDRF). The relationship between HF-QRF and MSDRF was identified using a quantitative subjective rating scales (0-10). Results showed a strong association between many, but not all, common MSDRF and QRF. The average median ratings for the association between QRF and MSDRF were strong in the product design stage (average median rating=8), moderate in both workstation design (average median rating=7) and process design (average median rating=5). The study indicates that considering human-related factors in the design of manufacturing systems may significantly reduce both quality deficits and the risk of MSD.

KEYWORDS: Musculoskeletal disorders; Product quality; Manufacturing system design

Introduction

A recent systematic review by Kolus et al. (2018) examined workplace human factors (related to manufacturing design stages) impacting product quality in manufacturing; these factors were called HF quality risk factors (HF-QRF). The review identified a total of 207 quality risk factors based on 73 empirical studies. Similar risk factors were grouped resulting in 60 QRF, which were further categorized, based on human factors type, into 14 QRF groups. The HF-QRF groups were classified, based on manufacturing system design stages, into three classes: product design, process design, and workstation design stages. The objective of this study is to examine the similarity between HF-QRF and MSDRFs in manufacturing systems. This can be achieved by answering the research question: are the HF-QRF also MSDRF in manufacturing?



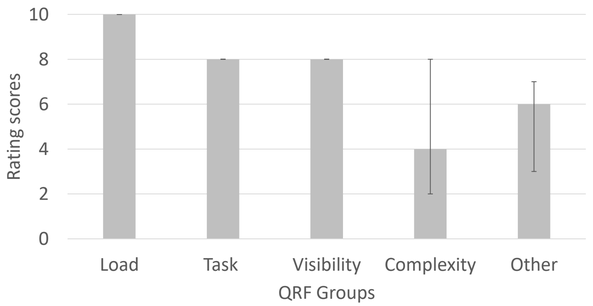
Methodology

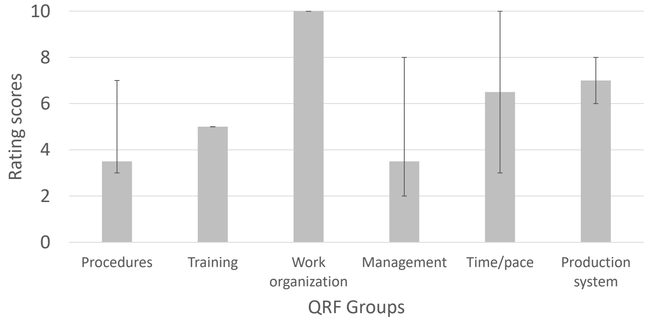
The HF-QRF were taken from the original review paper (Kolus et al., 2018). The relationship between HF-QRF and MSDRF was identified using a quantitative subjective rating scales (0-10) assigned by the three authors who have extensive research experience in human factors and musculoskeletal disorders. A rubric was developed to facilitate rating the strength of the linkage between HF-QRF and MSDRF. The rubric divides the 0-10 rating scale into five categories: no relation (0-1), weak (2-4), moderate (5-7) and strong (8-10). The strength of the linkage was determined based on four criteria: existence of a biologically feasible path linking MSDRF and QRF, number of intermediate steps on the path, number of necessary assumptions to construct the path, and existence of empirical evidence supporting the linkage between QRF and MSDRF. Each author rated the HF-QRF to MSDRF association independently. First, median ratings across the three raters were calculated for all 60 QRF to assess the relationship strength between each QRF and corresponding MSDRF. Second, average median ratings across the QRF were calculated at the group and design stage levels to assess the relationship strength between QRF and corresponding MSDRF at the group and design stage levels.

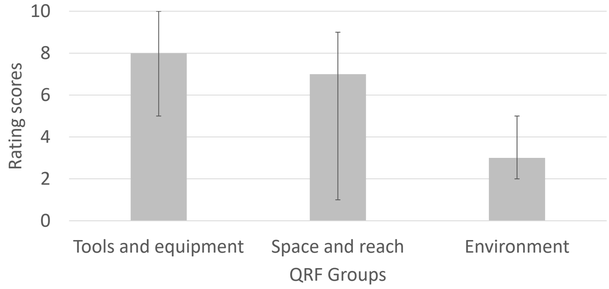
Design stage	Category of QRF	Description of QRF
Product design	Load	Load in physically exerting tasks (e.g. posture)
	Task	Factors related to task (e.g. static vs. dynamic work)
	Visibility	Distinguishability of items from surroundings
	Complexity	Knowledge/memory demanding and many choice options (e.g. no. of components in assembly)
	Other	Rigorous work (e.g., physically demanding)
Process design	Procedures	Work procedure (e.g. method of inspection)
	Training	Training programs and certificates (e.g. training for a specific technique)
	Work organization	Nature of work (e.g. monotony)
	Management	Managerial activities and policies (e.g. waging policy)
	Time & pace	Factors related to time or work pace (e.g. rest time)
	Production system	Type of production system (e.g. batch production)
Workstation design	Tools & equipment	Types and features of tools (e.g. weight of tools)
	Space & reach	Factors related to work space and layout (e.g. worker movement)
	Environment	Work environment (e.g. illumination)

Results

At the design stage level, the average median ratings for the association between QRF and MSDRF were strong in the product design stage (with average median rating of 8), moderate in both workstation design (with average median rating of 7) and process design (with average median rating of 5). Two QRFs related to management (i.e. employees selection & diversity) and space/reach (i.e. appearance of work environment) were rated as not being associated with MSD. The average median ratings at the QRF group level are shown in the following figures.







Conclusion

The study showed that there is a relationship between many HF-QRF in manufacturing and MSDRF. HF programs that focus only on MSD prevention may miss opportunities to improve product quality – a competitive cornerstone in this sector.

References

- Kolus, A., Wells, R., Neumann, W.P. (2018). Production quality and human factors engineering: A systematic review and theoretical framework. Applied Ergonomics, 73, 55–89.
- Neumann, W.P., Village, J. (2012). Ergonomics action research II: A framework for integrating HF into work system design. Ergonomics, 55 (10), 1140–1156.
- Theberge, N., Neumann, W.P. (2013). The relative role of safety and productivity in Canadian ergonomists' professional practices. Relations Industrielles/Industrial Relations, 68, 387–408.