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Review article

Job rotation: Effects on muscular activity variability

Andres C. Rodriguez*, Lope H. Barrero

Pontificia Universidad Javeriana, Department of Industrial Engineering, Carrera 7 # 40-62, Bogotá, Colombia

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ABSTRACT

Job rotation strategies have been used for years as an administrative intervention to reduce the risk of musculoskeletal disorders. The benefits of job rotation have been hypothesized to occur via changes in muscular activity variability (MAV). However, the effect of job rotation on MAV has not been fully analyzed in a literature review. A wide search was conducted to identify studies testing the effect of different job rotation strategies on MAV. Twenty-six studies of acceptable quality were included. Several studies on different types of tasks supported the view that job rotation can increase muscular activity variability, particularly with strategies such as alternating tasks and pace changes. However, it remains uncertain whether such variability changes immediately translate into benefits for the worker because little evidence was found that showed simultaneous changes in different muscular groups. Additionally, variability was occasionally achieved at the expense of average activity in the assessed muscles.

Contents

* Corresponding author. Pontificia Universidad Javeriana, Carrera 7 # 40-62, Facultad de Ingeniería, Piso 3, Bogotá, DC, Colombia.
E-mail address: a.rodrigueze@javeriana.edu.co (A.C. Rodriguez).

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1. Introduction

Job rotation is a common administrative control (i.e., redesign of work/rest schedules or job/career changes) that is thought to be beneficial to workers' musculoskeletal health. In general, job rotation consists of implementing planned changes in the tasks assigned to workers (Tharmmaphornphilas and Norman, 2007). Job rotation can appeal to industry because it is focused on work organization, which is an intervention that may be less costly to implement (Cunningham and Eberle, 1990). Specific strategies that may be considered in job rotation include alternating tasks, job enlargement, the use of active and passive pauses, changes in the work pace, shift scheduling, and changes in the overall organization of the development work (Luttmann et al., 2010; Rissen et al., 2002; Sundelin, 1993; Tharmmaphornphilas and Norman, 2007).

The main purpose of implementing job rotation is to reduce the exposure to risk factors for musculoskeletal disorders. Evidence of the benefits of this administrative control, however, appears to be still elusive (Luger et al., 2014). It has been reported that job rotation does not necessarily benefit all workers subjected to this type of control and that the use of job rotation does not necessarily result in an improvement of health outcomes or disability. Another reason to advocate for the implementation of job rotation is to introduce biomechanical exposure variability to a job, which is believed to have a beneficial effect for the worker (Madeleine and Farina, 2008; Madeleine et al., 2008).

Biomechanical exposure variability is thought to benefit workers by increasing their chances to recover from muscular demands (Mathiassen, 2006). Exposure variability is a general term that is associated with any estimator describing the dispersion of an exposure metric (e.g., Exposure Variation Analysis, standard deviation of the overall exposure distribution) (Loomis and Kromhout, 2004; Mathiassen, 2006). In the context of the present work, we are interested in changes in dispersion metrics along time or space of muscular activity that occur as a result of job rotation strategies. Changes in muscular activity variability are indicative of changes in muscular recruitment patterns (Srinivasan and Mathiassen, 2012), which have been hypothesized to occur when muscles go to rest or when muscular demands are changed (Hägg, 1991). However, there is little evidence indicating that job rotation indeed results in changes in muscular activity variability.

One previous review aimed to analyze the effects of task variation on physiological responses, including muscle activation, endurance time and subjective responses. The authors classified work variation as temporal variation (within task variation) and activity variation (between-task variation) and included studies focusing on non-computer repetitive tasks that involved the shoulder and lasted for more than 30 min. The authors concluded that there is some evidence for a positive effect of within task variation in some physiological metrics, such as blood pressure and endurance time, but not in metrics related to fatigue measured with electromyography (EMG). They also found that there are 'ambiguous' effects of between-task variation on muscle fatigue, as evidenced by the observed lower amplitude and higher frequency of EMG signals (Luger et al., 2014). This review, however, provided no evidence that work variation has a specific effect on muscular activity variability.

In the present study, we systematically analyze the literature to answer the following question: can job rotation strategies result in changes in muscular activity variability? We specifically aim to search for evidence of this impact on upper limb muscles such as trapezius, bicep and forearm muscles. An auxiliary question is whether a specific job rotation strategy is more likely to achieve changes in muscular activity variability. Finally, when the studies assessed more than one muscle group, we attempted to examine whether job rotation strategies differentially affect the assessed muscle groups. This is important because it could be argued that even if a job rotation increases muscular activation variability in one muscular group, it can perhaps reduce muscular activation variability in another muscular group, which would jeopardize the overall expected benefits of job rotation.

2. Methods

The literature search was designed to find articles published between 1975 and February 2016. We sought articles that included in the title, abstract or keywords 4 types of terms: terms that imply that there was job rotation; terms that imply occupational settings; terms that imply the assessment of an ergonomic demand; and terms that imply the use of muscle activity assessment (Table 1). The search was performed in 5 databases: OVID, EBSCOhost, PubMed, ISI Web of Science and Psychnet. All articles published in English were of interest. The search also included articles reported in the references of the identified articles.

2.1. Selection of the articles

The articles identified in the search were selected first based on the titles and then based on abstracts. Two trained reviewers reviewed all titles and abstracts using a protocol developed for this purpose. When there were doubts about the relevance of the article for the purpose of review, we decided to allow the manuscript to enter a full review.

2.2. Quality analysis of the articles

A critical assessment of the quality of the manuscripts was conducted based on the presence or absence of the following factors: specific definition of a hypothesis, sample size greater than 10, the randomized allocation of persons undergoing testing, monitoring of the effects of interest for at least 3 months to assess medium-term effects, the presentation of inclusion criteria of participants (e.g., age, sex, work environment, disease and work injuries) (Cole and Hudak, 1996), presentation of participant experience with the assigned tasks, analysis of study dropouts, standardization of employed work methods (i.e., training on the method beforehand, specified activities and duration of the tasks), the completeness of the analysis of EMG metrics (i.e., frequency and amplitude analysis), the use of alternative exposure measurement tools to give greater support to the results and coherent statistical analysis of data. Studies that complied with at least 11 of the 14 factors were considered to be of high quality, and studies that were said to comply with 8–10 of the factors were considered to be of medium quality. The remaining studies were considered of low quality. Only one low-quality study was found. It aimed to examine the effect of job rotation on EMG activity, but the specific metrics of EMG and the characteristics of the rotation were not reported (Jonsson, 1988). Hence, only medium- and high-quality studies were included in the review.

2.3. Information extraction

Each manuscript was studied in detail to extract information regarding the following: overall study design, study population, tasks involved in the rotation, risk factor or exposure intended for modification, job rotation strategy, aspects of the exposure intended for modification (i.e., duration, magnitude or frequency), variability of the muscle activity metric used, muscle or muscle group that was the main object of modification through the rotation and muscular activity metrics and statistical analysis used. For