The effect of stance width on trunk kinematics and trunk kinetics during sagitally symmetric lifting

Christopher J. Sorensen 1, Omid Haddad 1, Samuel Campbell 1, Gary A. Mirka*  

The Ergonomics Laboratory, Department of Industrial and Manufacturing Systems Engineering, Iowa State University, Ames, IA 50011-2164, USA

A R T I C L E   I N F O

Article history:
Received 23 December 2009
Received in revised form 24 May 2010
Accepted 14 December 2010
Available online 26 January 2011

Keywords:
Lifting stance
Electromyography
Low back injury

A B S T R A C T

Lifting technique can have a significant impact on spine loading during lifting. The sports biomechanics literature has documented changes in trunk and lower extremity kinematics and muscle coactivation patterns as a function of stance width during high force dead lift and squat exercises. The focus of the current study was to explore whether these lifting stance width effects might translate into the occupational setting under more moderate load level conditions. Twelve subjects performed repetitions of a sagitally symmetric lifting and lowering task (10 kg load) under three stance width conditions: narrow (feet together), moderate (feet shoulder width) and wide (feet 150% of shoulder width). As they performed these exertions, trunk kinematics were captured using the lumbar motion monitor while the activity of the trunk muscles (erector spinae, rectus abdominis) and lower extremity muscles (gluteus maximus, vastus lateralis and vastus medialis) were evaluated using normalized electromyography. The results showed that both the range of motion and peak acceleration in the sagittal plane were significantly affected by the stance width. The muscle activation levels, however, were not significantly affected by the stance width. These results collectively would indicate that the stance width effects seen in power lifting activities do not translate well into the occupational environment where more moderate loads are typically lifted.

Relevance to industry: Exploring alternative lifting strategies may provide an opportunity to reduce the incidence of low back disorders. Lifting stance width is one variable that has not been explored in the ergonomics literature.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

Low back pain is a common musculoskeletal pain complaint in occupational settings. Sengupta and Reno (2007) estimated that the employers in the United States paid $87.4 billion in worker’s compensation costs in 2004 due to low back pain. It is recognized that employees involved in manual materials handling are exposed to a number of risk factors for low back pain such as heavy physical work, forceful movements, and awkward trunk postures (Bernard, 1997). It is also recognized that lifting technique has the capacity to change the level of exposure to some of these risk factors by altering trunk posture and moments generated by the external load.

While there have been a number of studies that have considered the differences between the stoop and the squat lift technique (often with conflicting recommendations) (van Dieën et al., 1994; Dolan et al., 1994; Anderson and Chaffin, 1986; de Looze et al., 1998; Adams and Hutton, 1986), one characteristic of occupational lifting technique that has not been considered is lifting stance width (herein defined as the distance between the feet in the medial-lateral direction with sagittal symmetry of stance). There have been a number of studies in the sport and exercise fields that have noted significant differences in the systems-level biomechanics (interaction between lower extremities and low back) when stance width is varied during various power lifting exercises. In an evaluation of subjects participating in the 1989 Canadian Power lifting Championships, Cholewicki et al. (1991) noted that these trained power lifters performing a dead-lift exercise (an exercise wherein a barbell load lifted from the ground to mid-thigh height) using a wide stance style generated significantly lower L4/L5 moments (~10% lower) and calculated an 8% reduction in L4/L5 shear force as compared to the conventional stance (~shoulder width) dead lift. In a study of 12 “sumo” (i.e. wide stance) and 12 conventional style dead-lift experts, Escamilla et al. (2000) observed that at both lift-off and as the load passed the