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## BIOMEDICAL ENGINEERING | RESEARCH ARTICLE

# Musculoskeletal model of awkward carrying postures

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**Abstract:** Improper posture of carrying loads can cause low back disorders. This study investigates the impact of using a footstool in spinal force and muscle activity when: (1) pushing/pulling load farther/nearer from the body and (2) twisting the trunk while carrying load. A whole body musculoskeletal model carrying a light load of 5, 7.5 and 10 kg is developed and inverse dynamics analyzes are conducted. Electromyography activities are also recorded to compare to the results from analyzes. Analyzes demonstrated that using a footstool when carrying a light load can reduce the intradiscal compression force. The results from the analysis are found to be consistent with the electromyogram measurement. This study suggests that load should be positioned closer to the body and footstool of 5 cm height should be used to reduce spinal forces and muscle activity on the lumbar region.

**Subjects:** Engineering & Technology; Biomedical Engineering; Biomechanics

**Keywords:** carrying load; muscle activity; musculoskeletal model; back pain

### 1. Introduction

Work-related musculoskeletal disorders can cause significant costs for medical treatment and lead to decrease of productivity. Improper manual carrying of load is considered an important risk factor for the occurrence of low back disorders (LBDs). Any job involving load carrying such as manual material handling (MMH) is at higher risks of lower back pain. Numerous studies have linked LBDs with both lifting (Bernard, 1997) and pushing/pulling tasks (Hoozemans, Van Der Beek, Fringsdresen, Van Dijk, & Van Der Woude, 1998; Van Dieën, Hoozemans, & Toussaint, 1999). Lifting tasks can be considered a combination of carrying tasks, which place large compressive loads on the spine and pushing/pulling tasks, which can create large shear loads on the spine. In addition, studies showed that there are elevated risk of LBDs in awkward carrying posture such as twisting, which refers to trunk rotation or torsion (Bernard, 1997). Although lifting is a common task in the industry, the risks to the spine

### ABOUT THE AUTHOR

N.A. Abdul Majid received her Bachelor in Engineering degree in the year 2010 and Masters in Engineering degree in 2012 both from Meiji University, Japan. She has been working as a lecturer in the Department of Mechanical and Manufacturing Engineering at Universiti Malaysia Sarawak. She has published several papers in international and indexed journals. Her research interests include musculoskeletal modeling, sports biomechanics and rehabilitation.

### PUBLIC INTEREST STATEMENT

Work-related musculoskeletal disorders can cause significant costs for medical treatment and lead to decrease of productivity. Improper manual carrying of load is considered an important risk factor for the occurrence of low back disorders. Any job involving load carrying such as manual material handling is at higher risks of lower back pain. Strategies to prevent or reduce low back disorders should focus on reducing the exposure to awkward postures at work. In this study, we use a computational human body model to observe the effect of using a footstool on the human spine and muscles around the lumbar region in several awkward load carrying postures.