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Exploring physical exposures and identifying high-risk work tasks within the floor layer trade

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ABSTRACT

Introduction: Floor layers have high rates of musculoskeletal disorders yet few studies have examined their work exposures. This study used observational methods to describe physical exposures within floor laying tasks.
Methods: We analyzed 45 videos from 32 floor layers using Multimedia-Video Task Analysis software to determine the time in task, forces, postures, and repetitive hand movements for installation of four common flooring materials. We used the WISHA checklists to define exposure thresholds.
Results: Most workers (91%) met the caution threshold for one or more exposures. Workers showed high exposures in multiple body parts with variability in exposures across tasks and for different materials. Prolonged exposures were seen for kneeling, poor neck and low back postures, and intermittent but frequent hand grip forces.
Conclusions: Floor layers experience prolonged awkward postures and high force physical exposures in multiple body parts, which probably contribute to their high rates of musculoskeletal disorders.

1. Introduction

Work-related musculoskeletal disorders (WRMSD) are a leading cause of injury and disability in the United States (U.S. Bureau of Labor and Statistics, 2009). Between 2003 and 2007, flooring contractors had the highest average WRMSD rate of 87.3/10,000 of employed workers involving days away from work compared to all other construction groups and far above the private industry rate of 42.0/10,000 workers (Centers for Disease Control and Prevention, 2009). The past literature pertaining to floor layer injuries has primarily focused on the knee (Kivimäki et al., 1992; Village et al., 1993); kneeling and squatting postures, common in floor laying tasks, has been associated with knee osteoarthritis, meniscal tears, and knee bursitis (Coggon et al., 2000; Kivimäki et al., 1992; Yuan et al., 2011). With greater use of interventions and changes in work practices and policies, WRMSD have decreased in all industries over the past 10 years, although construction declines have lagged behind all other industries (Spector et al., 2011).

In construction, the levels of physical exposures experienced during work tasks differ depending on the trade examined due to the highly variable schedules of workers and their job tasks. Floor layers perform more similar work tasks than many trades with each job requiring the same steps to install the material. General work tasks involve the preparation of floor surface, installation of materials, and finishing of floors with transition or base materials. However, the physical demands may differ between workers depending upon the amount of time spent in the general tasks as well as the material installed on the floor (Jensen et al., 2000b). Few studies have completed time studies of floor layers work tasks (Bhattacharya et al., 1985; Jensen et al., 2010; Kivimäki et al., 1992; Thun et al., 1987) and all of these studies focused solely on exposures of the knee to install flooring material.

Floor layers spend long periods of time in awkward postures and with contact stress on the knee while kneeling and squatting to install materials (Ditchen et al., 2010; Jensen et al., 2000a; Manninen et al., 2002; Reid et al., 2010; Rytter et al., 2009b; Seidler et al., 2008). These workers also handle heavy loads, manipulate tools and materials during installation, and complete tasks involving hand

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repetition and force simultaneously, such as transporting materials and removing old flooring. The combination of repetitive manipulation, lifting heavy loads, and exerting high levels of force with awkward postures of the upper body, low back and lower extremity may increase the risk for WRMSDs in body parts other than the knee (Hartmann and Fleischer, 2005; Holmström and Engholm, 2003). It is important to assess physical exposures for all body parts within job tasks of floor layers across materials to understand the potential increased risks for WRMSDs in workers of this trade. Examining differences in exposures within material may shed light on opportunities for developing interventions.

The purpose of this study was to explore the duration of time and intensity levels of observed physical exposures within floor laying tasks. Physical exposures were examined between different types of material and within different body parts (low back, knee, neck, shoulder, and wrist). Measured physical exposures for floor layers were compared to suggested threshold for exposures associated with increased risk for WRMSDs. The goal of the analysis was to determine whether the daily physical exposures of floor layers exceeded acceptable thresholds of exposures.

2. Material and methods

2.1. Source data

We analyzed exposure data collected for the Predicting Carpal Tunnel Syndrome (PrediCTS) study, a prospective study of 1107 newly-hired workers from several work types (construction trade, service, technical, and hospital workers) in St. Louis, USA. All participants of the PrediCTS study provided written consent with study approval by the Institutional Review Board for Washington University School of Medicine. Exposure data came from worksite visits conducted with floor layers between 2007 and 2009. Thirty-eight floor layers participated in one or more worksite visits for a total of 54 visits. Each visit included a brief worker interview and videotape of job tasks performed by the worker on the day of the visit. All videos were reviewed for clarity of the picture, full body views of the worker, and at least 10 min of footage of job tasks. A minimum of 5 min of continuous work was needed for assessment of each non-cyclic job task, defined as activity with no repetitive pattern or 10 cycles of work activities for cyclic job tasks involving movements in the same pattern within the total footage recorded (Bao et al., 2006a). These criteria yielded 45 videos for analysis from worksite visits of 32 individual floor layers with some workers contributing more than one video from repeated worksite visits.

During worksite visits, technicians conducted brief interviews to learn about regularly performed job tasks, to obtain worker's daily time estimates for job tasks, and worker's ratings of perceived effort for job tasks using the modified Borg-CR 10 scales (Borg, 1990). Workers were asked to estimate the average daily time spent in the three general job tasks of preparation, installation, and finishing of flooring materials. The technician discussed the steps required for each job task for each of four material types (Vinyl Composite Tile (VCT), Ceramic Tile, Hardwood, or Carpet) so workers could give informed estimates of daily time spent in each task (Jensen et al., 2000b). Self-reported time estimates in predefined tasks have been used in several previous studies and have shown good reliability when compared to direct observation

Table 1
Exposure cut points and definitions.

Exposure	Cut point	Definition from the literature	Literature
Force			
Power grip	≥10 lbs	Conspicuous force applied to an object≥10 lb to hold or manipulate an unsupported object. Grip postures *must include* contact of the palm and have all fingers grasp the object	Bao et al., 2006b; Stetson et al., 1991; Washington State Ergonomic Checklist 2009
Pinch grip	≥2 lbs	Conspicuous force applied to an object with fingertips in 3 point pinch or lateral pinch position ≥2 lb to hold or manipulate. Pinch grip uses fewer than 5 fingers and may include the pads, tips, or radial side of fingers and thumb. *The palm cannot be included*	Bao et al., 2006b; Stetson et al., 1991; Washington State Ergonomic Checklist 2009
Lift/carry	≥10 lbs	The weight of an *unsupported* object lifted or carried, relative to gravity in a vertical plane, in order to transport it with one or both hands; weighing greater≥10 lbs. Lifting between 11 and 22 lbs of force has shown a positive relationship with knee osteoarthritis.	Coggon et al., 2000
Push/pull	Whole body	Body part contact with a surface or object by a worker to move it in a horizontal direction. Using force through multiple proximal body parts or using the weight of the body to help push or pull the object.	Bao et al., 2006b
Posture			
Neck	Away from neutral (flexion or extension)	Away from neutral (flexion or extension) (Based on van Wely)	van Wely, 1970
Shoulder	≥90° elevation	Severe shoulder flexion or abduction over 90° is predictive of severe shoulder disorders; working or repeatedly raising the hands above head or the elbows above shoulder level.	Punnett et al., 2000; Leclerc et al., 2004; Washington State Ergonomic Checklist 2009
Wrist	≥45° extension or flexion	≥30 extension increases intracarpal pressure and risk for CTS. Pressure in the carpal tunnel also increases with flexion, which can cause damage to the median nerve.	Gelberman et al., 1981
Low back	≥30° and ≥90° flexion ≥20° lateral flexion or rotation	Cases of back disorder have been associated with mild flexion (neutral-45°), severe flexion (≥45°), and any lateral bending or twisting in any direction. Working with back bent more than 30°.	Punnett et al., 1991; Washington State Ergonomic Checklist 2009
Knee	Knee flexion of at least 90° (kneeling, kneeling with heel sit, squat)	Kneeling and squatting have been associated with knee disorders.	Jensen et al., 2000a,b; Jensen, 2005; Washington State Ergonomic Checklist 2009

Note: the Washington State Ergonomic Checklist 2009 was based on the duration of time spent working at the defined intensity level. A caution rating required exposure of two or more hours per day. A hazard rating required exposure of four or more hours per day.