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Workstation configuration and container type influence upper limb posture in grocery bagging

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ABSTRACT

Introduction: Repetitive movements and awkward postures are two persistent injury risk factors for grocery store cashiers. Due to the recent rise in popularity of environmentally-friendly grocery bagging options, current recommendations for cashiers are likely outdated. Correspondingly, the objective of this study was to examine the effects of cashier-specific work demands, workstation configuration, and container type on upper limb postures during typical job activities.

Methods: Fifteen experienced cashiers bagged groceries at varying combinations of workstation height (low, medium, high) and container type (reusable bins, reusable bags, plastic bags). Upper limb movement was quantified with motion capture and amplitude probability distribution functions of humeral elevation and humeral axial internal rotation were used to assess the static (10th percentile), median (50th percentile), and peak (90th percentile) postural demands, which were then interpreted in the context of existing postural guidelines.

Results: High workstation height and reusable bags increased right arm elevation at peak posture by 15.7° compared to the low workstation height and reusable bin combination. However, reusable bins increased internal rotation demands of the right arm by 4.3° compared to other container types. Left arm elevation and internal rotation were consistently lower than right arm angles.

Conclusion: Cashiers are encouraged to adjust the workstation to decrease the arm elevation and internal rotation required by higher workstation heights and tall containers, and to use both arms for scanning and packing, when possible, to reduce undesirable arm postures.

1. Introduction

Cashiers are at high risk for musculoskeletal disorders, specifically of the upper limbs. Up to 51% of cashiers reportedly experience shoulder disorders (Niedhammer et al., 1998). Rates of upper limb cumulative trauma disorders in supermarket cashiers remain high. Even after adoption of improved scanners and muscle strength training programs (Baron and Habes, 1992; Bonfiglioli et al., 2007; Hoffman, 1996; Marras et al., 1995), injuries among cashiers account for up to 35% of all workplace injuries in the retail sector (Health and Safety Ontario, 2011). In recent years, the demands of cashiers have likely changed with the increased popularity of various kinds of environmentally-friendly grocery bags and bins. This combination of changing consumer demands and already high rate of injury mandates the development of evidence-based approaches to control these newly emerging exposures for the cashier population.

Cashier tasks require repetitive movements and prolonged awkward or elevated arm postures, which may contribute to increased injury risk. Certain arm postures are more strongly associated with shoulder injuries than others; arm elevation and humeral internal rotation are particularly implicated (Brossmann et al., 1996; Silverstein et al., 2008; Svendsen et al., 2004). An elevated arm posture increases the muscular demand for muscles crossing the shoulder (Bergmann et al., 2011; Ludewig et al., 1996) and both arm elevation and internal rotation

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decrease the size of the subacromial space, especially at elevations between 60° and 120° (Graichen et al., 2000; Nishinaka et al., 2008). An elevated and internally rotated humeral posture also increases rotator cuff tendon contact area (Soslowsky et al., 1992). As subacromial space size decreases and tendon contact increases, impingement of the supraspinatus tendon may occur, which can precipitate tendinitis or a rotator cuff tear (Neer, 1983). Finally, muscle activation increases with arm elevation, especially when holding a weighted object (Bergmann et al., 2011), suggesting that the shoulder musculature will fatigue more rapidly in these positions. As the shoulder muscles fatigue, the humeral head migrates upward toward the acromion, further increasing the risk of impingement (Chopp et al., 2010). The elevation and internal rotation arm posture requirements for cashiers is currently unknown in the context of environmentally-friendly grocery containers. Determining the arm postural demand during grocery bagging tasks will highlight which, if any, arm postures could be contributing to shoulder injuries of cashiers.

Existing ergonomic guidelines developed to mitigate risk factors for cashiers and other retail workers have limited modern relevance and effectiveness. Despite the dissemination of the current guidelines and other workstation interventions, they have modest workplace compliance (Shinnar et al., 2004). For example, the Ontario Safety and Health Association (OSHA) (2004) recommends that the bagging area of a cashier station should be adjusted to a height of 50.8 cm (20 in) from the ground; however a previous investigation (Shinnar et al., 2004) identified that the average height of cashier bagging stations was more than double the recommended height, at 108.4 cm (42.7 in) from the ground. Increased workstation height, particularly the bagging area, necessitates lifting and placing each item into the container, increasing cashier muscular demand (Grant et al., 1993; Maciukiewicz et al., 2017). The recent adoption of environmentally-friendly grocery bagging options, such as reusable bags and bins (Health and Safety Ontario, 2011), may also alter the physical demands. Reusable bins are available at many grocery stores as an alternative to reusable and plastic bags for transporting purchased groceries; bins are a rigid container, often made of hard plastic, with two canvas handles to facilitate transport (Fig. 1). Since the introduction of more environmentally-friendly packaging, the average weight of a grocery container has increased by up to 14 kg (30 lbs) as a result of the greater capacity of reusable bags and bins (Health and Safety Ontario, 2011). In addition, the size and rigidity of reusable bags and bins may require a different scanning and bagging strategy than the smaller, store-provided plastic bags (Madigan and Lehman, 1996). The combined effects of workstation configuration and current cashier-specific work demands on arm posture are unknown. Therefore, the purpose of this investigation was to evaluate the influence of workstation height, container type, number of items, right or left side of the body, and gender on arm elevation and internal rotation as key postural demand indicators. It was hypothesized that arm posture demands would be highest when using reusable grocery bags at the high workstation height. It was expected that sex and side of the body would influence arm postures as a result of strength and size differences between males and females, and the single directional flow of the groceries, respectively.

2. Methods

2.1. Participants

Experienced supermarket cashiers (seven male [age: 21.5 ± 1.4 years, stature: 1.80 ± 0.08 m, body mass: 76.3 ± 8.1 kg, cashier experience: 2.3 ± 1.3 years] and eight female [age: 20.5 ± 1.1 years, stature: 1.67 ± 0.05 m, body mass: 62.7 ± 8.1 kg, cashier experience: 2.5 ± 1.6 years]) participated in this study. Exclusion criteria were self-reported upper extremity or back discomfort or injury within the past year. The study protocol was approved by the University Research Ethics Board and all participants provided written informed consent.

2.2. Experimental setup

A simulated cashier station in a laboratory provided the venue for data collection (Fig. 1). The workstation matched the dimensions and adjustability of a standard workstation evaluated in a previous pilot field study (unpublished data), including a bagging area with adjustable height. The cashier was asked to scan the items after obtaining them from an initial placement on the right side of the cashier, then package them in a bagging area to the left of the cashier. A laser level mounted above the center of the workstation simulated the product scanner. Above the scanning area a keyboard was mounted on a stand for cashiers to input produce price look-up codes.

2.3. Experimental protocol

Motion capture was used to measure thorax and upper arm positions. Prior to the experiment participants were outfitted with reflective markers. Ten individual passive reflective markers were placed on the skin covering bony anatomical landmarks on the arms and torso (Table 1). All movements were tracked using 8 VICON MX20 (Vicon Motion Systems, Oxford, UK) optoelectronic infrared cameras positioned around the collection space. The three-dimensional positions of the markers were sampled at 50 Hz.

Participants performed 36 trials with variations in workstation height, container type, and number of items to assess their influence on cashier work demand. Trials were block randomized by workstation height where three different heights were evaluated based on the adjustment capabilities of existing standard cashier workstations: low (66 cm), medium (78 cm), and high (90 cm), as measured from the floor to the top surface of the bagging area (Fig. 1). The workstation heights were chosen to test the full range of the workstation capabilities; whereby the low workstation was set to match the minimum possible height of standard workstations, while the high workstation height

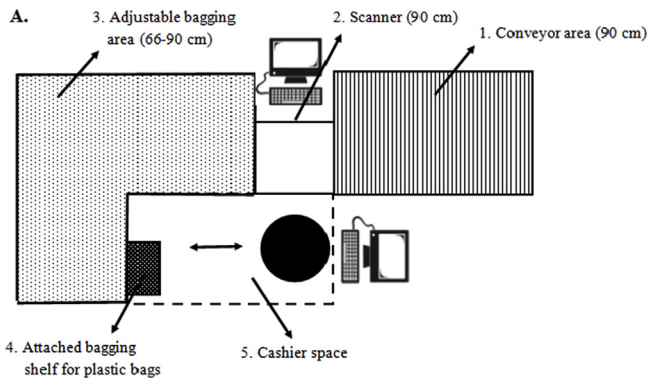

Fig. 1. A) Diagram of workstation layout, with heights of each area in parentheses. The entire bagging area (#3, dotted area) had adjustable vertical height. When the bagging area was set to 90 cm, the bagging area was the same height as the scanner. Cashiers were able to move throughout the workspace defined by the dotted line (#5). B) The three different container types were reusable bins (top), plastic bags (bottom left), and reusable bags (bottom right). When placed on the bagging area of the workstation the plastic bags laid flat, while the reusable bags and bins stood upright.

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