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Assessing the ergonomic exposures for drywall workers

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ABSTRACT

Objective: The study was conducted to assess the ergonomic exposures to risk factors that may lead to the reported musculoskeletal injuries (especially back, neck and wrist injuries) of drywall workers.
Methods: A hierarchical taxonomy for construction of drywall panel hanging (drywall panel fitting and installation) was developed with activities defined within the interior wall systems tasks (drywall panel, studs and insulation). Exposures were characterized for the drywall panel work with the PATH (Posture, Activity, Tools, and Handling) work-sampling observation method. Data on working postures were collected for three main body parts: legs, arms and trunk. Activities performed for each task, tools used, and manually handled loads were also recorded for each observation.
Results: The study identified several ergonomic exposures in interior systems construction. Several risk factors were especially prevalent in the drywall panel installation task: awkward body postures such as overhead arm posture, trunk flexion, and handling of heavy drywall panels. Some tasks were observed to have combinations of these musculoskeletal risk factors, such as drywall panel installation, where the workers lifted heavy drywall panels in awkward body postures. In addition, a safety hazard frequently resulted when a worker's foot was poorly supported on a ladder while lifting heavy drywall panels to hang them on the ceiling or upper wall.
Conclusion: The drywall panel installation task poses a severe threat to the safety and musculoskeletal health of the drywall workers. Much of this could be eliminated by reducing the burden of handling heavy and bulky drywall panels.
Relevance to industry: The construction industry is well-documented to have high rates of injury and musculoskeletal disorders. Design of appropriate interventions requires specific knowledge of which tasks and activities involve the highest levels of exposure to relevant factors. Assessment of such factors in drywall panel hanging has provided data that will be useful to evaluate the ergonomics efficacy of future changes in task processes or tools. Feasible solutions appear to exist; effectiveness trials and worker input are needed in order to evaluate whether they could eliminate the observed exposures.
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1. Introduction

Drywall hanging is a carpentry sub-trade where drywall workers layout the whole interior wall system with studs and hang large drywall panels on the ceiling and sidewalls. Drywall panels consist of a layer of gypsum between two layers of heavy paper. The installation process of drywall panels includes fitting, measuring, cutting, carrying and lifting the drywall panels to fit around doors, windows, electric outlets, etc. The standard size of drywall panels are 4 ft by 8 ft and 4 ft by 12 ft with a 5/8 inch thickness in commercial applications. The usual weight of a 4 ft by 8 ft sheet is 70 lbs and that of a 4 ft by 12 ft is 105 lb (Yuan et al., 2007).

In both residential and commercial construction, drywall panels are typically installed on both the walls and ceiling. The installation of drywall panels is accomplished by manual lifting of the panels by one or two workers at the site of installation. When a 4 ft by 12 ft or 4 ft by 8 ft drywall panel is installed on the ceiling or upper wall, both workers will stand on separate ladders, scaffold, or lift. In the case of drywall panels with small dimensions, a single worker can carry out the same activities.

The drywall panel installers are also called applicators or hangers, as they fasten or hang the heavy and bulky drywall panel

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to the inside framework of residential houses and other buildings. The job content depends somewhat on whether or not the workers are unionized; unionized drywall carpenters (unlike their non-unionized counterparts) only install the drywall panels, whereas non-unionized carpenters also tape or finish the drywall panels in order to prepare them for painting.

Researchers have described the frequency of worker injuries in drywall panel installation, especially musculoskeletal disorders (MSDs), which are common and affect the wrist, neck and back. Attention has been called particularly to the carrying, lifting and installing of heavy drywall panel pieces as likely relevant causes of musculoskeletal injuries of the drywall installers (Chiou et al., 2000; Lemasters et al., 1998; Lipscomb et al., 1997, 2000, 2008; Schneider and Susi, 1994). Chiou et al. (2000) analyzed the traumatic injury data (BLS, 1992–1995) on drywall installers. The researchers reported on work-related musculoskeletal injuries, specifically muscle, joint and tendon injuries which accounted for 44.8% of the total traumatic injuries. Back injury was the second leading body part affected (27.8%) among all body parts affected for the traumatic injury cases.

A 2008 study by Lipscomb et al. reported a high rate of back injury due to overexertion from heavy manual materials handling tasks in drywall installation. This study, through analysis of compensation claims in a cohort of union carpenters, showed a total of 4138 back injuries. The crude IR (incidence rate) and crude RR (rate ratio) back injuries were higher in the drywall workers (crude IR = 5.4, RR = 1.8) than any other carpentry trades for non-paid lost time. For paid lost time the crude IR (3.8) and crude RR (1.7) were higher than any other trades than residential (crude IR = 4.6, crude RR = 1.7) carpentry. Lemasters et al. (1998) reported that drywall and ceiling workers had the highest rate of hand and wrist MSD (21%) and knee MSD (19%) among 4 different carpentry trades. Shoulder MSD was reported by 18% of the drywall workers. Duration of employment was found to be the strongest risk factor for work related MSDs among the drywall workers (OR = 3.2, 95% CI = 1.1–8.9). Table 2 shows a summary of exposures to different body regions of the drywall installers, leading to injuries in drywall installation task.

The installers typically use ladder during the installation process for walls less than 12 ft high. Acute injuries have been reported for drywall installers as a result of falls from ladders. The study by Chiou et al. (2000) analyzed that fall events were responsible for 32.0% of a total of 16,023 traumatic injuries of drywall installers (BLS data 1992–1995). Among the total fall events, 21.2% events were accounted for falls to a lower level. Lipscomb et al. (2003b) performed injury surveillance on a cohort of 5137 unionized, residential and drywall carpenters for 37 months and a total of 783 injuries were reported within this time. Falls accounted for 20% of the total injuries among which fall from ladders accounted for 21.8% of the total injury cases.

Pan et al. (1999) carried out a questionnaire survey of 60 carpenters to identify the workers' perception of their most hazardous task in the drywall panel handling job. Physical stress, fall potential, and the risk of being struck by or against an object were evaluated as risk factors for three tasks: hanging drywall panels to the ceiling, on the upper half of the wall or the lower half of the wall. For all three tasks, the workers perceived that the activity of lifting or holding a drywall panel in an overhead position posed the maximum physical stress. For any of these three tasks mentioned, the subjects perceived physical stress primarily in the neck (27.5%), shoulders (23.5%) and lower back (21.6%) from hanging drywall panels on the ceiling. When hanging drywall panel on the ceiling or upper wall, 28.8% reported upper back stress and 26.9% reported neck stress.

This qualitative information is useful addition to the literature for providing an insight on work hazards of the job. Despite these findings, there is no study to date that has systematically quantified the specific exposures, such as frequency of handling the drywall panels, awkward body postures of the installers and etc. Therefore, direct measurement of the physical exposures of drywall installation in real-time construction field environment would identify specific activities that are associated with the ergonomic exposures and would be able to focus on ways to reduce those exposures.

The objective of this study was therefore to characterize the ergonomic exposures of drywall installation task (leading to musculoskeletal injuries) in detail which might be useful in developing suitable preventive measures for the drywall workers.

2. Methods

2.1. Study site

The study took place at three construction sites in the greater metropolitan area of Boston, Massachusetts. The sites were selected by convenience, but we attempted to sample as broadly as possible across the various different kinds of equipment (e.g., scissor lift, ladder, scaffold, etc.) used at these sites.

2.2. Taxonomy

Based on a pre-existing hierarchical taxonomy (Buchholz et al., 1996; Moir et al., 2003), the drywall panel process was categorized systematically into smaller units. Each drywall panel operation is a component of the interior systems stage that is performed by at least one worker and comprises one or more job tasks. The tasks are the functional objective and the ergonomic exposures are thought to be characteristic of a task.

Information about operations and job tasks was obtained from contractor documentation, direct observation, and interviews with contractor personnel, foremen and drywall workers. These helped to develop the hierarchical taxonomy of the main drywall operation and corresponding tasks (Table 1) and to customize the observation template (in Section 2.3). This taxonomy was defined prior to data collection although additional items were added during the observation period as needed.

Table 1
Operations, tasks and activities involved in the interior wall system construction stage.[a] Table 1 shows the list of activities done under each task of the three operations (studs, insulation, drywall hanging) of interior systems stage. The tasks are subdivisions of each operation and several activities are carried out to complete one task. The activities are not performed cyclically.

Operation	Task	Work done
Metal studs	**(a) Layout, (b) fit studs, (c) install studs**	Studs are measured according to the layout and then installed
	(d) Build, fit and install special parts, blocks construct partitions	Measuring and cutting special parts, handling and carrying them to the place of installation
Insulation	(f) Fit insulation	The workers measure and cut the insulation pieces
	(g) Install insulation	Same as install drywall panel task, using insulation materials instead of drywall panel
Drywall hanging	(h) **Fit drywall panels**	Mainly cutting and measuring the panels
	(i) **Install drywall panels**	Carrying the drywall panel to the place of installation; lifting, holding and permanently attaching with screw gun
	(j) **Housekeeping**	Keeping drywall panel organized; throwing away scrap pieces, keeping other materials/equipments in place

[a] The tasks in bold represent the ones that are discussed in detail in the paper.

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