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Are Workers Who Leave a Job Exposed to Similar Physical Demands as Workers Who Develop Clinically Meaningful Declines in Low-Back Function?

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Objective: The objective is to quantify differences in physical exposures for those who stayed on a job (survivor) versus those who left the job (turnover).

Background: It has been suggested that high physical job demands lead to greater turnover and that turnover rates may supplement low-back disorder incidence rates in passive surveillance systems.

Method: A prospective study with 811 participants was conducted. The physical exposure of distribution center work was quantified using a moment monitor. A total of 68 quantitative physical exposure measures in three categories (load, position, and timing) were examined. Low-back health function was quantified using the lumbar motion monitor at baseline and 6-month follow-up.

Results: There were 365 turnover employees within the 6-month follow-up period and 446 "survivors" who remained on the same job, of which 126 survivors had a clinically meaningful decline in low-back functional performance (cases) and 320 survivors did not have a meaningful decline in low-back functional performance (noncases). Of the job exposure measures, 6% were significantly different between turnover and cases compared to 69% between turnover and noncases. Turnover employees had significantly greater exposure compared to noncases.

Conclusion: Turnover employees had similar physical job exposures to workers who remained on the job and had a clinically meaningful decline in low-back functional performance. Thus, ergonomists and HR should be aware that high turnover jobs appear to have similar physical exposure as those jobs that put workers at risk for a decline in low-back functional performance.

Keywords: employee turnover, warehousing, low-back injury

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INTRODUCTION

Low-back pain continues to be a costly medical condition (Gore, Sadosky, Stacey, Tai, & Leslie, 2012). In a study that reviewed workers compensation claim costs, the warehousing industry was among those industries with the highest medical and indemnity costs due to low-back injuries (Dunning et al., 2010). There may be several explanations for the higher costs due to low-back injuries in the warehousing industry. One reason for the higher costs may be the type of injury or diagnosis (e.g., muscle strain, disc herniation) with more severe types of injuries occurring in warehousing due to high physical demands. Another cause for the higher costs in the warehousing industry may be that the increased physical demands on these jobs result in longer lost time. The high physical demand may require more recovery time before returning to work full duty. In either case a greater understanding of the physical exposure in warehousing jobs is essential for increasing our understanding of low-back injuries and the recovery process that may lead to reducing injury costs in the warehousing industry.

Warehousing jobs such as grocery selectors have been shown to place workers at high risk for low-back injury via several ergonomic assessment tools (Waters, Putz-Andersson, & Baron, 1998). Marras, Lavender, Ferguson, Splittstoesser, and Yang (2010b) in a recent prospective study of warehouse workers found that approximately 41% of the 888 initially recruited turned over within the 6-month follow-up time. It is well established in the literature that warehouse workers have a high turnover rate (Min, 2007). Lavender and Marras (1994) have suggested that high turnover rates could be used as supplemental incidence rates to identify high-risk jobs for low-back injury. However, most turnover models examine psychosocial issues rather than quantitative measures of physical exposure (de Croon, Sluiter, Blonk, Broersen, & Frings-Dresen, 2004). Thus, there is a void in the literature quantifying physical job exposure measures in jobs with high turnover compared to jobs where workers have remained on the job.

The purpose of this paper is to examine the differences in physical exposure measures between turnover employees and those who remained on the job (survivors) who did and did not develop clinically meaningful declines in low-back functional performance throughout the follow-up period (6 months). Workers who remain on the job provide multiple groups for comparison. Thus, the objective of this analysis was to first quantify exposure differences between turnover employees who left the job versus those who remained on the job after 6 months. A second objective was to quantify exposure differences between turnover employees and two groups of survivors: (a) cases, defined as those with a clinically meaningful decline in low-back functional performance, and (b) noncases, defined as those without a clinically meaningful decline in low-back functional performance.

METHOD

Approach

This was a prospective study to examine the health effects and physical demands of distribution center jobs. Baseline health effects were measured including low-back functional performance, psychosocial questionnaire, symptom survey, and demographic measures. In addition, the physical demands of the job were measured. Follow-up health effects including low-back functional performance and psychosocial and symptom questionnaires were assessed approximately 6 months after baseline.

Participants

In the research study, 811 workers in 19 different distribution centers participated. All 811 participants performed a low-back functional assessment at baseline and completed a psychosocial and individual risk factor questionnaire. The psychosocial questionnaire included the job control, supervisor support, and coworker support sections from the NIOSH Generic Job Stress Questionnaire (Hurrell & McLaney, 1988). In addition, there was one question regarding job satisfaction on the questionnaire. A follow-up low-back functional assessment and questionnaire were completed approximately 6 months later. Workers who remained at the facility but were on a different job at the time of follow-up were not considered for this analysis.

Equipment

The clinical lumbar motion monitor (LMM) was used to measure low-back functional performance of the workers. The LMM is an exoskeleton of the spine and has been validated previously for the clinical LMM protocol (Marras et al., 1995; Marras et al., 1999). The clinical LMM protocol required subjects to control their twisting position while bending sagittally as fast as they can comfortably. A full description of the protocol has been previously published (Ferguson & Marras, 2004). The clinical LMM assessment provides an objective quantitative assessment of low-back functional performance.

Recently, a device was developed that measured moments (force times distance). This device is called the moment monitor and measures low-back moments and trunk kinematics in high variability work environments such as distribution centers. Figure 1 illustrates the moment monitor on a subject during data collection. A full description of the moment monitor development has been previously published (Marras, Lavender, Ferguson, Splittstoesser, Yang, & Schabo, 2010).

Procedure

Health effects—Data collection. All workers in manual material handling jobs selected for study were invited to participate in the health effects study. Those interested signed a University Human Subjects consent form. After signing the consent form workers completed the health effect survey, which included a brief questionnaire and the clinical LMM functional assessment. In all, 3 to 65 workers per job participated in the health effect survey with an average of 16.2 and standard deviation of 14.0 per job. From those who participated in the health effects, 3 to 7 (*Mdn* = 4) workers were randomly selected to wear the moment monitor

Figure 1. Moment monitor on worker.

for up to 4 hours while performing their job. A follow-up health effects assessment was performed approximately 6 months after the baseline assessment. At the follow-up evaluation workers completed the questionnaires and low-back functional performance evaluation.

Moment monitor—Data collection. Workers who wore the moment monitor signed a second consent form. Workers were instructed to work at a normal pace and lift as normally as possible with the moment monitor. Workers wore the moment monitor for up to 4 hours of their shift on one workday.

Data Analysis

Turnover employees were defined as those individuals who were no longer working at the facility at the time of the follow-up. These workers had no follow-up data.

Health effects—Decline in low-back functional performance. The clinical LMM assessment results in a low-back functional performance probability from 0 to 1 that has been developed over the past two decades (Marras et al., 1993; Marras et al., 1994; Marras et al., 1995; Marras et al., 1999). A database of healthy controls (Marras et al., 1994) and low-back pain patients with specific diagnosed low-back disorder has been used to develop the probability (Marras et al., 1995; Marras et al., 1999). A probability of less than 0.5 indicated that an individual's low-back functional performance was impaired for his or her age and gender, whereas a score greater than 0.5 indicated healthy low-back functional performance (Ferguson et al., 2009). The clinical LMM low-back function performance results provide an objective measure of low-back function.

For those who remained on the job, cases of a clinically meaningful decline in low-back functional performance were defined as individuals with a decrease in functional performance (pn) of –0.14 or more (Ferguson et al., 2009). Noncases were defined as any survivor with a change in functional performance greater than –0.14. If workers were still at the plants but changed jobs during the 6 months they were not considered in the analysis.

Health effects—Questionnaire. The questionnaire had several questions about the individual's back health history. First was a question asking the individual if he or she had ever had back pain symptoms that limited his or her activities. Second, there was a question stating, "Have you had back pain more than once in the last 12 months that limited your activities?" There was also a question regarding visiting a health care professional in the past 12 months for back pain symptoms. Finally, there was a question about missing days of work because of back symptoms in the past 12 months. The same questionnaire was used at baseline as well as follow-up.

Health effects—Psychosocial and demographic. The job control, supervisor support, and coworker support questions were scored according to Hurrell and McLaney (1988). Age, height, weight, gender, smoking status, and job satisfaction measures were also reported in the database.

Exposure measures. The exposure data from each of the employees who wore the moment monitor were analyzed. A total of 78,360 exertions were in the physical exposure database. Job exposure was calculated by averaging the peak exposures across all workers on that job who wore the moment monitor. The job exposure was assigned to all workers who participated in the study from that job.

There were 390 measures in the physical exposure database, however only a subset of these will be examined in this paper. Physical exposure measures were classified into three low-back disorder risk factor categories including load, position, and timing variables as listed in Tables 1 to 3, respectively. The load category included measures such as weight, force, and moment. The position category consisted of start height, moment arm, trunk angle, trunk velocity, and trunk acceleration. The timing category incorporated measures of task frequency and duration as well as when during the exertion peak moments occurred. Marras, Lavender, Ferguson, Splittstoesser, and Yang (2010a) provide a detailed description of the biomechanical relationship to low-back disorder risk for each risk factor category. Table 4 lists the 14 individual or psychosocial factors evaluated in the study.

Statistical Analysis

Of the 390 exposure measures, 68 were selected for statistical analysis. These 68 measures were selected because these measures have been previously reported in Marras et al. (2010b). Given the relatively large employee turnover rate, it was thought that exploring the differences between survivors and turnover employees may provide some interesting insights. Thus, descriptive statistics with means and standard deviations as a function of the groups were calculated. In addition, two-sample *t* tests between each survivor group and the turnover employees were performed for loads, positions, timing, and psychosocial/individual measures.

RESULTS

Follow-Up

There were 365 (45%) turnover employees and 446 survivors who were on the same job at follow-up. Of the 446 survivors, 126 were identified as cases (clinically meaningful decline in low-back functional performance) and 320 survivors were considered noncases. The sample sizes are not exactly the same as in Marras et al. (2010b) due to some incomplete questionnaires and those who remained at the same facility on different jobs were not considered in this analysis.

Load Measures

Table 1 lists the mean loading measures for the survivors and turnover employees. For all survivors, the load weight alone was not significantly different between survivors and turnover workers; however several of the complex measures such as dynamic forward-bending load moment were significantly different. In total 14 of the 22 load measures were significantly different and all showed that the turnover exposure was significantly greater than the survivor exposure. Further breakdown of the survivors showed that 19 of the 22 load variables were significantly different between the survivor noncases and turnover group. Similarly, the turnover employees had greater exposure than the survivor noncases. The survivors with a clinically meaningful decline in low-back functional performance (cases) showed no significant differences compared to the turnover workers for all 22 loading variables.

Position Measures

For all survivors versus turnover employees 18 exposure measures were significantly greater for the turnover group compared to the survivors (Table 2). Similarly, the survivor noncases had 18 of the 26 measures that were significantly greater for the turnover group. Of the survivors that were cases, however, only three of the position risk factors were significantly different compared to turnover employees. Again the turnover group had significantly greater exposure than the survivors.

Timing Measures

Of the 20 timing measures, 9 were significantly different between all survivors and the turnover group as listed in Table 3. The survivors had significantly shorter task durations as well as significantly shorter duration of carry. The timing of the peak load was significantly later in the task for the turnover group compared to the survivors. The survivor noncases had 10 of the 20 timing variables show significant differences as indicated in Table 3 similar to all survivors. The survivor cases had only one variable that was significantly different compared to the turnover employees. The cases had significantly lower task frequency than the turnover group.

TABLE 1: Load Measures Means and Standard Deviations for All Survivors, Turnover Employees, Survivor Noncases, Survivor Cases, and *p* Values Compared to Turnover Group

Load Measure	All Survivors (n = 446) M (SD)	Turnover (n = 365) M (SD)	All Survivors vs. Turnover p Value
Load weight (N)	68.2 (14.2)	69.9 (15.9)	.1145
Max dynamic lift force (N)	102.6 (29.1)	109.4 (32.8)	.0021*
Abs. max dynamic slide force (N)	44.0 (13.6)	45.7 (15.4)	.0879
Abs. max dynamic lift/slide force (N)	111.3 (30.2)	117.8 (34.9)	.0051*
Abs. max static transverse plane load moment (Nm)	35.9 (8.6)	37.1 (9.0)	.0692
Abs. average static transverse plane load moment (Nm)	23.6 (5.4)	23.9 (5.9)	.5589
Abs. max static forward-bend load moment (Nm)	35.1 (8.3)	36.1 (8.8)	.0729
Abs. max static side-bend load moment (Nm)	12.2 (3.3)	12.7 (3.5)	.0368*
Max static right side-bend load moment (Nm)	9.7 (2.5)	9.9 (2.6)	.1392
Max static left side-bend load moment (Nm)	–9.2 (3.1)	–9.8 (3.3)	.0073*
Abs. max dynamic forward-bend load moment (Nm)	43.6 (13.0)	46.1 (13.6)	.0069*
Abs. max dynamic side-bend load moment (Nm)	13.0 (4.1)	13.8 (4.4)	.0028*
Max dynamic right side-bend load moment (Nm)	9.7 (2.8)	10.2 (3.0)	.0062*
Max dynamic left side-bend load moment (Nm)	–9.4 (3.7)	–10.2 (3.9)	.0023*
Abs. max dynamic transverse plane load moment (Nm)	44.8 (13.4)	47.5 (14.0)	.0064*
Abs. average dynamic transverse plane load moment (Nm)	21.1 (5.3)	21.6 (5.7)	.1740
Abs. max dynamic forward-bending resultant (sagittal) moment (Nm)	44.5 (13.1)	47.0 (14.1)	.0093*
Abs. max dynamic resultant moment (Nm)	45.9 (13.5)	48.5 (14.5)	.0089*
Abs. average dynamic resultant moment (Nm)	23.0 (5.7)	23.6 (6.4)	.1689
Abs. max dynamic twisting slide moment (Nm)	5.5 (2.0)	5.8 (2.3)	.0305*
Abs. max dynamic forward-bend slide moment (Nm)	11.3 (3.9)	11.9 (4.1)	.0496*
Abs. max dynamic lateral plane slide moment (Nm)	12.3 (4.2)	12.9 (4.5)	.0435*

(continued)

TABLE 1: (continued)

Load Measure	Turnover (*n* = 365) *M* (*SD*)	Survivor Noncases (*n* = 320) *M* (*SD*)	Noncases vs. Turnover *p* Value	Survivor Cases (*n* = 126) *M* (*SD*)	Cases vs. Turnover *p* Value
Load weight (N)	69.9 (15.9)	67.4 (13.9)	.0352*	70.0 (14.8)	.9155
Max dynamic lift force (N)	109.4 (32.8)	101.4 (28.3)	.0007*	105.7 (30.8)	.2696
Abs. max dynamic slide force (N)	45.7 (15.4)	43.3 (13.4)	.0286*	45.7 (13.8)	.9789
Abs. max dynamic lift/slide force (N)	117.8 (34.9)	109.8 (29.4)	.0015*	114.9 (32.0)	.4085
Abs. max static transverse plane load moment (Nm)	37.1 (9.0)	35.5 (8.4)	.0187*	37.1 (8.8)	.9814
Abs. average static transverse plane load moment (Nm)	23.9 (5.9)	23.4 (5.3)	.2977	24.2 (5.6)	.5985
Abs. max static forward-bend load moment (Nm)	36.1 (8.8)	34.6 (8.2)	.0202*	36.2 (8.6)	.9797
Abs. max static side-bend load moment (Nm)	12.7 (3.5)	12.0 (3.2)	.0069*	12.7 (3.4)	.9721
Max static right side-bend load moment (Nm)	9.9 (2.6)	9.5 (2.4)	.0375*	10.0 (2.5)	.7382
Max static left side-bend load moment (Nm)	–9.8 (3.3)	–9.1 (3.0)	.0020*	–9.6 (3.2)	.5084
Abs. max dynamic forward-bend load moment (Nm)	46.1 (13.6)	43.0 (12.8)	.0023*	45.0 (13.4)	.4312
Abs. max dynamic side-bend load moment (Nm)	13.8 (4.4)	12.7 (4.0)	.0006*	13.5 (4.3)	.4422
Max dynamic right side-bend load moment (Nm)	10.2 (3.0)	9.6 (2.9)	.0015*	10.1 (2.9)	.5222
Max dynamic left side-bend load moment (Nm)	–10.2 (3.9)	–9.2 (3.6)	.0006*	–9.8 (3.9)	.3474
Abs. max dynamic transverse plane load moment (Nm)	47.5 (14.0)	44.2 (13.2)	.0021*	46.3 (13.8)	.4250
Abs. average dynamic transverse plane load moment (Nm)	21.6 (5.7)	20.9 (5.2)	.1016	21.5 (5.6)	.8363
Abs. max dynamic forward-bending resultant (sagittal) moment (Nm)	47.0 (14.1)	43.8 (12.8)	.0024*	46.1 (13.7)	.5639
Abs. max dynamic resultant moment (Nm)	48.5 (14.5)	45.2 (13.2)	.0023*	47.6 (14.1)	.5638
Abs. average dynamic resultant moment (Nm)	23.6 (6.4)	22.8 (5.5)	.0684	23.6 (6.2)	.9594
Abs. max dynamic twisting slide moment (Nm)	5.8 (2.3)	5.4 (2.0)	.0062*	5.8 (2.1)	.8969
Abs. max dynamic forward-bend slide moment (Nm)	11.9 (4.1)	11.1 (3.9)	.0150*	11.8 (3.9)	.8871
Abs. max dynamic lateral plane slide moment (Nm)	12.9 (4.5)	12.1 (4.2)	.0126*	12.8 (4.2)	.8735

*Statistically significant difference at alpha = .05.

TABLE 2: Position Measures Means and Standard Deviations for All Survivors, Turnover Employees, Survivor Noncases, Survivor Cases, and *p* Values Compared to Turnover Employees

Position Measure	All Survivors (*n* = 446) *M* (*SD*)	Turnover (*n* = 365) *M* (*SD*)	All Survivors vs. Turnover *p* Value
Max transverse plane moment arm (cm)	0.52 (0.04)	0.52 (0.04)	.1743
Start transverse plane moment arm (cm)	0.44 (0.04)	0.44 (0.04)	.7815
End transverse plane moment arm (cm)	0.42 (0.04)	0.42 (0.04)	.9079
Max resultant moment arm (cm)	0.60 (0.05)	0.61 (0.04)	.0072*
Start height (m)	0.91 (0.09)	0.90 (0.08)	.1574
End height (m)	1.03 (0.12)	1.02 (0.13)	.2276
Start asymmetry (deg)	89.6 (2.51)	90.2 (2.85)	.0034*
End asymmetry (deg)	89.3 (2.52)	89.7 (2.67)	.0166*
Abs. max forward moment arm (cm)	0.18 (0.02)	0.18 (0.02)	.1199
Abs. max side moment arm (cm)	0.51 (0.04)	0.51 (0.04)	.2134
Abs. max up moment arm (cm)	0.36 (0.05)	0.37 (0.04)	.0016*
Abs. max lateral plane moment arm (cm)	0.52 (0.04)	0.52 (0.04)	.1743
Abs. max sagittal plane moment arm (cm)	0.59 (0.05)	0.60 (0.04)	.0084*
Abs. max sagittal trunk angle (degrees)	52.6 (10.3)	54.5 (9.0)	.0043*
Abs. max lateral trunk angle (degrees)	17.7 (1.8)	18.3 (1.7)	.0001*
Max right lateral trunk angle (degrees)	14.5 (2.1)	15.2 (2.1)	.0001*
Max left lateral trunk angle (degrees)	–13.8 (2.0)	–14.4 (1.9)	.0001*
Max sagittal trunk flexion velocity (deg/sec)	76.8 (14.2)	81.3 (13.9)	.0001*
Max sagittal trunk extension velocity (deg/sec)	–84.9 (14.5)	–88.8 (13.1)	.0001*
Max sagittal trunk acceleration (deg/sec^2)	730.8 (135.2)	778.6 (137.5)	.0001*
Max sagittal trunk deceleration (deg/sec^2)	–695.9 (136.5)	–741.7 (139.1)	.0001*
Abs. max lateral trunk velocity (deg/sec)	108.8 (15.9)	114.0 (14.3)	.0001*
Max rightward lateral trunk velocity (deg/sec)	92.9 (14.7)	98.1 (13.7)	.0001*
Max leftward lateral trunk velocity (deg/sec)	–93.4 (14.5)	–98.0 (13.2)	.0001*
Max lateral trunk acceleration (deg/sec^2)	883.9 (141.7)	933.6 (133.3)	.0001*
Max lateral trunk deceleration (deg/sec^2)	–882.9 (137.0)	–931.8 (128.2)	.0001*

(continued)

TABLE 2: (continued)

Position Measures	Turnover (*n* = 365) *M* (*SD*)	Survivor Noncases (*n* = 320) *M* (*SD*)	Noncases vs. Turnover *p* Value	Survivor Cases (*n* = 126) *M* (*SD*)	Cases vs. Turnover *p* Value
Max transverse plane moment arm (cm)	0.52 (0.04)	0.52 (0.04)	.1086	0.52 (0.04)	.8030
Start transverse plane moment arm (cm)	0.44 (0.04)	0.44 (0.04)	.8004	0.44 (0.03)	.8515
End transverse plane moment arm (cm)	0.42 (0.04)	0.42 (0.04)	.7720	0.42 (0.04)	.7924
Max resultant moment arm (cm)	0.61 (0.04)	0.60 (0.05)	.0028*	0.61 (0.05)	.3768
Start height (m)	0.90 (0.08)	0.91 (0.09)	.1167	0.91 (0.09)	.4023
End height (m)	1.02 (0.13)	1.03 (0.12)	.1506	1.02 (0.12)	.8354
Start asymmetry (deg)	90.2 (2.85)	89.5 (2.5)	.0037*	89.7 (2.5)	.1087
End asymmetry (deg)	89.7 (2.67)	89.2 (2.6)	.0033*	89.7 (2.4)	.8406
Abs. max forward moment arm (cm)	0.18 (0.02)	0.18 (0.02)	.0510	0.18 (0.02)	.9231
Abs. max side moment arm (cm)	0.51 (0.04)	0.50 (0.04)	.1386	0.51 (0.04)	.8390
Abs. max up moment arm (cm)	0.37 (0.04)	0.36 (0.05)	.0005*	0.37 (0.04)	.2563
Abs. max lateral plane moment arm (cm)	0.52 (0.04)	0.52 (0.04)	.1058	0.52 (0.04)	.8030
Abs. max sagittal plane moment arm (cm)	0.60 (0.04)	0.59 (0.05)	.0034*	0.60 (0.04)	.3882
Abs. max sagittal trunk angle (degrees)	54.5 (9.0)	52.3 (10.3)	.0028*	53.3 (10.4)	.2433
Abs. max lateral trunk angle (degrees)	18.3 (1.7)	17.6 (1.8)	.0001*	18.0 (1.7)	.0547
Max right lateral trunk angle (degrees)	15.2 (2.1)	14.4 (2.1)	.0001*	14.7 (2.1)	.0228*
Max left lateral trunk angle (degrees)	–14.4 (1.9)	–13.6 (2.0)	.0001*	–14.2 (1.9)	.5125
Max sagittal trunk flexion velocity (deg/sec)	81.3 (13.9)	75.7 (14.3)	.0001*	79.4 (13.7)	.1778
Max sagittal trunk extension velocity (deg/sec)	–88.8 (13.1)	–84.5 (14.5)	.0001*	–86.0 (14.4)	.0427*
Max sagittal trunk acceleration (deg/sec^2)	778.6 (137.5)	721.8 (135.7)	.0001*	753.5 (131.5)	.0741
Max sagittal trunk deceleration (deg/sec^2)	–741.7 (139.1)	–686.8 (138.3)	.0001*	–719.0 (130.2)	.1096
Abs. max lateral trunk velocity (deg/sec)	114.0 (14.3)	107.6 (16.0)	.0001*	111.6 (15.4)	.1181
Max rightward lateral trunk velocity (deg/sec)	98.1 (13.7)	92.0 (14.8)	.0001*	95.8 (14.3)	.0488*

(continued)

TABLE 2: (continued)

Position Measures	Turnover (*n* = 365) *M* (*SD*)	Survivor Noncases (*n* = 320) *M* (*SD*)	Noncases vs. Turnover *p* Value	Survivor Cases (*n* = 126) *M* (*SD*)	Cases vs. Turnover *p* Value
Max leftward lateral trunk velocity (deg/sec)	–98.0 (13.2)	–92.4 (14.6)	.0001*	–95.8 (13.9)	.1126
Max lateral trunk acceleration (deg/sec^2)	933.6 (133.3)	873.9 (142.5)	.0001*	909.3 (137.1)	.0809
Max lateral trunk deceleration (deg/sec^2)	–931.8 (128.2)	–873.0 (137.8)	.0001*	–907.9 (132.4)	.0733

*Statistically significant difference at alpha = .05.

Individual and Psychosocial Measures

The turnover employees were significantly younger than the survivors by approximately 5 years as listed in Table 4. Furthermore, the survivors were older than the turnover group regardless of changes in low-back functional performance (i.e., both cases and no cases were significantly older). The job satisfaction scores were significantly lower for the turnover employees compared to all survivors. Similarly, the survivor noncases had higher job satisfaction scores than the turnover employees, whereas the job satisfaction scores for the survivor cases were not significantly different than the turnover employees. There was no significant difference in low-back functional performance between all survivors with an average score of 0.55 (*SD* = 0.26) and turnover employees 0.57 (*SD* = 0.25). There was a significant difference in the percentage of the population reporting low-back pain during their lifetime, with 50% of turnover employees reporting yes whereas only on 42% of survivors had back pain during their lifetime (p = .0297). There were no significant differences in the percentage of medical visits as shown in Table 4. There was no statistical difference between all survivors and turnover for those reporting lost days. The survivor noncases were not statistically significantly different from the turnover group; however interestingly the survivor cases reported significantly less (10%) missed work due to back symptoms compared to the turnover group, who reported 17% missed work due to back pain.

DISCUSSION

Figure 2 illustrates the percentage of exposure measures that were significantly different between survivor noncases versus turnover employees and survivor cases versus turnover employees as a function of dependent measure category. The most striking difference was in the load exposure measures where 86% of the measures were significantly lower for survivor noncases versus turnover employees; in comparison no measures were significantly different between survivor cases versus turnover employees. In all significant comparisons the survivor noncases had less exposure than the turnover employees. The vast majority (95%) of the physical exposure measures where employees turned over (i.e., turnover) were not significantly different than those jobs where workers had a clinically meaningful decline in low-back functional performance (cases). Thus, it may be hypothesized that these workers left the job rather than remaining on the job and risking a clinically meaningful decline in low-back functional performance. Lavender and Marras (1994) suggested that turnover rates supplement incidence rates in passive surveillance programs to reduce incidence of low-back injury. The current analysis supports the theory that high turnover might also identify jobs that place a worker at high risk of clinically meaningful decline in low-back functional performance.

Distribution center jobs traditionally have high turnover rates (Min, 2007), however few studies have suggested that the high rate of

TABLE 3: Timing Measures Means and Standard Deviations for All Survivors, Turnover Employees, Survivor Noncases, Survivor Cases, and *p* Values Compared to the Turnover Employees

	All Survivors (*n* = 446)	Turnover (*n* = 365)	All Survivors vs. Turnover
Timing Measures	*M* (*SD*)	*M* (*SD*)	*p* Value
Duration (sec.)	2.85 (0.76)	3.09 (0.69)	.0045*
Duration of non load exposure (sec.)	20.62 (9.03)	19.89 (9.32)	.2624
Duration of get (sec.)	0.69 (0.15)	0.72 (0.15)	.0055*
Duration of carry (sec.)	1.92 (0.65)	2.03 (0.58)	.0062*
Duration of place (sec.)	0.52 (0.13)	0.53 (0.12)	.6767
Percentage time of max dynamic lift force (%)	53.7 (6.1)	54.5 (5.6)	.0315*
Percentage time of abs. max dynamic slide force (%)	48.4 (3.9)	48.5 (3.9)	.5217
Percentage time of abs. max dynamic lift/slide force (%)	53.1 (5.9)	53.9 (5.5)	.0640
Percentage time of abs. max static transverse plane load moment (%)	49.2 (5.6)	49.5 (5.6)	.4232
Percentage time of abs. max static forward-bending load moment (%)	49.5 (5.6)	49.8 (5.6)	.4173
Percentage time of abs. max static side-bending load moment (%)	50.5 (3.1)	50.4 (2.9)	.7889
Percentage time of abs. dynamic forward-bending load moment (%)	52.1 (6.8)	53.1 (6.2)	.0348*
Percentage time of abs. max side-bending dynamic load moment (%)	52.7 (3.6)	53.3 (3.2)	.0150*
Percentage time of abs. max dynamic transverse plane load moment (%)	52.1 (6.8)	53.0 (5.3)	.0338*
Percentage time of abs. forward-bending resultant (sagittal) moment (%)	55.2 (4.8)	56.1 (4.8)	.0093*
Percentage time of abs. max dynamic resultant moment (%)	54.8 (4.9)	55.7 (4.7)	.0079*
Percentage time of abs. max dynamic twisting slide moment (%)	48.5 (3.7)	48.4 (3.2)	.9405
Percentage time of abs. max dynamic forward-bending slide moment (%)	47.6 (6.4)	47.8 (6.0)	.6417
Percentage time of abs. max dynamic lateral plane slide moment (%)	46.7 (6.2)	46.9 (5.9)	.6351
Frequency (lifts/min)	2.1 (1.1)	2.2 (1.0)	.4961

(continued)

TABLE 3: (continued)

Timing Measures	Turnover (*n* = 365) *M* (*SD*)	Survivor Noncases (*n* = 320) *M* (*SD*)	Noncase vs. Turnover *p* Value	Survivor Cases (*n* = 126) *M* (*SD*)	Cases vs. Turnover *p* Value
Duration (sec.)	3.09 (0.69)	2.89 (0.78)	.0005*	3.07 (0.70)	.8105
Duration of non load exposure (sec.)	19.89 (9.32)	20.51 (9.24)	.3818	20.88 (8.48)	.2956
Duration of get (sec.)	0.72 (0.15)	0.68 (0.15)	.0010*	0.71 (0.14)	.6194
Duration of carry (sec.)	2.03 (0.58)	1.88 (0.66)	.0010*	2.02 (0.61)	.7746
Duration of place (sec.)	0.53 (0.12)	0.52 (0.14)	.3357	0.54 (0.12)	.3990
Percentage time abs. max dynamic lift force (%)	54.5 (5.6)	53.5 (6.3)	.0234*	54.0 (5.4)	.3547
Percentage time abs. max dynamic slide force (%)	48.5 (3.9)	48.2 (5.6)	.2183	48.8 (3.9)	.4405
Percentage time abs. max dynamic lift/slide force (%)	53.9 (5.5)	52.9 (6.1)	.0410*	53.5 (5.3)	.5391
Percentage time abs. max static transverse plane load moment (%)	49.5 (5.6)	49.0 (5.6)	.2570	49.6 (5.6)	.8407
Percentage time abs. max static forward-bending load moment (%)	49.8 (5.6)	49.3 (5.6)	.2534	49.9 (5.4)	.8421
Percentage time abs. max static side-bending load moment (%)	50.4 (2.9)	50.6 (3.1)	.3982	50.1 (3.0)	.3346
Percentage time abs. max dynamic forward-bend load moment (%)	53.1 (6.2)	51.8 (6.9)	.0123*	52.8 (6.4)	.6987
Percentage time abs. max side-bending dynamic load moment (%)	53.3 (3.2)	52.6 (3.6)	.0090*	53.0 (3.6)	.3280
Percentage time abs. max dynamic transverse plane load moment (%)	53.0 (5.3)	51.8 (7.0)	.0123*	52.8 (6.5)	.7002
Percentage time abs. forward-bending resultant (sagittal) moment (%)	56.1 (4.8)	55.0 (4.8)	.0035*	55.7 (4.8)	.4100
Percentage time abs. max dynamic resultant moment (%)	55.7 (4.7)	54.6 (4.9)	.0034*	55.2 (5.0)	.3390
Percentage time abs. max dynamic twisting slide moment (%)	48.4 (3.2)	48.4 (3.6)	.8735	48.6 (3.8)	.6494
Percentage time abs. max dynamic forward-bending slide moment (%)	47.8 (6.0)	47.3 (6.5)	.3318	48.3 (5.9)	.4560
Percentage time abs. max dynamic lateral plane slide moment (%)	46.9 (5.9)	46.4 (6.3)	.3032	47.4 (5.8)	.4064
Frequency (lifts/min)	2.2 (1.0)	2.2 (1.1)	.7752	1.9 (0.9)	.0204*

*Statistically significant difference at alpha = .05.

TABLE 4: Psychosocial and Individual Factors Means and Standard Deviations for All Survivors, Turnover Employees, Survivor Noncases, Survivor Cases, and *p* Values Compared to Turnover Employees

Individual and Psychosocial Measures	All Survivors (*n* = 446)	Turnover (*n* = 365)	All Survivors vs. Turnover	Survivor Noncases (*n* = 320)	Noncases vs. Turnover	Survivor Cases (*n* = 126)	Survivor Cases vs. Turnover
	M (*SD*)	*M* (*SD*)	*p* Value	*M* (*SD*)	*p* Value	*M* (*SD*)	*p* Value
Age (years)	36.8 (10.9)	31.5 (10.0)	.0001*	36.3 (11.0)	.0001*	37.9 (10.8)	.0001*
Weight (kg)	85.6 (19.4)	85.0 (20.2)	.6921	85.7 (19.7)	.6667	85.3 (19.0)	.8880
Height (cm)	175.6 (9.88)	177.2 (8.82)	.0185*	174.9 (9.83)	.0023*	177.2 (9.85)	.9213
Job control	2.83 (1.04)	2.88 (1.04)	.5041	2.88 (1.04)	.9644	2.71 (0.92)	.1150
Supervisor support	1.70 (0.74)	1.65 (0.74)	.2914	1.71 (0.76)	.6265	1.70 (0.69)	.4899
Coworker support	1.79 (0.68)	1.75 (0.67)	.4148	1.76 (0.68)	.7906	1.85 (0.68)	.1400
Job satisfaction	2.21 (0.71)	2.01 (0.79)	.0002*	2.25 (0.73)	.0002*	2.11 (0.67)	.1860
Baseline low back functional performance (pn)	0.55 (0.26)	0.57 (0.25)	.4320	0.50 (0.20)	.0009*	0.69 (0.19)	.0001*
Percentage of males (%)	82	86	.1273	80	.0452*	86	.8932
Percentage of smokers (%)	50	56	.0961	50	.1195	51	.2731
Percentage of those reporting ever having back pain that limited their activities (%)	42	50	.0237*	42	.0347*	42	.1384
Percentage of those reporting back pain more than once in the past 12 months that limited their activities (%)	26	31	.1486	29	.5647	20	.0166*
Percentage of those reporting having been to a medical provider in the past 12 months for back symptoms (%)	26	26	.9958	27	.6903	22	.4564
Percentage of those reporting having missed work in the past 12 months because of back symptoms (%)	14	17	.2365	16	.6029	10	.0401*

*Statistically significant difference at alpha = .05.

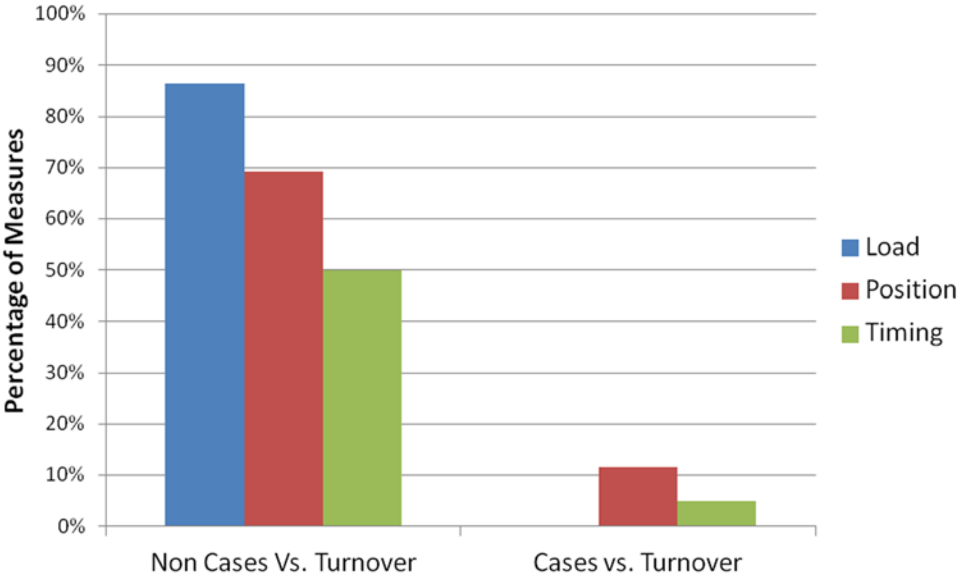

Figure 2. Percentage of exposure measures with a significant difference for noncases versus turnover employees and cases versus turnover employees as a function of exposure measure category.

turnover might be due to the physical demands of the job (de Croon et al., 2004). Furthermore, in a definition of employee turnover and factors determining turnover physical exposure was not even mentioned (Muntaner, Benach, Hadden, Gimeno, & Benavides, 2006). The results of this study indicate that high turnover may be the result of increased physical demands even in comparison to other warehousing jobs. Thus, in addition to traditional measures that are evaluated for turnover such as psychosocial measures of job satisfaction and the individual factors of age and gender, this study would suggest that physical exposure measures should be considered a part of the equation leading to high employee turnover rates. The physical exposure measures that identified risk of employee turnover were complex measures and not just simple load measures. This demonstrates the importance of increased quantification of exposure and that risk is not simple. Voluntary employee turnover is a complex issue in the warehousing industry (Mullins, 2002), and physical exposure provides another component to evaluate when considering methods to reduce the high turnover rates.

Individual factors have been considered as key components affecting employee turnover (Min, 2007). Age was one of those key individual factors influencing turnover. Campo, Weiser, and Koenig (2009) found younger workers were more likely to have job turnover than older workers. In the current study it was found that the turnover group was on average nearly 5 years younger than those who remained on the job. Furthermore, survivors were significantly older than turnover employees regardless of low-back functional performance changes. Thus, our study confirms the findings of Campo et al. that younger workers are more likely to experience turnover.

Low-back functional performance scores were not significantly different between turnover employees and all survivors. Further breakdown shows that the survivors classified as cases had significantly better low-back functional performance (pn = 0.69) at baseline than the turnover employees (pn = 0.57). The follow-up low-back functional performance score for cases was on average 0.36 with a standard deviation of 0.19. This was significantly lower than the baseline functional performance score of the turnover group. This may suggest that the turnover employees were in the process of becoming cases and that these individuals chose to leave the job rather than develop a decline in low-back functional performance. Furthermore, those individuals who were categorized as noncases on average had a follow-up functional performance score of 0.58 with a standard deviation of 0.27. Overall there was a change of 0.09 from baseline to follow-up in the noncases. This does not represent a clinically meaningful change in low-back functional performance (Ferguson et al., 2009).

Anderson and Briggs (2008) suggested that those with insufficient physical ability to meet job demands may be at increased risk of injury when placed on a job. The findings of the current study did not support this concept because the low-back functional performance score of the cases was on average 0.69 (0.19) at baseline, suggesting a healthy low-back functional performance score initially. One explanation for these differences is that Anderson and Briggs examined strength and energy expenditures demands rather than direct measure of low-back function. In addition, Anderson and Briggs examined workers compensation claims in warehousing and not just back injuries. Thus, there were considerable differences in the measures evaluated between the two studies.

The practical implications of this study suggest that risk of low-back disorder in these environments may be significantly greater than observed from the survivor with follow-up data alone. Future research efforts might consider employee turnover occurrences as an additional measure of low-back pain cases.

One limitation of this study was the short follow-up time. However, given the high number of turnover employees, which has been shown to characteristic of this industry, it would be impractical to include longer follow-up periods. A second limitation of the study was not having the follow-up health effects on the turnover employees.

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Key Points

- Job exposure measures were significantly greater for turnover employees compared to those who remained on the job and did not have a clinically meaningful decline in low-back functional performance (noncases).
- Job exposure measures were not significantly different between turnover employees and those who remained on the job and had a clinically meaningful decline in low-back functional performance (cases).
- In jobs with employee turnover issues the physical demands of the job should be considered.
- It appears that employees leave jobs that may lead to a decline in low-back functional performance, which may result in an underestimate of low-back incidence rates.

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