Evaluating Different Measures of Low Back Pain Among U.S. Manual Materials Handling Workers: Comparisons of Demographic, Psychosocial, and Job Physical Exposure

Ruoliang Tang, Sichuan University-Pittsburgh Institute, Chengdu, China, and University of Wisconsin-Milwaukee, USA, **Jay M. Kapellusch**, University of Wisconsin-Milwaukee, USA, **Kurt T. Hegmann**, **Matthew S. Thiese**, University of Utah, Salt Lake City, USA, **Inga Wang**, University of Wisconsin-Milwaukee, USA, and **Andrew S. Merryweather**, University of Utah, Salt Lake City, USA

Objective: To examine differences in demographic, psychosocial, and job physical exposure risk factors between multiple low back pain (LBP) outcomes in a prospective cohort of industrial workers.

Background: LBP remains a leading cause of lost industrial productivity. Different case definitions involving pain (general LBP), medication use (M-LBP), seeking healthcare (H-LBP), and lost time (L-LBP) are often used to study LBP outcomes. However, the relationship between these outcomes remains unclear.

Method: Demographic, health status, psychosocial, and job physical exposure risk factors were quantified for 635 incident-eligible industrial workers. Incident cases of LBP outcomes and pain symptoms were quantified and compared across the four outcomes.

Results: Differences in age, gender, medical history, and LBP history were found between the four outcomes. Most incident-eligible workers (67%) suffered an LBP outcome during follow-up. Cases decreased from 420 for LBP (25.4 cases/100 person-years) to 303 for M-LBP (22.0 cases/100 person-years), to 151 for H-LBP (15.6 cases/100 person-years), and finally to 56 for L-LBP (8.7 cases/100 person-years). Conversely, pain intensity and duration increased from LBP to H-LBP. However, pain duration was relatively lower for L-LBP than for H-LBP.

Conclusion: Patterns of cases, pain intensity, and pain duration suggest the influence of the four outcomes. However, few differences in apparent risk factors were observed between the outcomes. Further research is needed to establish consistent case definitions.

Application: Knowledge of patterns between different LBP outcomes can improve interpretation of research and guide future research and intervention studies in industry.

Keywords: musculoskeletal disorders, low back pain, epidemiology, prevalence and incidence, manual materials handling

Address correspondence to Ruoliang Tang, Sichuan University-Pittsburgh Institute, Chengdu 610065, China; e-mail: tangr.cn@outlook.com

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INTRODUCTION

Low back pain (LBP) remains a leading cause of lost industrial productivity (Crow & Willis, 2009; Dagenais et al., 2008; Feuerstein et al., 2001; Katz, 2006; NIOSH, 1997) and a primary reason for early retirement and disability pensions (Andersson, 1981; Kim et al., 2005). In the United States (U.S.), industrial workers continue to experience high incidence of LBP (Bureau of Labor Statistics, 2015) and report LBP as the most frequent reason for days away from work (Courtney & Webster, 1999). According to the California Commission on Health and Safety and Workers' Compensation (CHSWC), the average cost of back-related injuries increased from 2000 to 2010 (CHSWC, 2011) and stabilized at around $53,500 over the past decade (CHSWC, 2018).

It is important for the industry to establish successful workplace ergonomic interventions to control work-related LBP (Nelson & Hughes, 2009). In literature, LBP is most commonly defined as a binary outcome (i.e., present or absent; Ozguler et al., 2000; Thiese et al., 2014); however, negative low back health outcomes, such as LBP symptoms, LBP-related lost time, and disability can also be used as surveillance measures to evaluate the efficacy of ergonomic interventions (Courtney & Webster, 1999). A challenge with selecting an LBP outcome for research and/or intervention is that risk factors associated with LBP may vary depending on the corresponding outcome measures used (Ozguler et al., 2000; Vasseljen et al., 2013). Therefore, it may be necessary and helpful to include additional outcome measures, for example, medication use (Kapellusch et al., 2014), healthcare visit (Garg, Kapellusch, et al., 2014), and lost time (Feuerstein et al., 2001; Hoogendoorn et al., 2002), since together these measures may represent a hierarchy of cascading events corresponding to a progression of LBP severity (Ferguson et al., 2019). However, what appears to suggest an increase in LBP severity might simply be conflated with treatments in accordance with the LBP management strategy developed by medical professionals or a circumstance of company policies or culture. For example, the American College of Physicians (ACP) and the American Pain Society (APS) recommend the use of medication, such as over-the-counter (OTC) pain reliever (e.g., acetaminophen) and nonsteroidal anti-inflammatory drugs (NSAIDs), as a first-line intervention to improve or resolve nonspecific LBP (Bannwarth et al., 2012; Chou et al., 2007; Falope & Appel, 2015; Hart et al., 1995); and approximately 70% of patients in primary care reported medication use for LBP as recommended by their physicians in the United States (Cherkin et al., 1998; Ivanova et al., 2011). However, most prior comparisons of LBP measures have been conducted in clinical settings (Norton et al., 2016; Taylor-Stokes et al., 2011; Wilkie et al., 2015) and using cross-sectional study designs (Ferguson et al., 2019; Ozguler et al., 2000). In addition, there is a lack of studies examining and comparing pain symptoms, demographics, job physical exposure, and psychosocial factors, based on LBP measures, prospectively in a large occupational population in the United States.

This report uses data from a large, prospective cohort of manual materials handling (MMH) workers: (1) to examine the potential influence of four outcome measures on the estimates of LBP incidence in workplace, including: (a) LBP symptoms, (b) medication use for LBP, (c) healthcare visit for LBP, and (d) lost time due to LBP; and (2) to determine if (a) worker demographics, (b) LBP characteristics, (c) crude job physical exposure, and/or (d) simple psychosocial factors are associated with differences in incident cases between the four LBP incident-case groups.

METHOD

The "BackWorks" study was a National Institute for Occupational Safety and Health (NIOSH) funded prospective cohort study with initial aims to identify MMH risk factors for LBP among industrial working populations. Detailed descriptions of the BackWorks study cohort and data collection methods have been published elsewhere (Garg et al., 2013). A brief description of these methods is provided below. Workers were recruited from 30 employers with 28 diverse production facilities located in the states of Illinois, Texas, Utah, and Wisconsin. These workers performed mainly MMH jobs from a variety of manufacturing worksites, for example, high physical demand jobs included palletizing and low physical demand jobs including assembly. Recruitment meetings were held to explain the study and attract potential workers to participate. Employers paid workers regular wages, and respondents were not given additional incentives for participation. A total of 871 workers provided written, informed consent to participate in the study. The overall participation rate is unclear, although it is believed to be more than 50% of the total available workers. The BackWorks study was approved by the Institutional Review Board of the University of Wisconsin-Milwaukee (#04-02-049).

Participating workers were asked to complete a questionnaire and a structured interview, administrated by the Health Outcomes Assessment Team (Garg et al., 2013), to provide information on: (1) demographics (e.g., age, sex/gender), (2) cigarette usage, (3) medical history of LBP, (4) history of other medical conditions (i.e., diabetes mellitus, high blood pressure, high cholesterol, thyroid problem, gout, rheumatoid arthritis, and osteoarthritis), (5) workplace social support measured by a modified APGAR scale (Bigos et al., 1991), and (6) perceived depression measured by a modified Zung scale (Zung, 1965). Each worker's height and weight were measured and used to calculated body mass index (BMI).

Low Back Health Outcomes

At baseline, a dichotomous response (yes/no) to the question "In the past 12 months, have you had low back pain every day for a week (7 days) or more?" was used to determine an individual worker's eligibility to become an incident case (i.e., Yes: Negative Baseline Group; No: Incident-Eligible Group). Workers who reported that they had past spinal surgeries (e.g., fusion, laminectomy, and laminotomy), history of sciatica, or were diagnosed with sciatica at baseline were excluded from subsequent analyses. In addition, those workers who reported that their LBP episode was due to an accident (e.g., fall and automobile accident) were also excluded from subsequent analyses. Throughout the study, LBP intensity (I) was measured using an 11-point rating system with verbal anchors: *no pain*, for a pain rating of 0; and *worst pain imaginable*, for a rating of 10. Duration of LBP (D) was entered in days. The cohort was followed monthly with on-site interviews to determine: (1) new LBP symptoms, (2) changes in current LBP, (3) medication use for LBP, (4) healthcare visit(s) for LBP, and (5) LBP-related lost time (including light and/or modified duty) during the previous month. Workers who were absent were asked to provide information for the time elapsed since their prior on-site interview.

An incident case of LBP (LBP) was defined as an individual worker with self-reported regional pain in the lumbosacral area, of any intensity, and lasting at least 1 day during follow-up. An incident case of medication use for LBP (M-LBP) was defined as self-reported use of medication to treat LBP during follow-up. The questionnaire did not distinguish between OTC and prescription medications, nor did it account for the potential for illegal use of prescription medications. An incident case of healthcare visit for LBP (H-LBP) was defined as self-reported seeking care for LBP treatment, from healthcare provider(s) including physicians and/or nurse, physical therapists and/or occupational therapists (PT/OT), chiropractors and/or massage therapists during follow-up. An incident case of lost time due to LBP (L-LBP) was an individual worker who reported missing work and/or being placed on light and/or modified duty for at least 1 day due to LBP during follow-up. For the purpose of this study, each individual worker's specific low back health status was determined using these four outcome measures, based on the data collected throughout the entire follow-up period. Therefore, a specific worker could contribute an incident case to more than one outcome group. However, workers could only contribute one case per outcome (e.g., even if a worker became pain free and then subsequently redeveloped LBP, he/she could not contribute a second LBP case). It should be noted that this summarization of follow-up data did not consider the temporal relationship associated with the four outcomes. For example, an individual worker could take medication for LBP first (i.e., become an M-LBP case first) and report LBP symptoms (i.e., become an LBP case later) in a later follow-up or never report any LBP symptoms at all (i.e., not an LBP case).

In this study, for each low back health outcome measure, peak pain intensity (I_{peak}) and total days in pain during the entire follow-up period (D_{total}) were calculated and analyzed. Also, for a specific worker, three additional variables were proposed and calculated to investigate overall LBP characteristics for each outcome group, based on all monthly follow-up records indicating the presence of low back health outcome determined by each outcome measure accordingly, including:

(1) the *time-weighted-average pain intensity* (I_{twa}) (Eq. (1))

$$I_{\mathrm{twa}} = \frac{\sum_{j=1}^{n} i_j \times d_j}{\sum_{j=1}^{n} d_j} \tag{1}$$

j is the j^{th} *episode,* i is the *pain intensity of the* j^{th} *episode,* d is the *duration of pain of the* j^{th} *episode, n* is the *total number of episodes during follow-up*

(2) the *average proportion of days in pain* (P_{mean}) (Eq. (2))

$$P_{\mathrm{mean}} = \frac{\sum_{j=1}^{n} \frac{d_j}{t_j}}{n} \tag{2}$$

t is the *follow-up period in days of the* j^{th} *episode*

(3) the *maximum proportion of days in pain* (P_{max}) (Eq. (3))

$$P_{\max} = \max_{j=1}^{n} \frac{d_j}{t_j} \quad (3)$$

I_{twa} reflects the average pain workers experienced throughout the entire follow-up. Because workers commonly experienced multiple episodes of pain that varied in both intensity and duration, a weighted average is used. P_{mean} is the average proportion of days in pain during a month, whereas P_{max} is the maximum proportion of days in pain during a given month across the whole study. When examined with traditional measures of peak pain intensity and total days in pain, these three measures of LBP characteristics provide insight into how workers in the study experienced LBP.

Job Physical Exposure Assessment

Job physical variables were separately and independently collected on-site by trained ergonomists (i.e., Job Exposure Assessment Team) at baseline and, if there was a significant physical exposure change, every 3 months throughout follow-up, using the Revised NIOSH Lifting Equation (RNLE; Waters et al., 1993). More detailed methodology can be found in prior publications (Garg et al., 2013; Tang, Lu, et al., 2018). Since the RNLE lacks the capability to directly evaluate one-handed lifting (Marras & Davis, 1998), an additional multiplier dedicated to "one-handed operation" (O_M = .6) was applied to the original RNLE approach according to the European standard (Ringelberg & Koukoulaki, 2003).

A majority of the workers had multiple tasks throughout the daily work shift (i.e., had job rotation). Thus, "peak exposure" was used to assign job physical exposure at the worker level, as past studies have shown that the peak demands of a job are more predictive of LBP than the average physical demands of a job (Garg, Boda, et al., 2014; Norman et al., 1998). Specifically, peak frequency independent lifting index (pkFILI)—the maximum of subtask FILIs—was used to assign worker exposure at the subtask level. Similarly, peak composite lifting index (pkCLI)—the maximum of composite lifting indexes (CLIs) across multiple tasks—was used to represent an individual worker's job physical exposure at the task level. Using the methodology proposed by Garg and Kapellusch (2016), cumulative lifting index (CULI) was also calculated to estimate an individual worker's job physical exposure for an entire shift (i.e., job level).

Statistical Analyses

Proportion of workers in the Negative Baseline Group was calculated. Based on each low back health outcome measure, the corresponding incident case group was determined. Case definitions necessarily allowed workers to contribute an incident case to multiple outcome groups. Nevertheless, each outcome group was treated as independent of the other groups. Therefore, group-wise comparisons were made based on the data collected from each outcome group. Mean values, standard deviations, medians, ranges, and frequencies were calculated for each outcome group. One-way analysis of variance (ANOVA) or Kruskal–Wallis test was used to examine the differences in continuous variables across the four incident case groups. Specific between-group comparisons were conducted using independent samples *t* tests or Mann–Whitney–Wilcoxon tests, depending on the distributions of data. Categorical variables (i.e., sex/gender, cigarette usage, LBP history, and medical history) were analyzed using χ^2 tests. All data analyses were conducted using R statistical software for Mac OS (R-64 version 3.5.3, The R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was at $p < .05$.

RESULTS

Out of the 871 workers initially enrolled in this study, 44 workers did not complete baseline data collection. One hundred and six workers had at least one episode of LBP lasting a week or more within the preceding year at baseline. Of these 106 workers, seven were excluded from becoming prevalent cases due to an accident precipitating the LBP episodes (i.e., Negative Baseline Group = 99). Out of the remaining 721 workers, 56 workers were immediately lost to follow-up, primarily due to unforeseen plant closings or layoffs. In addition, during the follow-up period, 30 workers reported accident-related LBP. Therefore, the final LBP Incident-Eligible Group for this study included 635 workers. The Incident-Eligible Group was followed for a median of 22.5 months (average = 31.6 ± 26.4, range = 0.1–93.6 months). During the follow-up period, study participation decreased, primarily due to plant closings and layoffs and also from retirements and employer changes. No workers withdrew or were dismissed from the study.

Negative Baseline Group Versus Incident-Eligible Group

Descriptive statistics regarding the Negative Baseline Group and Incident-Eligible Group are provided in Table 1. While both groups were mostly male (>60%, p = .325), the Negative Baseline Group was older (p < .001) and felt more depressed (p = .030). In addition, Negative

TABLE 1: Comparisons Between Negative Baseline Group and Incident-Eligible Group

	Negative Baseline (n = 99)	Incident-Eligible (n = 635)	p Value[c]
	Mean ± SD or % (Median, Range)		
Demographic			
Age (years)	43.2 ± 11.4	38.1 ± 11.9	**<.001**
	(44.4, 22.0–62.7)	(36.7, 18.3–69.0)	
Gender			
Male	68.7%	63.0%	.325
Female	31.3%	37.0%	
Height (cm)	168.4 ± 10.1	169.0 ± 10.4	.567
	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)	
Weight (kg)	83.4 ± 20.4	83.9 ± 21.7	.732
	(80.3, 44.0–153.3)	(81.4, 43.1–247.7)	
BMI (kg/m^2)	29.2 ± 5.3	29.3 ± 6.5	.848
	(28.1, 18.3–43.6)	(28.3, 15.8–85.5)	
Smoking			
Current	29.3%	20.0%	**.022**
Past	27.3%	22.2%	
Never	43.4%	57.8%	
Medical history			
Yes	49.5%	34.8%	**.007**
LBP history			
Yes	81.8%	40.2%	**<.001**
Psychosocial factors			
Social support [a]	4.3 ± 3.3	4.3 ± 3.3	.940
	(4.0, 0.0–13.0)	(4.0, 0.0–13.0)	
Depression [b]	7.2 ± 3.9	6.2 ± 3.9	**.030**
	(7.0, 0.0–16.0)	(6.0, 0.0–19.0)	

Note. BMI = body mass index; LBP = low back pain.
[a] Higher numbers imply decreased social support from coworkers.
[b] Higher numbers imply increased feelings of depression.
[c] Bold indicates statistically significant results.

Baseline Group had more past or current smokers ($p = .022$), history of LBP ($p < .001$), and other medical conditions ($p = .007$). No difference was found in either height, weight, BMI, or perceived workplace social support ($p > .05$).

Comparison of Workers With and Without Low Back Health Outcomes

During the approximately 8 years of follow-up, about 30% of the cohort ($n = 208$) reported no low back health outcomes. Of the 427 workers who reported some low back outcomes, 98% ($n = 420$) reported LBP symptoms (LBP cases), 71% ($n = 303$) reported medication use for LBP (M-LBP cases), 35% ($n = 151$) reported healthcare visit for LBP (H-LBP cases), and 13% ($n = 56$) reported lost time due to LBP (L-LBP cases), resulting in incident rates of 25.4 cases, 22.0 cases, 15.6 cases, and 8.7 cases per 100 person-years for each outcome, respectively. Results from the comparisons between workers with and without negative low back health outcomes are presented in Table 2. In addition, results from the comparisons across the four incident case groups are also presented in Table 2.

Figure 1 illustrates the detailed breakdown of all incident cases. Each line style (i.e., arrow and dashes) corresponds to a specific outcome group. Multiple arrows indicate the number of workers contributing to multiple case groups. For example, out of the 427 workers who developed LBP outcomes, seven workers reported medication use for LBP (M-LBP case) and never reported LBP symptoms. Out of these seven workers, two workers also reported seeking care for LBP (H-LBP case), while the other five reported no additional action. In another example, out of the 427 workers who developed LBP outcomes, 420 reported LBP symptoms (LBP case). Out of these workers, 296 reported medication use for LBP (M-LBP case), while the other 124 did not report any medication use. However, among these 124 workers, three reported lost time due to LBP (L-LBP cases) and seven reported seeking care for LBP (H-LBP case), while the other 114 workers reported no additional action (i.e., remained as LBP). In addition, only 9% of the cases (i.e., 40/427) reported all four LBP outcomes. As illustrated in Figure 1, workers with LBP outcomes did not necessarily follow the logic order (i.e., from LBP ⇒ M-LBP ⇒ H-LBP ⇒ L-LBP), when contributing to multiple case groups.

According to each outcome measure, workers in LBP group had an average of 7.9 monthly follow-up records of reported pain symptoms (7.9 ± 10.2, range: 1–79), as compared to those in M-LBP group (4.9 ± 7.7, range: 1–51), H-LBP group (3.3 ± 4.5, range: 1–27), and L-LBP group (1.3 ± 0.7, range: 1–5).

Information regarding the annual incident rate for each of the years of follow-up based on each outcome measure is presented in Tables 3 and 4. At the end of year 1 (i.e., Yr 1), out of the 208 overall non-cases, 63 workers did not have a follow-up period greater than 1 year, and therefore were determined lost during the first year (i.e., Lost). On the other hand, all 420 overall LBP cases had a follow-up period greater than 1 year. However, out of these LBP cases, 70 workers did not report their first symptoms yet (i.e., Not yet within Case Group). The annual incident rate (IR) of LBP for Yr 1 was calculated by first adding all available workers (i.e., 208 – 63 = 145 from the non-cases group plus 420 from LBP case group; 565 in total) and then dividing the total number of workers by the number of LBP cases reported in Yr 1 (i.e., [420 – 70] / 565 = 61.9%). At the end of Yr 2, out of the 145 remaining non-cases from Yr 1, 70 workers did not have a follow-up period greater than 2 years (i.e., Lost; 75 remaining as None). Out of the 420 overall LBP cases, 161 workers did not have a follow-up period greater than 2 years (i.e., Lost) and 20 workers did not report their first symptoms yet (i.e., Not yet). Therefore, the IR of LBP for Yr 2 was calculated as 71.6% (i.e., [420 – 161 – 20] / [565 – 70 – 161] = 71.6%). It should be noted that the annual IR for a given year was derived from the follow-up records during the specific time window and did not take input from the previous years. For example, an individual worker, who was a case for LBP during Yr 1, did not report any LBP symptoms during Yr 2, and was therefore determined as non-cases for Yr 2. Similarly, an individual worker who had follow-up records over 6 years, might contribute LBP cases to Yr 2, Yr 4, Yr 6 and remain non-cases for Yr 1, Yr 3, and Yr 5.

Compared with the workers without negative low back outcomes, only H-LBP cases were found significantly older ($p = .003$) with M-LBP cases

TABLE 2: Comparisons Between Non-Cases and Cases, and Across Four Incident Case Groups

	Non-Cases (*n* = 208)	LBP Outcomes (*n* = 427)	LBP (*n* = 420)	M-LBP (*n* = 303)	H-LBP (*n* = 151)	L-LBP (*n* = 56)	LBP vs. M-LBP	LBP vs. H-LBP	LBP vs. L-LBP	M-LBP vs. H-LBP	M-LBP vs. L-LBP	H-LBP vs. L-LBP
			Mean ± *SD* or % (Median, Range)									
Demographic												
Age (years)	37.5 ± 11.6	38.4 ± 12.0	38.3 ± 12.1	39.4 ± 12.0	***41.4 ± 12.2***	39.0 ± 12.3		.008				
	(36.4, 18.8–60.8)	(37.5, 18.3–69.0)	(37.4, 18.3–69.0)	(38.8, 18.3–61.9)	***(42.3, 18.3–61.9)***	(36.4, 18.3–60.9)						
Gender												
Male	66.8%	61.1%	61.4%	59.4%	***55.0%***	67.9%						
Female	33.2%	38.9%	38.6%	40.6%	***45.0%***	32.1%						
Height (cm)	169.3 ± 10.0	168.9 ± 10.7	168.9 ± 10.6	168.9 ± 10.6	168.8 ± 11.3	171.9 ± 11.1			.061		.066	.076
	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)	(170.2, 147.3–195.6)						
Weight (kg)	85.0 ± 20.8	83.4 ± 22.1	83.5 ± 22.1	84.7 ± 22.3	84.7 ± 20.9	86.7 ± 19.6						
	(83.0, 49.9–160.0)	(80.7, 43.1–247.7)	(80.7, 43.1–247.7)	(82.1, 43.5–247.7)	(80.7, 45.4–169.6)	(84.1, 49.4–132.9)						
BMI (kg/m^2)	29.6 ± 6.2	29.1 ± 6.7	29.1 ± 6.7	29.6 ± 6.9	29.6 ± 6.0	29.2 ± 5.5						
	(29.1, 15.8–50.5)	(28.0, 17.7–85.5)	(27.9, 17.7–85.5)	(28.5, 17.7–85.5)	(28.5, 17.7–53.7)	(28.7, 19.9–42.7)						
Smoking												
Current	18.8%	20.6%	21.0%	19.5%	16.6%	26.8%						
Past	22.1%	22.2%	22.1%	23.8%	25.8%	19.6%						
Never	59.1%	57.1%	56.9%	56.8%	57.6%	53.6%						
Medical history												
Yes	29.3%	*37.5%* [a]	*36.9%*	***42.6%***	***45.0%***	37.5%		.097				
LBP history												
Yes	18.8%	***50.6%*** [b]	***51.0%***	***55.1%***	***60.3%***	***60.7%***		.061				
Psychosocial factors												
Social support [c]	3.8 ± 3.3	***4.6 ± 3.3***	***4.6 ± 3.3***	***4.7 ± 3.4***	*4.3 ± 3.3*	***5.2 ± 3.3***						.097
	(4.0, 0.0–13.0)	***(4.0, 0.0–13.0)***	***(4.0, 0.0–13.0)***	***(5.0, 0.0–13.0)***	*(4.0, 0.0–11.0)*	***(5.5, 0.0–11.0)***						
Depression [d]	5.8 ± 3.9	***6.5 ± 3.9***	***6.5 ± 3.9***	*6.5 ± 3.9*	5.9 ± 3.9	6.3 ± 3.8						
	(5.0, 0.0–17.0)	***(6.0, 0.0–19.0)***	***(6.0, 0.0–19.0)***	*(6.0, 0.0–19.0)*	(5.0, 0.0–19.0)	(6.0, 1.0–15.0)						

(Continued)

TABLE 2 (Continued)

	Non-Cases (n = 208)	LBP Outcomes (n = 427)	LBP (n = 420)	M-LBP (n = 303)	H-LBP (n = 151)	L-LBP (n = 56)	LBP vs. M-LBP	LBP vs. H-LBP	LBP vs. L-LBP	M-LBP vs. H-LBP	M-LBP vs. L-LBP	H-LBP vs. L-LBP
Job physical exposure												
CULI	3.4 ± 2.4	3.1 ± 1.9	3.1 ± 1.9	3.0 ± 1.9	3.1 ± 1.8	3.0 ± 1.7						
	(2.9, 0.2–16.8)	(2.8, 0.2–14.1)	(2.8, 0.2–14.1)	(2.8, 0.2–14.1)	(2.8, 0.5–14.1)	(2.8, 0.5–8.3)						
pkCLI	3.2 ± 2.3	3.0 ± 1.9	3.0 ± 1.9	2.9 ± 1.9	2.9 ± 1.8	2.9 ± 1.7						
	(2.8, 0.2–13.0)	(2.6, 0.2–13.7)	(2.6, 0.2–13.7)	(2.6, 0.2–13.7)	(2.7, 0.5–13.7)	(2.7, 0.5–8.3)						
pkFILI	2.2 ± 1.3	2.2 ± 1.1	2.2 ± 1.1	2.1 ± 1.1	2.2 ± 1.0	2.2 ± 1.1						
	(2.0, 0.1–7.6)	(1.9, 0.1–5.2)	(2.0, 0.1–5.2)	(2.0, 0.1–5.2)	(2.0, 0.4–4.8)	(2.0, 0.4–4.8)						
Pain characteristics												
$Intensity_{peak}$	-	-	6.0 ± 2.1	6.4 ± 2.0	7.0 ± 2.1	8.0 ± 1.8	.008	<.001	<.001	.005	<.001	.001
			(6.0, 1.0–10.0)	(6.0, 1.0–10.0)	(7.0, 1.0–10.0)	(8.0, 4.0–10.0)						
$Intensity_{time-weighted-average}$	-	-	4.5 ± 1.6	4.7 ± 1.6	4.7 ± 1.6	5.3 ± 1.7			.001		.004	.020
			(4.5, 1.0–10.0)	(4.6, 1.0–10.0)	(4.6, 1.0–10.0)	(5.3, 2.2–10.0)						
Total days in pain	-	-	186.7 ± 309.7	229.5 ± 354.2	302.4 ± 385.7	229.7 ± 317.8	.031	<.001	.046	.001		
			(76.8, 1.0–2689.5)	(108.8, 1.0–2689.5)	(182.3, 2.0–2539.0)	(123.8, 4.0–1799.3)						
Average % of days in pain	-	-	46.3 ± 27.4	47.9 ± 26.3	55.3 ± 24.3	46.7 ± 24.6		<.001		.004		.038
			(43.4, 0.9–100.0)	(25.0, 0.9–100.0)	(53.0, 8.1–100.0)	(47.5, 8.1–100.0)						
Max % of days in pain	-	-	63.1 ± 34.7	67.8 ± 33.8	81.2 ± 28.3	72.0 ± 33.5	.061	<.001	.073	<.001		.093
			(75.0, 0.9–100.0)	(75.0, 0.9–100.0)	(100.0, 8.1–100.0)	(100, 8.1–100.0)						

Note. BMI = body mass index; CULI = cumulative lifting index; LBP = low back pain; pkCLI = peak composite lifting index; pkFILI = peak frequency independent lifting index.
[a] *Italic font* indicates that .05 < p ≤ .10 when comparing to non-cases group.
[b] Bold and italic font indicates p < .05 when comparing to non-cases group.
[c] Higher numbers imply decreased social support from coworkers.
[d] Higher numbers imply increased feelings of depression.

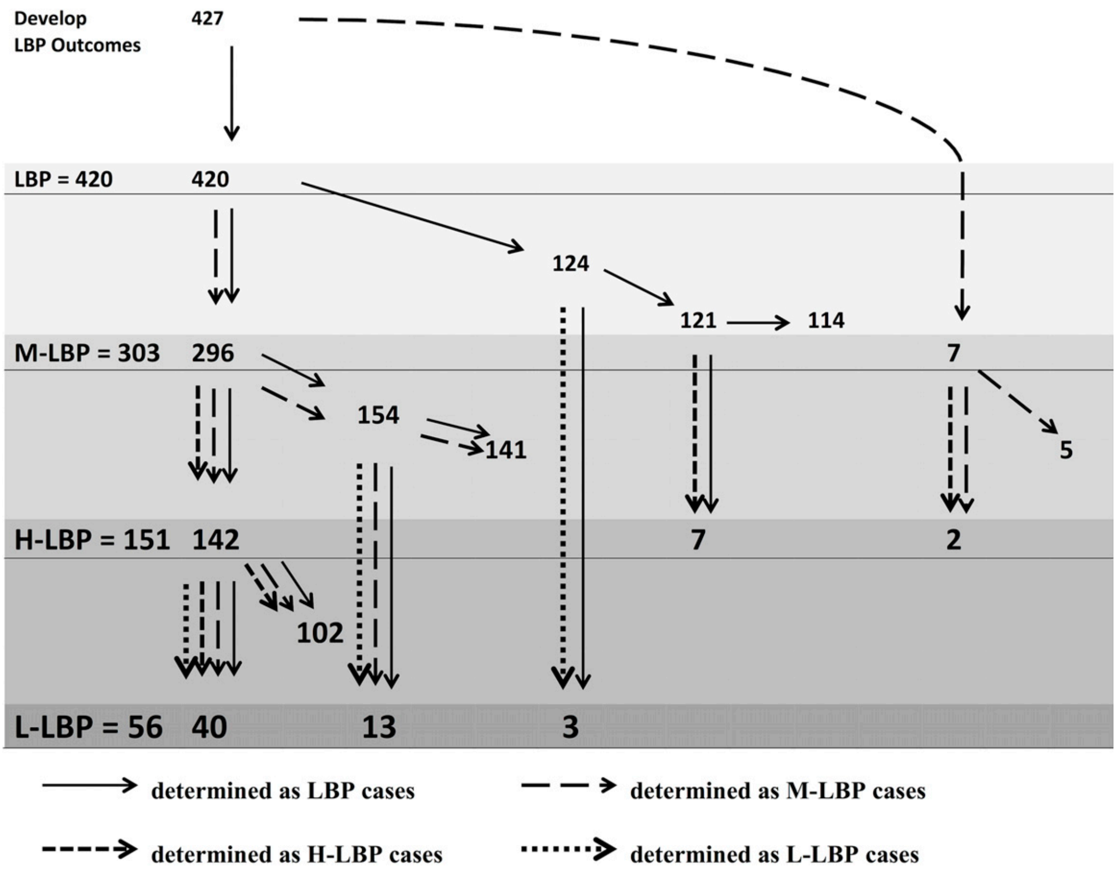

Figure 1. Detailed breakdown of four incident case groups. LBP = low back pain.

approaching the significance level ($p = .080$). The only difference in gender was also found among H-LBP cases ($p = .030$). No difference was found in height, weight, BMI, or cigarette usage ($p > .05$). Regardless of the low back health outcome measures used, workers with LBP outcomes were more likely to have a history of LBP ($p < .001$). Similarly, the differences in the likelihood of having a history of other medical conditions were also significant among M-LBP ($p = .003$) and H-LBP cases ($p = .003$) or approaching the significance level among LBP cases ($p = .073$), with the exception of L-LBP cases ($p = .312$). In terms of psychosocial factors, workers with LBP outcomes perceived less workplace social support ($p = .05$; for H-LBP, $p = .084$). LBP cases also felt more depressed ($p = .040$), followed by M-LBP cases ($p = .062$), with the exception of H-LBP ($p = .832$) and L-LBP cases ($p = .400$). With respect to job physical exposure, no difference was found at either subtask, task, or job level, regardless of outcome measures used.

Comparison of Low Back Health Outcomes Based on Four Outcome Measures

Comparisons across incident case groups corresponding to the four outcome measures revealed no significant difference in gender, weight, BMI, cigarette usage, depression level, or job physical exposure ($p >.05$). The only difference in age was found between LBP cases and H-LBP cases ($p = .008$; Figure 2). L-LBP cases seem to be taller than the LBP ($p = .061$), M-LBP ($p = .066$), and H-LBP cases ($p = .076$). The influence of the history of LBP and other medical conditions approached significance when comparing to the LBP and the H-LBP cases ($p = .061$ and $p = .097$,

TABLE 3: Annual Incident Rate for Each of the Years of Follow-Up Based on Each Outcome Measure

			Yr 1[b]			Yr 2[c]			Yr 3			Yr 4		
		Overall[a]			IR			IR			IR			IR
LBP			Lost			Lost			Lost			Lost		
			63	None		70	None		38	None		11	None	
	None	208		145			75			37			26	
	Case Group	420		Not yet			Not yet			Not yet			Not yet	
				70			20			11			4	
				Case			Case			Case			Case	
				350	61.9		239	71.6		95	66.4		63	67.7
			Lost			Lost			Lost			Lost		
			0			161			153			39		
	All	628		565			334			143			93	
M-LBP			Lost			Lost			Lost			Lost		
			63	None		70	None		38	None		11	None	
	None	208		145			75			37			26	
	Case Group	303		Not yet			Not yet			Not yet			Not yet	
				93			24			15			7	
				Case			Case			Case			Case	
				210	46.9		160	61.8		66	55.9		48	59.3
			Lost			Lost			Lost			Lost		
			0			119			103			26		
	All	511		448			259			118			81	

(Continued)

TABLE 3 (Continued)

			Yr 1[b]			Yr 2[c]			Yr 3			Yr 4		
		Overall[a]			IR			IR			IR			IR
H-LBP			Lost			Lost			Lost			Lost		
			63	None		70	None		38	None		11	None	
	None	208		145			75			37			26	
	Case Group	151		Not yet			Not yet			Not yet			Not yet	
				63			25			17			10	
				Case			Case			Case			Case	
				88	29.7		70	41.2		32	37.2		25	41.0
			Lost			Lost			Lost			Lost		
			0			56			46			14		
	All	359		296			170			86			61	
L-LBP			Lost			Lost			Lost			Lost		
			63	None		70	None		38	None		11	None	
	None	208		145			75			37			26	
	Case Group	56		Not yet			Not yet			Not yet			Not yet	
				32			14			6			1	
				Case			Case			Case			Case	
				24	11.9		21	19.1		8	15.7		7	20.6
			Lost			Lost			Lost			Lost		
			0			21			21			6		
	All	264		201			110			51			34	

[a] Overall: Specific case status was determined by the aggregated records over the entire follow-up period.
[b] Yr 1 IR for LBP was calculated by (420 – 70) / ([208 – 63] + [420 – 0]) = 61.9%.
[c] Yr 2 IR for LBP was calculated by (420 – 161 – 20) / (565 – 70 – 161) = 71.6%.

TABLE 4: Annual Incident Rate for Each of the Years of Follow-Up Based on Each Outcome Measure

			Yr 5			Yr 6			Yr 7			Yr 8		
		Overall[a]			IR			IR			IR			IR
LBP			Lost			Lost			Lost			Lost		
				12 None			1 None			3 None			10 None	
	None	208		14			13			10			0	
	Case Group	420		Not yet			Not yet			Not yet			Not yet	
				4			1			0			0	
				Case			Case			Case			Case	
				47	72.3		30	68.2		20	66.7		19	100
			Lost			Lost			Lost			Lost		
			16			20			11			1		
	All	628		65			44			30			19	
M-LBP			Lost			Lost			Lost			Lost		
				12 None			1 None			3 None			10 None	
	None	208		14			13			10			0	
	Case Group	303		Not yet			Not yet			Not yet			Not yet	
				5			1			0			0	
				Case			Case			Case			Case	
				30	61.2		25	64.1		20	66.7		14	100
			Lost			Lost			Lost			Lost		
			20			9			6			6		
	All	511		49			39			30			14	

(Continued)

TABLE 4 (Continued)

			Yr 5		Yr 6		Yr 7		Yr 8	
		Overall[a]		IR		IR		IR		IR
H-LBP			Lost		Lost		Lost		Lost	
			12 None		1 None		3 None		10 None	
	None	208	14		13		10		0	
	Case Group	151	Not yet		Not yet		Not yet		Not yet	
			7		3		0		0	
			Case		Case		Case		Case	
			11	34.4	11	40.7	10	50.0	4	100
			Lost		Lost		Lost		Lost	
			17		4		4		6	
	All	359	32		27		20		4	
L-LBP			Lost		Lost		Lost		Lost	
			12 None		1 None		3 None		10 None	
	None	208	14		13		10		0	
	Case Group	56	Not yet		Not yet		Not yet		Not yet	
			1		1		0		0	
			Case		Case		Case		Case	
			0	0.0	0	0.0	2	16.7	0	0.0
			Lost		Lost		Lost		Lost	
			7		0		0		2	
	All	264	15		14		12		0	

[a] Overall: Specific case status was determined by the aggregated records over the entire follow-up period.

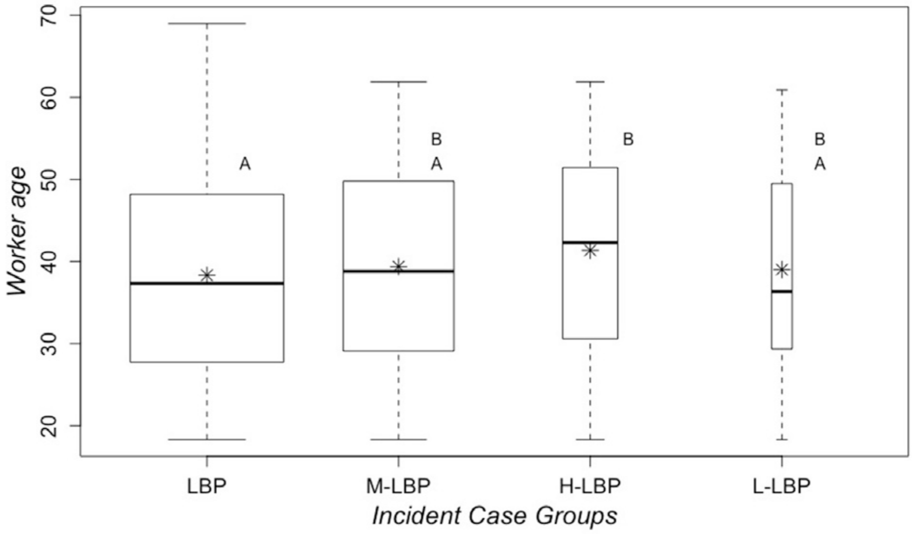

Figure 2. Comparison of worker age across four case groups. The plots with different letters above them are statistically significantly different from one another. * indicates mean. LBP = low back pain.

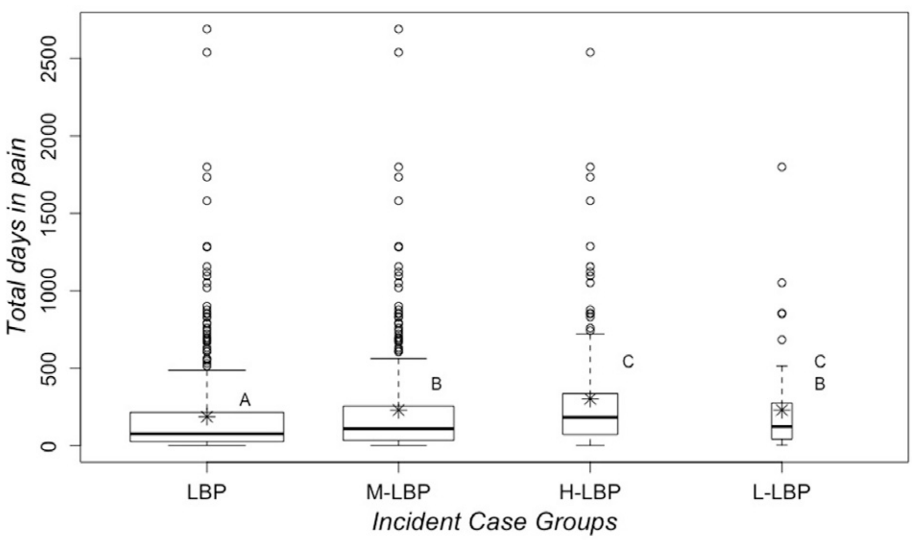

Figure 3. Comparison of peak pain intensity across four case groups. The plots with different letters above them are statistically significantly different from one another. *indicates mean. LBP = low back pain.

respectively). Similarly, the impact of workplace social support approached significance when comparing to the H-LBP and the L-LBP cases ($p = .097$).

In terms of pain intensity, during the whole course of follow-up, peak pain intensity (i.e., I_{peak}; Figure 3) was significantly different across the four case groups ($p < .05$), where L-LBP

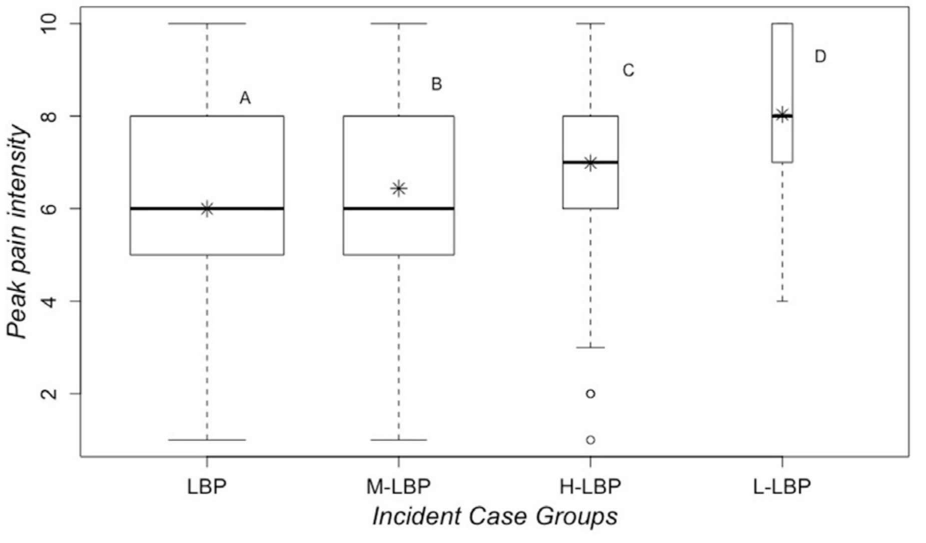

Figure 4. Comparison of time-weighted-average pain intensity across four case groups. The plots with different letters above them are statistically significantly different from one another. * indicates mean. LBP = low back pain.

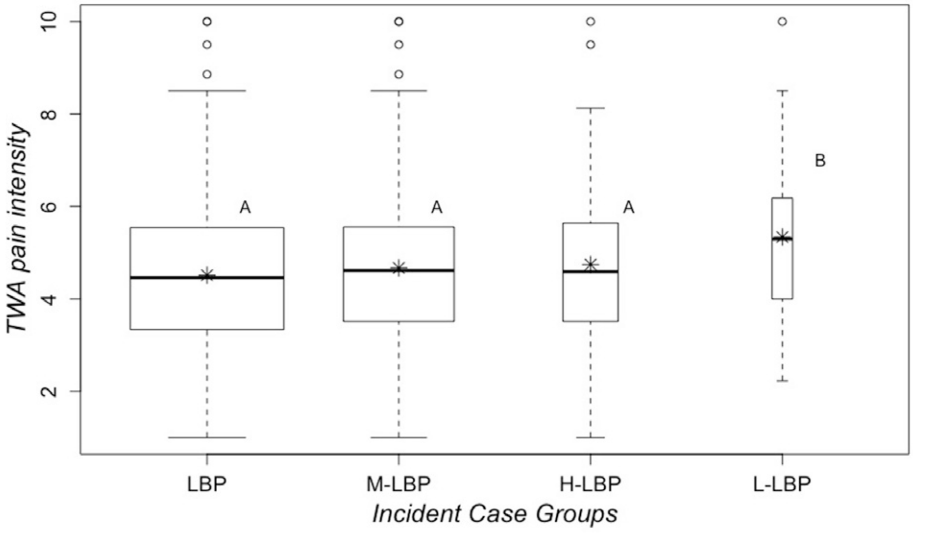

Figure 5. Comparison of total days in pain across four case groups. The plots with different letters above them are statistically significantly different from one another. * indicates mean. LBP = low back pain.

cases reported the highest (median = 8.0), and LBP cases reported the lowest (median = 6.0). As shown in Figure 4, L-LBP cases also reported higher time-weighted-average intensity (i.e., I_{twa}) than the other three groups ($p < .05$), between which the difference was not significant ($p > .05$).

With respect to the total duration of pain (i.e., D_{total}; Figure 5), LBP cases reported the least

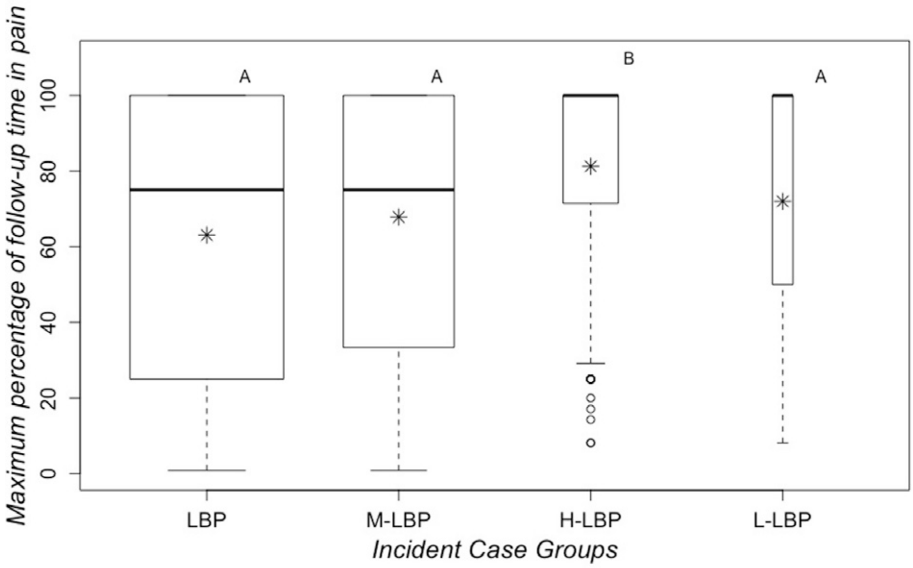

Figure 6. Comparison of mean proportion of follow-up time in pain across four case groups. The plots with different letters above them are statistically significantly different from one another. * indicates mean. LBP = low back pain.

amount of total days in pain, compared with the other case groups ($p < .05$).

In addition, H-LBP cases, on average, spent more time in pain for a given follow-up as measured by the average proportion of days in pain (i.e., P_{mean}; $p < .05$; Figure 6) and the maximum proportion of days in pain (i.e., P_{max}; $p < .001$; approaching significance level when compared to L-LBP, $p = .093$; Figure 7).

DISCUSSION

This study found material differences in case incident rates as well as differences in worker demographics, medical histories, and psychosocial factors between four LBP outcome measures (LBP, M-LBP, H-LBP, and L-LBP). In addition, consistent with the theory of time progression of low back disorders posed by Ferguson and Marras (1997), the results of these current analyses suggest a progressive worsening of LBP outcomes from simple LBP to H-LBP and ultimately L-LBP.

LBP Surveillance and Relevance of Pain Characteristics

Results of this study suggest that MMH workers are at a high risk of developing LBP, considering that more than two-thirds (67.2%) of the Incident-Eligible Group reported one or more low back health outcomes during follow-up, which was substantially higher than the ones found in a general population (Andersson, 1998; Hart et al., 1995; Kopec et al., 2004), supporting previous reports of higher LBP incidence among occupations with high physical demands (Garg, Boda, et al., 2014; NIOSH, 1997; Xiao et al., 2004). Biomechanical studies have reported that individuals performing heavy manual lifting tasks can generate large mechanical loadings on the spinal motion segments (Freivalds et al., 1984; Tang, Holland, et al., 2018; Wilke et al., 1999), and hence be exposed to an elevated risk of LBP (Guo et al., 1995; Hoogendoorn et al., 1999; Lu et al., 2014; Marras, 2000; NIOSH, 1997; Waters et al., 2011). During follow-up, over 70% of LBP cases reported using medication for LBP,

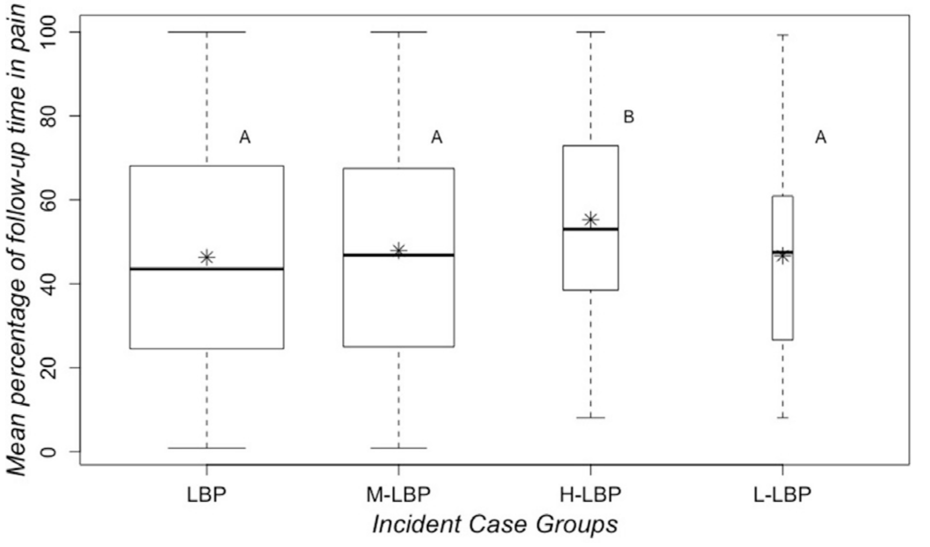

Figure 7. Comparison of maximum proportion of follow-up time in pain across four case groups. The plots with different letters above them are statistically significantly different from one another. * indicates mean; median maximum proportion for H-LBP and L-LBP are 100%. LBP = low back pain.

which is comparable with previous observations among industrial workers and patients with LBP (58% to 80%; Cherkin et al., 1998; Ivanova et al., 2011; Kapellusch et al., 2014) but considerably higher than that observed in a general population suffering from LBP in Norway (≃35%; Vasseljen et al., 2013). This study also found that NSAIDs and OTC pain relievers were the most frequently used types of medications (≃90%) to treat LBP in accordance with prior studies of industrial workers (Kapellusch et al., 2014) and general population (Vasseljen et al., 2013). These findings may reflect the real-world practice pattern of the clinical guidelines for LBP management, regardless of an individual's occupation (Bannwarth et al., 2012; Chou et al., 2007; Falope & Appel, 2015; Hart et al., 1995; Holcomb, 2008).

Consistent with previous estimates (5% to 44%; Carey et al., 1996; IJzelenberg & Burdorf, 2004; Kent & Keating, 2005; Vasseljen et al., 2013; Vingård et al., 2000; Walker et al., 2004; Woodhouse et al., 2016), this study also found that only a small fraction (24%) of workers reported seeking healthcare for their LBP. Physicians (i.e., MD/DO) were the primary source of care (60%), which is comparable to the prior estimates among general population (Côté et al., 2001; Deyo & Tsui-Wu, 1987; Hurwitz & Morgenstern, 1997; Shekelle et al., 1995). However, LBP-related lost time (9%) found in this study was relatively low, as compared with previous estimates (11% to 20%; Hemingway et al., 1997; Hoogendoorn et al., 2002; Rossignol et al., 1993; Smedley et al., 1997). The median duration of time lost (2 days) reported in this cohort was also considerably shorter than the nationwide estimate among private industrial workers in the United States who required a median of 7 days to recuperate from back injuries (Bureau of Labor Statistics, 2015). The inconsistent findings reported in the literature may be explained by discrepancies in methodology used by various studies. For example, the current study included workers primarily from MMH jobs in manufacturing settings and focused on self-reported episodes in the low back region and related to their work (i.e., excluding accident-related episodes), as compared with the U.S. national estimate, which was based on workers from all occupations reporting all injury cases related to the whole back that may include accident-related injuries.

For low back health outcomes, pain intensity is generally believed to be associated with medication use (Taylor-Stokes et al., 2011), healthcare visit (Carey et al., 1996; Côté et al., 2001; de Vet et al., 2002; Garg, Kapellusch, et al., 2014; IJzelenberg & Burdorf, 2004; Walker et al., 2004), and lost time (Reme et al., 2009; Sjöström et al., 2009). However, most previous studies examined these measures individually; therefore, their findings were not cohesive or comprehensive. This may lead to the conflicting reports found in the literature (Kapellusch et al., 2014; Mortimer & Ahlberg, 2003; Ozguler et al., 2000). On the other hand, it is less clear whether LBP duration plays a role in the progression of low back health outcomes with little evidence suggesting that longer duration of LBP episode may be associated with the medication use (Kapellusch et al., 2014). Overall, these discrepancies may be explained by the varying research methodology (e.g., prospective cohort versus cross-sectional design, and occupational population versus community/general population) used by different studies. In this prospective study, results from comprehensive comparisons indicate that, at the end of the follow-up, reported pain intensity increases as incident cases measured from simple LBP to LBP-related lost time (L-LBP), supporting the theory that the four outcome measures represent a series of worsening health outcomes, although the actual increase in pain intensity was relatively small (from 6.0 to 8.0). LBP duration (as measured by total days in pain) increases as incident cases measured from LBP to H-LBP and remained steady for L-LBP cases, which similarly provides some evidence suggesting a potential positive association with the cascading health outcomes. It is evident that L-LBP cases spent more time in severe pain (as measured by the time-weighted-average intensity); however, it remains unclear whether the relatively lower number of total days in pain among L-LBP cases is a result of a proactive LBP management strategy to prevent further disabling LBP by allowing workers to take days off work, or merely a spurious coincidence. This topic should be investigated in future research. In addition, during the approximately 8-year study period, follow-up records indicate that workers with low back health outcomes are likely to experience multiple episodes of pain, and therefore can shift their case status depending on the procedures they took to cope with the pain. This phenomenon may be interesting to ergonomics researchers and professionals in occupational medicine to study the success and efficacy of intervention programs to mediate and, more desirably, prevent low back health conditions. Data and statistical methods with superior capability of handling the temporal/sequential changes in a series of events may be appropriate to statistically study the status shift between multiple outcome measures.

Relevance of Individual Factors and Job Physical Factors

Prior investigations have identified multifactorial risk factors associated with the development of LBP, with many potential etiologies (Manchikanti, 2000). Some researchers have reported that females, overweight/obese individuals, cigarette usage, and individuals with poor health are at an elevated risk of LBP; however, the associations are weak and sometimes inconsistent (Battié et al., 1991; Croft et al., 1999; Frymoyer, 1992; Kopec et al., 2004; Manchikanti, 2000; Rubin, 2007). In the literature, there is a body of evidence suggesting associations between job physical exposure and the development of work-related LBP (Guo et al., 1995; Hoogendoorn et al., 1999; Lu et al., 2014; Marras, 2000; NIOSH, 1997; Punnett et al., 2005; Waters et al., 2011). Nevertheless, systematic reviews have failed to find evidence that simple physical exposure factors such as weight, "material handling," twisting, and so forth are independent risk factors for LBP (Balagué et al., 2012; Roffey et al., 2010a, 2010b). However, recent prospective cohort studies have found positive associations between the RNLE and LBP (Garg, Boda, et al., 2014; Lu et al., 2014; Waters et al., 2011), suggesting that combinations of physical exposure factors pose a genuine risk. In this study, however, there was no difference between the RNLE lifting indexes of workers with and without incidence of LBP outcomes. It should be noted that in the current study, the analyses were based on data aggregated for up to 8 years. Given the high occurrence of LBP in this study (67% effective prevalence of LBP), it is possible that more sophisticated analyses, such as proportional hazards regression, that control for confounding factors such as prior history of LBP would find positive associations within this cohort between the RNLE and one or more LBP outcomes. This study also found no statistically significant difference in height, weight, BMI, or cigarette usage between cases and non-cases using four LBP outcomes. It should be noted that this study cohort was relatively young (mean = 38.1 years), exclusively employed in MMH jobs, and was generally active in physical activities outside of work. Most of the workers never smoked and had no history of medical conditions. Therefore, high BMI reported in this study cohort may possibly reflect greater muscle mass rather than adipose tissue. In addition, some studies have reported the associations between body anthropometry and the geometry of lumbar spine and paraspinal muscles (Gungor et al., 2015a, 2015b, Gungor et al., 2019; Tang et al., 2016, 2019); however, the relationships between anthropometric characteristics and risk of negative low back health outcomes remain unclear (Frymoyer, 1992; Manchikanti, 2000; Rubin, 2007).

Consistent with previous investigations (Garg, Boda, et al., 2014; Hestbaek et al., 2003; Inoue et al., 2015; Papageorgiou et al., 1996), this study found that workers with a history of LBP are more likely to develop future episodes of LBP. It should be noted that, in the literature, there seems to be no consensus definition of LBP history. In this study, LBP history was defined as prior LBP that resulted in workers' compensation claim, lost time/light duty/job change, visit to any healthcare provider, medication use for LBP, and/or LBP radiating to the leg(s). This study also found that, during follow-up, workers who reported negative low back health outcomes likely perceived lower workplace social support (measured by the modified APGAR). However, conflicting findings have been reported in the literature regarding the associations between psychosocial factors and LBP. Although some researchers have found an association between low workplace social support or low job satisfaction and LBP (Hoogendoorn et al., 2000, 2001; Macfarlane et al., 2009; Papageorgiou et al., 1997), others have reported either no association or weak association (Clays et al., 2007; Hartvigsen et al., 2004; Jansen et al., 2004). This inconsistency in past studies may be due to (1) differences in measures of psychosocial and biomechanical stressors used in these studies, and (2) potential confounding from biomechanical stressors from work (Davis & Heaney, 2000). In addition, this study also found a higher level of depression among LBP and M-LBP cases, which is in agreement with prior reports (Currie & Wang, 2004; Jarvik et al., 2005; Leino & Magni, 1993; Patten et al., 2008). It should be noted that this study only evaluated baseline information regarding the psychosocial factors. During follow-up, psychosocial status of workers may change and potentially affect the associations between psychosocial factors and negative low back health outcomes.

Using the same cohort to prospectively study LBP, M-LBP, H-LBP, and L-LBP makes it possible to compare the individual factors and job physical factors for these outcome measures, according to the theoretical progression of worsening events. Results of this study indicate that pain characteristics vary across the incident case groups. Differences in age, height, history of LBP and/or other medical conditions, and perceived workplace social support were also noticed. On the other hand, the current study found no difference in gender, weight, BMI, cigarette usage, or job physical exposure. Current literature provides scant information about whether or how individual factors might lead to differences in these LBP outcomes in industry, and findings that are reported are inconsistent. Some studies suggest that female workers are more likely to use medication for LBP (Kapellusch et al., 2014) and seek care from healthcare professionals (Ozguler et al., 2000). In general population, females are more willing to use medication for health-related issues as compared with males (Obermeyer et al., 2004). However, it is noted that this difference might be more evident when the health issues are mild (Hibbard & Pope, 1986). Some researchers suggested that when it comes to health issues, males, in general, display a greater willingness to seek advice from their peers (e.g., family members, coworkers, friends, etc.), whereas females more heavily rely on advice from healthcare professionals (Obermeyer et al., 2004). Therefore, it remains unclear whether female and male workers cope differently with LBP and subsequently result in different low back health conditions. This should be investigated in the future. In addition, Kapellusch et al. (2014) found no difference in psychosocial factors and job physical exposure between workers who sustained LBP without further actions and M-LBP workers, whereas Ozguler et al. (2000) reported that frequent load carrying tasks were associated with medication use for LBP and healthcare utilization for LBP. Unfortunately, the reasons why workers take medication, seek healthcare, and take days off work were not studied in the current investigation.

Strengths and Limitations

This study's strengths include (1) prospective methods, (2) enrollment of a large number of workers from diverse employers performing different jobs, (3) use of computerized structured interviews, (4) assessments and measurements of various individual factors (e.g., demographics, body anthropometry, psychosocial factors, etc.), (5) quantification of each worker's job physical exposure based on specific biomechanical stressors, (6) blinding of team members, (7) monthly follow-ups of LBP status, (8) quarterly assessments of job physical exposure, and (9) up to 8 years of cohort follow-up. This study was able to examine the differences in a variety of individual factors, psychosocial factors, and job physical factors simultaneously based on the utilization of multiple incidence measures varying from symptom to more specific on the basis of LBP-related medication use, healthcare visit, and lost time, and subsequently compare the characteristics associated with each incident case group.

Limitations of this study include the following. (1) Workers were primarily from manufacturing settings, and thus the results might not be directly applicable in other environments. (2) The overall 72% participation rate among those workers attending the recruitment meetings and estimated >50% rate from all potentially eligible workers could be a source of bias if those who did not participate differed substantially from those who did. (3) Only the RNLE was used to quantify job physical exposures, and thus other aspects of MMH, such as pushing and pulling, were ignored. (4) The scales used to measure psychosocial factors were developed for use in this study and have not been used elsewhere, and only two factors—social support and depression—were assessed, which does not adequately capture the full extent of potential psychosocial risk factors (Bigos et al., 1991; Clays et al., 2007; Davis & Heaney, 2000; Ghaffari et al., 2008; Hoogendoorn et al., 2000; Papageorgiou et al., 1997). (5) Statistical analyses used in this study assume that outcomes are independent; however, many workers contributed cases to multiple groups. Simple groupwise comparisons were used to determine the potential difference in individual factors, job physical factors, and psychosocial factors and examine the impact of using four different incidence measures. Future investigations of LBP and related outcomes should consider using more rigorous and frequent assessments of outcomes so that time-series analyses can be used to explore the inter-relatedness of various LBP outcomes and the quantify risk factors associated with LBP outcomes.

CONCLUSION

Progressively fewer cases are identified as outcome measures progress from LBP to L-LBP. However, it is not clear that these outcomes truly reflect an increase in outcome severity. Few apparent differences were found between outcome groups in this study. Nevertheless, different specific risk factors might be observed for each outcome even within the same cohort of workers. Thus, further research is needed to determine how these outcomes relate to each other in working populations. Similarly, the large differences in case counts and potential for risk factor differences suggests an urgent need for researchers to develop more consistent case definitions for investigating LBP. In the meantime, more specific outcome measures for low back health outcome, such as medication use, healthcare visit, and lost time, are likely less influenced by recall bias than the simple survey of LBP symptoms, and should be used in future investigations of LBP.

ACKNOWLEDGMENTS

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KEY POINTS

- During follow-up, workers with LBP outcomes did not exactly follow the flow from LBP to L-LBP.
- When comparing each incident case group to the non-cases, the difference in LBP history was consistent, compared to inconsistent differences found in gender, age, medical history, and psychosocial factors and no difference found in other factors, including job physical exposure.
- Differences across the four incident case groups were more evident in LBP characteristics than in other factors.
- Progressively fewer incident cases are identified as outcome measures progress from symptoms to lost time.
- The differences in incident case counts suggest that different risk factors will be observed for each outcome even within the same cohort of MMH workers.

ORCID iD

Ruoliang Tang https://orcid.org/0000-0002-5960-7451

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Ruoliang (Rio) Tang is an assistant professor at Sichuan University-Pittsburgh Institute (SCUPI). He received his PhD degree in industrial engineering in 2013 from Auburn University.

Jay M. Kapellusch is an associate professor and chair of the Department of Occupational Science and Technology at the University of Wisconsin-Milwaukee. He received his PhD degree in industrial engineering in 2010 from the University of Wisconsin-Milwaukee.

Kurt T. Hegmann is a professor and director of the Rocky Mountain Center for Occupational and Environmental Health in the Department of Family and Preventive Medicine at the University of Utah. He received his MD degree in 1987 from the Medical College of Wisconsin.

Matthew S. Thiese is an associate professor at the Rocky Mountain Center for Occupational and Environmental Health in the Department of Family and Preventive Medicine at the University of Utah. He received his PhD degree in occupational injury prevention in 2008 from the University of Utah.

Inga Wang is an associate professor in the Department of Occupational Science and Technology at the University of Wisconsin-Milwaukee. She received her PhD degree in rehabilitation science in 2007 from the University of Florida.

Andrew S. Merryweather is an associate professor in the Department of Mechanical Engineering at the University of Utah. He received his PhD degree in mechanical engineering in 2008 from the University of Utah.

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