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Early Imaging for Acute Low Back Pain:

One-Year Health and Disability Outcomes Among Washington State Workers

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Abstract

Study Design.—A population-based, prospective cohort study.

Objective.—To evaluate the association of early imaging and health and disability status 1 year following acute low back injury, among a population-based sample of Washington State workers' compensation claimants.

Summary of Background Data.—Use of early diagnostic magnetic resonance imaging (MRI) for low back pain (LBP) contributes to increasing health care costs but may not lead to better outcomes than delayed imaging. In the worker's compensation system, LBP is common and costly. This research examines the association between early MRI among workers with LBP and health outcomes (pain intensity, Roland disability score, and 36-Item Short Form Health Survey scores) and disability status 1 year after injury.

Methods.—This nonrandomized prospective cohort study of Washington State workers' compensation claimants with nonspecific LBP used administrative claims and interview data.

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Multivariable regression methods were used to estimate change in health outcome scores, the relative risk of disability at 1 year, and the rate of recovery 1 year after injury.

Results.—Of 1226 participants, 18.6% received early MRI. Most (77.9%) had mild/major sprains and 22.1% had radiculopathy. Participants with early MRI differed significantly at baseline in pain, function, and psychosocial variables. After adjusting for covariates, early imaging was not associated with substantial differences in 1-year health outcomes for sprains or radiculopathy. For workers with mild/major sprain, early imaging was associated with a 2-fold increase in the likelihood of work disability benefits at 1 year (adjusted relative risk: 2.03, 95% confidence interval: 1.33–3.11). Early imaging was not associated with an increased risk of long-term disability for workers with radiculopathy (adjusted relative risk: 1.31, 95% confidence interval: 0.84–2.05). For both groups, early MRI was associated with longer disability duration ($P < 0.001$).

Conclusion.—Among workers with LBP, early MRI is not associated with better health outcomes and is associated with increased likelihood of disability and its duration. These associations warrant further testing in a randomized controlled trial. Our findings suggest that adherence to evidence-based guidelines is an important factor in ensuring that workers receive the highest quality care for occupational injuries.

Keywords

low back pain; workers' compensation; diagnostic imaging; early imaging; evidence-based guidelines; MRI; population-based

Because of recent advancements in technology and radiological research, use of advanced diagnostic imaging has been increasing rapidly.[1,2] Among injured workers, the use of complex diagnostic testing nationally rose 57% from 1996 to 2002.[3] It remains unclear whether the use of advanced imaging, such as magnetic resonance imaging (MRI), contributes to better health and disability outcomes in injured workers with low back pain (LBP).

Randomized controlled trials suggest that early imaging for LBP may contribute to increased health care utilization and costs but may not contribute to treatment planning or provide diagnostic information of enough value to justify additional costs.[4] Furthermore, use of early imaging may not be associated with improved outcomes.[5,6] In fact, early imaging may deleteriously affect a patient's emotional and psychological well-being.[7] A "cascade of care" may occur following early imaging, in which conditions not attributable to the LBP (and potentially asymptomatic) may be discovered and unnecessarily treated.

To address the potential over- or misuse of early imaging for LBP, evidence-based guidelines discourage routine imaging in the first 4 to 6 weeks of LBP for patients without signs of neurological impairment or other complications.[8–11] The majority of patients with LBP typically do not bear these indications, which include recent significant trauma, or milder trauma (age older than 50 yr), unexplained weight loss or fever, immunosuppression, history of cancer, intravenous drug use, prolonged use of corticosteroids, osteoporosis, age older than 70 years, or focal neurological deficit with progressive or disabling symptoms.[11–13]

It is prudent to consider the health outcomes associated with early imaging within the workers' compensation population, where LBP is the most prevalent and costly occupational injury.[14–16] Use of MRI is a common and expensive component of LBP claims, so much so that, following a statutory directive by the state legislature, the Washington State Department of Labor & Industries (L&I) recently instituted utilization review processes to address inappropriate use of MRI for LBP.[17]

This research evaluates the association of early imaging on health and disability status 1 year following acute low back injury, independent of baseline characteristics, among a population-based sample of Washington workers' compensation claimants.

MATERIAL AND METHODS

Design

This prospective observational cohort study used administrative claims, medical billing, and survey data to compare health and disability outcomes in injured workers who received an MRI consistent with guidelines (after 6 wk or not at all) and those who received an early MRI (within 6 wk of injury).

Data Source

The Washington workers' compensation program comprises approximately two-thirds of all nonfederal workers in the state. The Washington workers' compensation Disability Risk Identification Study Cohort (D-RISC) study identified workers with new claims for occupational back injuries filed between July 2002 and April 2004. Details of the D-RISC study have been reported elsewhere.[18–20] Participants were restricted to adults (older than 18 yr of age) with an accepted claim, with at least 4 missed workdays due to injury, and no hospitalization following the injury.

Trained interviewers performed computer-assisted telephone interviews at baseline and after 1 year. Baseline interviews were conducted 2 to 3 weeks (median 18 d; range, 10–58 d) after filing a workers' compensation claim. Follow-up interviews were conducted 1 year (median 343 d; range, 332–395 d) after baseline interview. Interviews included questions regarding overall and injury-specific health status, work, and personal characteristics. The University of Washington Institutional Review Board approved this study. All participants provided informed consent and were provided $10 compensation for participation in each interview.

The Washington State L&I provided workers' compensation administrative claims data for D-RISC participants. These data include the date of injury, wage replacement benefits, and job type. D-RISC survey and L&I administrative data were linked with workers' compensation medical bill data, which included provider type, dates, and types of procedures.

Health Measures

The Roland-Morris Disability Questionnaire (RDQ) consists of 24 yes/no items to assess the physical disability due to LBP.[21] The summary score ranges from 0 (no disability) to 24 (severe disability). The RDQ is reported as reliable and responsive to change and is

frequently used to detect short-term changes in back pain and related disability.[21,22] The 36-Item Short Form Health Survey (SF-36v2) is a generic health profile that measures dimensions of health-related quality of life, each scored from 0 (worst) to 100 (best). Raw scores were converted using a norm-based scoring system, which uses a mean of 50 and a standard deviation of 10 in the general US population for each scale (range, 0–100).[23,24] SF-36v2 Role Physical and Physical Function scales have been shown to be predictive of long-term disability among workers in this cohort.[25] Workers' pain intensity was evaluated at each interview, using an adaptation of the pain intensity subscale of the Graded Chronic Pain Scale, which has been shown to be reliable, valid, and appropriate for acute or chronic LBP.[26,27] The score ranges from 0 to 10, with 0 indicating "no pain" and 10 indicating "pain as bad as could be."[28]

Disability Measures

Administrative claims data were used to determine the cumulative number of days each worker received wage replacement benefits and disability status 1 year after claim receipt (on/off disability). A worker was considered to be "on disability" if he or she is receiving benefits for missing work due to work-related low back injury. All follow-up times were right-censored at 365 days, the duration of this study. In addition, workers were asked several detailed questions in follow-up interviews about their work pattern since their injury. If workers were not working at 1 year, they were asked whether the primary reason was their injury.

Covariates

Covariates included in all analyses were selected *a priori*, informed by health services utilization models and the current literature pertaining to LBP disability.[18,29,30] Covariates were ascertained at baseline from D-RISC interviews (sociodemographic, clinical, psychosocial, and employment variables), medical chart reviews (injury type), administrative data (age, previous claims, industry), or medical bills (type of first medical visit).

D-RISC participants provided demographic information in interviews. Body mass index was calculated from self-reported height and weight. Health status (aside from injury) was rated on a Likert scale for both the year before injury and at the time of the injury.

Mental health status was measured using the SF-36v2 and scored on the basis of US population norms.[23,24] Catastrophizing, a psychosocial health measure of coping response, was categorized into 3 levels: low, moderate, and high.[31] Work fear-avoidance was assessed by averaging responses to 2 items from the Fear-Avoidance Beliefs Questionnaire and categorized as very low, low-moderate, high, and very high.[32]

L&I claims data were used to determine whether the worker had a previous compensable back claim. In interviews, workers reported overall job satisfaction and whether their employer offered accommodations for the injury. Employment industry was determined according to the North American Industry Classification System.[33] Physical demands were self-reported as sedentary/light, medium, heavy, or very heavy on the basis of typical work activities.[19]

The type of first medical visit was obtained from the medical bill database. This variable was categorized as primary care, occupational medicine, chiropractor, surgeon, emergency department, or other provider (including specialists and physical medicine). Review of medical records by occupational health nurses provided a clinical categorization of injury type; categories included mild/major sprain, evidence of radiculopathy, or absent reflexes.[34]

Statistical Analysis

Workers who received MRI within 6 weeks of injury were categorized as receiving early imaging. Those who received MRI after 6 weeks or did not receive at all were considered as receiving imaging consistent with guidelines. This cutoff value reflects clinical guidelines, which recommend waiting 6 weeks before imaging.[8–11,35] Because LBP complicated by radiated pain (radiculopathy, sciatica) may be interpreted as a red flag for imaging,[11] analyses were run separately for cases with mild/major sprains and for those with radiculopathy. Analyses were performed using STATA/IC 10.1 for Macintosh (Stata Corp., College Station, TX). Baseline data on workers were reported using descriptive statistics for covariates and outcome measures.

The association between early imaging and health outcome measures (RDQ, pain, or SF-36) was assessed in 2 ways. First, unadjusted differences in scores at 1 year were assessed using *t* tests. Second, adjusted differences were evaluated using multivariable linear regression models that included covariates and baseline values for each outcome of interest (*e.g.*, baseline pain score in the pain model).

The relative risk of receiving wage replacement benefits or not working due to injury was estimated using modified Poisson regression with robust standard errors, comparing workers whose imaging was consistent with guidelines and those who received early imaging.[36] The log-rank test for equality in survival functions and the Wilcoxon (Breslow) test assessed the bivariate relationship between time on disability between imaging groups. Multivariable Cox regression analysis controlled for covariates and baseline pain and RDQ. Hazard ratios (HRs) represent the risk of a shorter time on disability; HRs less than 1 indicates increased disability duration. The proportional hazards assumption was tested and confirmed for all covariates.

RESULTS

Of the 4354 claimants identified by the D-RISC study, 49.3% agreed to participate, 27.1% could not be contacted, 20.9% declined, and 8.8% were ineligible due to language limitations, lacked disability compensation, or were excluded for other reasons (*e.g.*, incomplete records). D-RISC subjects (N = 1885) differed slightly from the nonparticipants in age, sex, receiving compensation at 1 year, and number of days on disability.[19] For this study, 566 workers did not complete follow-up interviews and were not included. Those who did not complete the follow-up interview were younger and included more Hispanic and unmarried workers with lower education and income ($P < 0.01$) than cases who completed the interviews. An additional 41 workers with more than 2 months' time between claim receipt and interview were excluded. To focus on workers with less severe injuries, 45 workers whose medical record review indicated severe injury (absent reflexes, bladder

complaints, or motor abnormalities) and 7 workers who lacked injury severity information were excluded.

Of the final sample of 1226 eligible study participants, 228 (18.6%) received an MRI within 6 weeks of injury. An additional 15.7% (N = 192) of workers received an MRI after 6 weeks of injury. Overall, among those with MRI, imaging was conducted on an average of 65 (SD = 69) days after injury. Among workers with early MRI, 164 (71.9%) received the MRI before the baseline interview. Most workers (77.9%) had injuries that were described as mild/major sprains; 22.1% of workers' medical records indicated evidence of radiculopathy. Significantly more workers with radiculopathy received early imaging compared with workers with mild/major sprains (39% *vs.* 13%, $P < 0.01$). Table 1 describes baseline characteristics of workers by early imaging, stratified by injury category. For both categories of injury, sociodemographic characteristics did not differ by early imaging; workers with early imaging were, however, more likely to have poorer scores for RDQ, pain, and psychosocial characteristics than workers who did not ($P < 0.01$).

Among workers with mild/major sprains, those with early MRI had higher unadjusted RDQ scores (greater impairment) at follow-up compared with workers whose treatment was consistent with guidelines (*t* test, $P < 0.01$) but did not differ significantly in terms of pain (Table 2). Among workers with radiculopathy, those with early imaging showed significantly higher pain and RDQ scores at follow-up (*t* test, $P < 0.05$). For both categories of injury, workers with early imaging had worse unadjusted SF-36 scores than workers whose treatment was consistent with guidelines ($P < 0.01$). After accounting for differences in baseline scores and covariates, however, results showed that early MRI was not associated with significantly different scores for pain or SF-36 measures after 1 year (for both categories of injury) (Table 3). Among workers with mild/major sprains, follow-up RDQ scores were 1.12 points higher for those with early imaging than for those with imaging consistent with guidelines (95% CI: 0.04–2.21, $P = 0.043$). This was the only measure observed to differ significantly at follow-up in the multivariate analysis.

At 1 year, administrative records showed that 14% of all workers were on disability. For workers with mild/major sprains, 31% of workers with early imaging were on disability compared with 7% of those whose treatment was consistent with guidelines (χ^2 test, $P = 0.01$) (Table 2). Among workers with radiculopathy, 40% of those with early imaging were on disability at 1 year compared with 23% among workers with imaging consistent with guidelines (χ^2 test, $P = 0.01$). Similar patterns were observed for self-report of not working because of injury at 1 year (Table 2). Workers with early imaging had significantly more days on disability than those with imaging consistent with the guidelines for categories of injury; as expected, workers with radiculopathy had substantially more days on disability than workers with mild/major sprains (Table 2).

Multivariable results show that among workers with mild/major sprains, those who received early imaging were twice as likely to be receiving disability at 1 year compared with workers with imaging consistent with guidelines (relative risk: 2.03, 95% CI: 1.33–3.11). Similar results were found for self-report of not working because of injury. Among workers

with radiculopathy, early imaging was not associated with either dichotomous disability measure (Table 3).

The log-rank test for equality in survival functions and the Wilcoxon (Breslow) test both showed significant differences in ending disability compensation between those with early imaging and those with imaging consistent with guidelines for both categories of injury (results in the Appendix, Supplemental Digital Content 1, http://links.lww.com/BRS/A684). Multivariable Cox regression showed that those with early MRI experienced a slower rate of ending disability compensation after adjusting for covariates (HR: 0.48, 95% CI: 0.38–0.60 among workers with mild/major sprains; HR: 0.57, 95% CI: 0.40–0.81 among workers with radiculopathy).

DISCUSSION

This analysis used a population-based, prospective design and large sample of Washington State workers with LBP to evaluate the association between early imaging (MRI within 6 wk of injury) and health and disability outcomes 1 year after injury. This study used administrative claims and interview data, which together provide a rich combination of independent and dependent variables for analyses. The availability of self-reported data is a substantial strength of the study, especially because the association between LBP, early imaging, and recovery emerges from a complex interaction between biological factors, pain tolerance, and psychosocial effects, such as catastrophizing and fear avoidance, work expectations, and social support.[37,38] In addition, occupational health research suggests that disability is associated with pain intensity, functional impairment, and psychosocial characteristics.[37,39–41]

Results show that early imaging was not associated with substantial improvements in pain or function, supporting previous research.[6,42] For workers with mild/major sprains, early imaging was associated with slightly higher RDQ scores at follow-up, although this difference is not clinically meaningful.[43,44] This research also supports studies that report an association between early imaging and prolonged work disability.[45,46] It is possible that baseline differences in RDQ, pain, and psychosocial characteristics between imaging groups may contribute to differences in duration of work disability. Although we controlled for baseline factors in the multivariable regression models, it is possible that residual confounding could contribute to observed associations. Symptom severity is associated with duration of recovery,[47,48] which may or may not be independent of the types of treatments and procedures a patient receives. Future research, potentially in the form of a randomized controlled trial, is necessary to evaluate the associations between LBP severity, health care treatments and procedures, and recovery.

We found that the association of early imaging on disability varied by injury category. Among patients with mild/major sprains, early MRI was associated with higher risk of receiving disability compensation and not working at 1 year. This association was not observed among workers with radiculopathy, which may be explained by high rates of disability among all workers with radiculopathy. All workers with early imaging, regardless

of injury category, though, experienced a significantly slower rate of discontinuing work disability than those who did not receive early imaging.

The finding that early imaging impacts disability duration in the absence of substantial impacts on health may be the result of a combination of factors. Routine imaging may have little effect on treatment of LBP,[5,49] but patients with early imaging may experience adverse effects of imaging results, such as an avoidance of exercise or work if results are abnormal, even in the absence of greater pain.[49] Exaggerated perceived symptoms, altered coping response, or other adverse psychological effects of imaging[50,51] may contribute to sensitivity to psychosocial job factors such as schedule flexibility, which are associated with higher rates of disability (independent of injury severity).[52]

This study does have several limitations. First, study subjects were limited to Washington State workers' compensation claimants with nonsevere injuries that resulted in 4 days of compensated lost work time or more. This restriction limits generalizability to the working population with compensable injuries. Second, about 50% of the eligible workers in the D-RISC study completed the baseline interview, and 30% were lost to follow-up after 1 year. This participation and retention rate is an inherent limitation of this study; however, self-reported pain and function data ascertained from interviews provide information that is not available from claims alone. Given limitations in study design and methods, we are not able to know whether early MRI utilization differed between study nonparticipants and participants. Third, other than age, information on patient characteristics that may have indicated appropriate use of early MRI was not available for this study. However, these characteristics are uncommon in the general population and are less likely to be prevalent in a population of workers.[53] Fourth, more than 70% of workers with early MRI completed the baseline interview after receiving imaging. This could contribute to biased interview responses, if the respondent received and was influenced by the imaging results. Finally, although we statistically adjusted for multiple individual-level variables, residual confounding may remain. Future research should address this topic using a randomized controlled design, which could validate our findings.

CONCLUSION

The relationship between early lumbar imaging, health care utilization, time away from work, and health outcomes warrants further investigation to determine possible mechanisms of treatment and recovery. It may be possible that early diagnostic imaging triggers a "cascade of care" effect: subsequent procedures and other health care activities that, while not associated with better health outcomes at 1 year, may result in more time away from work and lost productivity. The role of early imaging in the management of LBP and its contribution to health outcomes and recovery would be best evaluated in the future using a randomized controlled design.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

- Among workers with occupational LBP, early MRI was not associated with significant differences in pain intensity and SF-36 scores 1 year after injury after controlling for confounders.
- After adjusting for baseline scores and individual-level factors, such as demographics, work, and injury characteristics, early MRI was associated with slightly greater functional disability (higher Roland scores) 1 year after injury among patients with mild or major sprains/strains.
- Among patients with mild or major sprains/strains, early MRI was associated with higher risk of receiving disability compensation and not working because of injury at 1 year and significantly slower rate of discontinuing work disability after adjusting for confounders. These associations were not observed among workers with radiculopathy.

TABLE 1.

Baseline Characteristics of Study Subjects (Demographic, Work, Clinical, and Health History)

	Mild or Major Sprain/Strain			Radiculopathy		
	MRI Within 6 wk (N = 121) n (%)	Consistent With Guidelines (N = 834) n (%)	Significance	MRI within 6 wk (N = 107) n (%)	Consistent With Guidelines (N = 164) n (%)	Significance
Age (at injury)						
Younger than 24 yr	8 (6.6)	83 (10.0)		5 (4.7)	14 (8.5)	
25–34 yr	30 (24.8)	211 (25.3)		22 (20.6)	29 (17.7)	
35–44 yr	40 (33.1)	250 (30.0)		37 (34.6)	47 (28.7)	
45–54 yr	33 (27.3)	199 (23.9)		30 (28.0)	55 (33.5)	
Older than 55 yr	10 (8.3)	91 (10.9)		13 (12.1)	19 (11.6)	
Sex						*
Female	36 (29.8)	280 (33.6)		30 (28.0)	68 (41.5)	
Male	85 (70.2)	554 (66.4)		77 (72.0)	96 (58.5)	
Race/ethnicity						
Non-Hispanic, white	92 (76.0)	595 (71.3)		82 (76.6)	118 (72.0)	
Non-Hispanic, nonwhite	12 (9.9)	118 (14.1)		11 (10.3)	19 (11.6)	
Hispanic	14 (11.6)	103 (12.4)		13 (12.1)	23 (14.0)	
Education						
Less than high school	12 (9.9)	89 (10.7)		10 (9.3)	26 (15.9)	
High school diploma/GED	49 (40.5)	266 (31.9)		40 (37.4)	49 (29.9)	
Some college	50 (41.3)	391 (46.9)		52 (48.6)	72 (43.9)	
College degree	10 (8.3)	88 (10.6)		5 (4.7)	17 (10.4)	
Household income ($)						
<30,000	38 (31.4)	316 (37.9)		38 (35.5)	57 (34.8)	
30–45,000	34 (28.1)	203 (24.3)		20 (18.7)	49 (29.9)	
45–70,000	31 (25.6)	207 (24.8)		35 (32.7)	36 (22.0)	
>70,000	15 (12.4)	85 (10.2)		11 (10.3)	15 (9.1)	
Marital status						
Married	70 (57.9)	452 (54.2)		62 (57.9)	89 (54.3)	
Living with partner	19 (15.7)	115 (13.8)		12 (11.2)	20 (12.2)	
Divorced	23 (19.0)	151 (18.1)		23 (21.5)	33 (20.1)	
Other	9 (7.4)	115 (13.8)		10 (9.3)	22 (13.4)	
Body mass index						
Normal <25	28 (23.1)	262 (31.4)		25 (23.4)	46 (28.0)	
Overweight 25–29	50 (41.3)	321 (38.5)		42 (39.3)	59 (36.0)	
Obese 30–34	28 (23.1)	166 (19.9)		29 (27.1)	32 (19.5)	
Very obese >34	14 (11.6)	65 (7.8)		10 (9.3)	22 (13.4)	

	Mild or Major Sprain/Strain			Radiculopathy		
	MRI Within 6 wk (N = 121) n (%)	**Consistent With Guidelines (N = 834) n (%)**	**Significance**	**MRI within 6 wk (N = 107) n (%)**	**Consistent With Guidelines (N = 164) n (%)**	**Significance**
Health in year before injury						
Excellent	31 (25.6)	186 (22.3)		24 (22.4)	42 (25.6)	
Very good	43 (35.5)	320 (38.4)		39 (36.4)	51 (31.1)	
Good	36 (29.8)	249 (29.9)		29 (27.1)	55 (33.5)	
Fair/poor	11 (9.1)	77 (9.2)		15 (14.0)	16 (9.8)	
Health status at baseline interview			*			
Excellent	23 (19.0)	159 (19.1)		21 (19.6)	36 (22.0)	
Very good	42 (34.7)	329 (39.4)		39 (36.4)	51 (31.1)	
Good	41 (33.9)	257 (30.8)		30 (28.0)	54 (32.9)	
Fair/poor	13 (10.7)	89 (10.7)		17 (15.9)	23 (14.0)	
Roland–Morris score‡ (0–24)			†			†
Low (0–6)	7 (5.8)	271 (32.5)		2 (1.9)	19 (11.6)	
Moderate (7–12)	20 (16.5)	199 (23.9)		13 (12.1)	40 (24.4)	
High (13–18)	42 (34.7)	223 (26.7)		33 (30.8)	51 (31.1)	
Very high (19–24)	52 (43.0)	141 (16.9)		59 (55.1)	54 (32.9)	
Pain intensity§ (0–10)			†			†
Low/no pain (0–3)	18 (14.9)	269 (32.3)		5 (4.7)	30 (18.3)	
Mild pain (4–6)	47 (38.8)	314 (37.6)		34 (31.8)	62 (37.8)	
Moderate/high pain (7–10)	56 (46.3)	251 (30.1)		68 (63.6)	72 (43.9)	
SF-36v2 Role Physical score¶			†			†
2 SD below population mean	79 (65.3)	197 (23.6)		77 (72.0)	73 (44.5)	
1–2 SD below population mean	31 (25.6)	192 (23.0)		24 (22.4)	43 (26.2)	
1 SD below population mean	9 (7.4)	192 (23.0)		5 (4.7)	27 (16.5)	
At or above population mean	2 (1.7)	253 (30.3)		1 (0.9)	21 (12.8)	
SF-36v2 Physical Functioning score¶			†			†
2 SD below population mean	63 (52.1)	161 (19.3)		73 (68.2)	75 (45.7)	
1–2 SD below population mean	32 (26.4)	181 (21.7)		17 (15.9)	35 (21.3)	
1 SD below population mean	21 (17.4)	216 (25.9)		12 (11.2)	34 (20.7)	
At or above population mean	5 (4.1)	276 (33.1)		5 (4.7)	20 (12.2)	
SF-36v2 Mental health score¶			†			†

	Mild or Major Sprain/Strain			Radiculopathy		
	MRI Within 6 wk (N = 121) n (%)	**Consistent With Guidelines (N = 834) n (%)**	**Significance**	**MRI within 6 wk (N = 107) n (%)**	**Consistent With Guidelines (N = 164) n (%)**	**Significance**
2 SD below population mean	24 (19.8)	90 (10.8)		28 (26.2)	29 (17.7)	
1–2 SD below population mean	30 (24.8)	155 (18.6)		34 (31.8)	34 (20.7)	
1 SD below population mean	35 (28.9)	203 (24.3)		31 (29.0)	39 (23.8)	
At or above population mean	32 (26.4)	386 (46.3)		14 (13.1)	62 (37.8)	
Catastrophizing‖ (0–4)			†			*
Low (<1)	17 (14.0)	243 (29.1)		10 (9.3)	28 (17.1)	
Moderate (1–2.9)	71 (58.7)	438 (52.5)		57 (53.3)	97 (59.1)	
High (3–4)	33 (27.3)	153 (18.3)		40 (37.4)	39 (23.8)	
Work fear-avoidance ** (0–6)			†			*
Low (0–2.9)	10 (8.3)	179 (21.5)		9 (8.4)	36 (22.0)	
Moderate (3–4.9)	34 (28.1)	291 (34.9)		27 (25.2)	51 (31.1)	
High (5–5.9)	47 (38.8)	222 (26.6)		43 (40.2)	48 (29.3)	
Very high (6)	30 (24.8)	142 (17.0)		28 (26.2)	29 (17.7)	
Offered job accommodation for disability			†			
Yes	41 (33.9)	426 (51.1)		37 (34.6)	74 (45.1)	
No	77 (63.6)	401 (48.1)		66 (61.7)	88 (53.7)	
1+ previous compensable back claims			*			
Yes	34 (28.1)	152 (18.2)		23 (21.5)	32 (19.5)	
No	87 (71.9)	677 (81.2)		84 (78.5)	132 (80.5)	
Job satisfaction						
Not at all	5 (4.1)	46 (5.5)		5 (4.7)	7 (4.3)	
Not too satisfied	10 (8.3)	69 (8.3)		9 (8.4)	16 (9.8)	
Somewhat satisfied	58 (47.9)	350 (42.0)		42 (39.3)	69 (42.1)	
Very satisfied	48 (39.7)	368 (44.1)		51 (47.7)	71 (43.3)	
Industry						
Trade/transportation	27 (22.3)	213 (25.5)		27 (25.2)	34 (20.7)	
Natural resources	2 (1.7)	47 (5.6)		4 (3.7)	3 (1.8)	
Construction	22 (18.2)	143 (17.1)		21 (19.6)	29 (17.7)	
Manufacturing	11 (9.1)	52 (6.2)		12 (11.2)	13 (7.9)	
Management	26 (21.5)	138 (16.5)		18 (16.8)	30 (18.3)	
Education/health	21 (17.4)	139 (16.7)		12 (11.2)	30 (18.3)	
Hospitality	12 (9.9)	102 (12.2)		13 (12.1)	25 (15.2)	
Physical demands at work			*			

	Mild or Major Sprain/Strain			Radiculopathy		
	MRI Within 6 wk (N = 121) n (%)	**Consistent With Guidelines (N = 834) n (%)**	**Significance**	**MRI within 6 wk (N = 107) n (%)**	**Consistent With Guidelines (N = 164) n (%)**	**Significance**
Light	20 (16.5)	167 (20.0)		20 (18.7)	37 (22.6)	
Medium	35 (28.9)	267 (32.0)		36 (33.6)	52 (31.7)	
Heavy	29 (24.0)	206 (24.7)		22 (20.6)	38 (23.2)	
Very heavy	33 (27.3)	190 (22.8)		29 (27.1)	37 (22.6)	
Type of first medical visit			*			*
Primary care	61 (50.4)	385 (46.2)		53 (49.5)	61 (37.2)	
Occupational medicine	4 (3.3)	27 (3.2)		5 (4.7)	3 (1.8)	
Chiropractor	22 (18.2)	257 (30.8)		24 (22.4)	68 (41.5)	
Surgeon	7 (5.8)	17 (2.0)		2 (1.9)	1 (0.6)	
Emergency department/ clinic	23 (19.0)	132 (15.8)		22 (20.6)	27 (16.5)	
Other	4 (3.3)	16 (1.9)		1 (0.9)	4 (2.4)	

Significance tests compare workers with early imaging and those with imaging consistent with guidelines, using χ^2 *tests.*

* $p<0.05$

† $p<0.01$.

‡ *Roland-Morris disability questionnaire measures physical functioning relating to back pain.* [19,21]

§ *Any pain in the last week, scale ranges from 0 to 10.* [28]

¶ 36-Item Short Form Health Survey version 2.23,24 SD indicates standard deviation.

‖ *Mean of responses to 3 questions from the Pain Catastrophizing scale.* [31]

** *Mean of responses to 2 questions from the Fear-Avoidance Beliefs Questionnaire work scale.* [32]

TABLE 2.

Health and Disability Measures for Workers Who Underwent MRI Before 6 Weeks and Those Consistent With Guidelines, Stratified by Injury Severity Groups

	Mild or Major Sprain/Strain			Radiculopathy		
	MRI Within 6 wk (N = 121)	Consistent With Guidelines (N = 834)	*P*	MRI Within 6 wk (N = 107)	Consistent With Guidelines (N = 164)	*P*
Health Measures						
Pain intensity the last week *	5.0 (2.7)	4.1 (5.3)	0.050	5.6 (2.6)	4.8 (2.8)	0.029
Roland-Morris Disability score †	12.0 (7.1)	7.4 (6.8)	<0.001	13.8 (6.8)	11.5 (7.4)	0.010
SF-36v2 Role Physical score ‡	38.3 (13.1)	46.0 (11.5)	<0.001	35.8 (11.8)	41.2 (12.6)	<0.001
SF-36v2 Physical Functioning score §	37.0 (12.6)	44.7 (12.1)	<0.001	33.0 (11.7)	38.0 (12.6)	0.001
Disability measures						
On disability (receiving wage replacement benefits), n(%) ¶	37 (30.6%)	56 (6.7%)	<0.001	43 (40.2%)	37 (22.6%)	0.002
Not working due to injury, n(%) ‖	46 (38.0%)	91 (10.9%)	<0.001	52 (48.6%)	48 (29.3%)	0.001
Total days on disability **	163.5 (144.6)	42.6 (86.6)	<0.001	215.3 (137.5)	121.3 (142.6)	<0.001

Unless otherwise indicated, values reported are unadjusted means and standard deviations (in parentheses), or P values for significance tests. Significance tests compare workers with early MRI and those whose imaging is consistent with guidelines, using t tests for health measures and total disability days and χ^2 *tests for dichotomous disability measures.*

All measures were ascertained at 1-yr follow-up interviews.

* *Any pain in the last week, scale ranges from 0 to 10.* [28]

† *Roland-Morris Disability Questionnaire measures physical functioning relating to back pain.* [19,21]

‡ *36-Item Short Form Health Survey version 2 Role Physical scale, standardized (0–100).* [23,24]

§ *36-Item Short Form Health Survey version 2 Physical Functioning scale, standardized (0–100).* [23,24]

¶ Administrative report of no longer receiving time loss at 365 d.

‖ Self-report of working within the last week, at follow-up.

** Total number of compensated days accrued within 365 d of claim receipt. MRI indicates magnetic resonance imaging.

TABLE 3.

Results of Linear Regression and Survival Analyses Evaluating the Effect of Early MRI on Health and Disability Outcomes at 1 Year

	Mild or Major Sprain/Strain			Radiculopathy		
Health Measures	**Coefficient***	**95% CI**	**Significance**	**Coefficient***	**95% CI**	**Significance**
Pain intensity the last week	0.10	−0.88–1.08	0.838	0.06	−0.59–0.71	0.854
Roland-Morris Disability Questionnaire score	1.12	0.04–2.21	0.043	0.07	−1.53–1.67	0.931
SF-36v2 Role Physical score	−1.94	−3.98–0.10	0.063	−1.13	−4.00–1.73	0.438
SF-36v2 Physical Functioning score	−1.75	−3.77–0.27	0.089	−1.47	−4.15–1.21	0.283
Disability measures	**RR†§**	**95% CI**	**Significance**	**RR†§**	**95% CI**	**Significance**
Receiving wage replacement benefits‡	2.03	1.33–3.11	0.001	1.31	0.84–2.05	0.240
Not working due to injury¶	1.98	1.42–2.76	<0.001	1.21	0.85–1.74	0.293
	HR†	**95% CI**	**Significance**	**HR†**	**95% CI**	**Significance**
Ending work disability‖	0.48	0.38–0.60	<0.001	0.57	0.40–0.81	0.002

*Significance tests compare workers with early magnetic resonance imaging and those whose imaging is consistent with guidelines (*P *values).*

*Adjusted health outcome models control covariates listed in Table 1 and respective baseline health measure.

†Adjusted disability models control covariates listed in Table 1, and baseline pain and Roland-Morris Disability Questionnaire scores.

‡Administrative report of no longer receiving time loss at 1 yr.

§Relative risk (RR) compares workers who received an early magnetic resonance imaging with those whose imaging is consistent with guidelines, adjusting for covariates listed earlier.

¶Self-report of working within the last week, at follow-up.

‖Work disability calculated using total time loss accrued in 365 d from claim receipt. Hazard ratio (HR) describes rate of relative risk of ending disability comparing workers with early magnetic resonance imaging with those with those whose imaging is consistent with guidelines.

CI indicates confidence interval; RR, relative risk; HR, hazard ratio; SF-36v2, 36-Item Short Form Health Survey Version 2.