# Association Between Exercise and Low Back Pain Resulting in Modified Duty and Lost Time

## *A Cross-Sectional Analysis of an Occupational Population*

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**Objective:** The aim of the study was to assess the relationship between leisure time exercise and whether workers ever had modified duty or lost time (MD/LT) due to low back pain (LBP) in an occupational cohort. **Methods:** Workers ($N = 827$) completed a structured interview assessing characteristics of their LBP, whether or not the pain caused modified or lost work time, and their participation in leisure time exercise. Odds ratio of modified/lost time and minutes of exercise participation were assessed. **Results:** Workers who participated in over 316 min/wk of leisure time exercise incurred significantly less modified/lost time, adjusted odds ratio = 0.46 (95% confidence interval, 0.23 to 0.98). There also lies a significant trend between increases in leisure time exercise and reductions in modified/lost time ($P = 0.0016$). **Conclusion:** These results suggest exercise reduces risk of MD/LT from LBP.

**Keywords:** cross-sectional analysis, exercise, LBP, leisure time exercise, leisure time physical activity, lost time, low back pain, modified duty, MVPA, physical activity, worker health, worker productivity

Low back pain (LBP) is one of the most prevalent musculoskeletal diseases affecting 9.4% of individuals globally at any given time.[1] In addition to being responsible for approximately 57.6 million year's lived with disability globally in 2016,[2] LBP reduces an individual's workplace productivity by almost 5 h/wk, and is associated with nearly a quarter of all lost work days in the United States.[3,4] This lost productivity is estimated to cost approximately $61.2 billion USD annually.[4,5] Although LBP is costly and prevalent, treatment is challenging, in part due to its unknown and nonspecific pathophysiological cause(s).[3,6]

The US Office of Disease Prevention and Health Promotion guidelines advise 150 min/wk of moderate exercise or 75 min/wk of vigorous exercise to improve general health.[7–11] Additional health benefits (eg, improved metabolic function, reduction in risk of chronic diseases including cardiovascular disease, osteoporosis, diabetes mellitus) have been reported among those who complete more than 150 min/wk of exercise.[12–14] Despite these benefits, reports suggest that fewer than half of adults achieve the recommended amount of weekly exercise.[15]

Graded exercise therapy is an effective treatment for chronic LBP and may include a variety of different exercises.[16–20] Similarly, chronic LBP has also been shown to improve with exercise therapy.[21] A meta-analysis on the effectiveness of workplace exercise programs[22] reported that a majority of the included studies showed improvement in absenteeism despite most of the studies being of relatively low quality and showing mixed results in general. This study's objective was to assess the relationship between leisure time exercise and whether workers have ever had modified duty or lost time (MD/LT) due to LBP in an occupational cohort.

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## METHODS

This cross-sectional study analyzed baseline data from the BackWorks cohort study of LBP.[23] The Institutional Review Boards of the University of Utah (LBP IRB#00011889), University of Wisconsin-Milwaukee (LBP IRB #04.02.049), and Texas A&M University (LBP IRB #2003-0408) approved this study. All workers provided written consent. As a detailed methods paper was previously published,[23] a brief summary follows.

### Subjects

Eligible workers were (1) at least 18 years of age, (2) able to give informed consent, (3) had no plans to leave or retire within 4 years (ability to follow up), (4) able to speak English or Spanish for effective communication, and (5) had no major limb deformities and/or substantial amputations. Workers ($n = 897$) were recruited from 27 different employers at 30 different production facilities in the US states of Illinois, Texas, Utah, and Wisconsin. These facilities included a diverse range of operations, for example, poultry and meat processing, manufacturing, baking, printing, and grocery warehousing. Workers were paid their current wage and received no extra compensation for participation. Workers completed computerized questionnaires, structured interviews, physical examinations, health measurements, and had their job physical tasks measured.

### Questionnaires

Computerized questionnaires included demographics, health history (eg, diabetes mellitus, high cholesterol), smoking history (never, past, current), psychosocial questions (eg, job satisfaction measured by work APGAR), hobbies, and exercise.

Three questions for each type of exercise were used to quantify exercise habits ($n = 19$ common types of exercise queried, see examples in Table 1). Workers who indicated participation in exercise were then queried to provide the number of months out of the year, the number of times a week, and the average number of minutes that they participated in that specific exercise. An ''Other exercise'' option allowed the same data fields to be collected for each additional type of exercise that a worker added. These methods allowed summation of the worker's minutes of exercise/wk.

Body mass indices (BMI) were computed from measured height and weight. Blood pressure was measured using automated cuffs (Omron HEM-780) after at least 5 minutes of rest. To be considered hypertensive for these analyses, workers had to either report having been diagnosed with hypertension, or had a measured systolic blood pressure above 140 mm Hg and/or diastolic blood pressure above 90 mm Hg at enrollment.

### Low Back Pain

LBP was assessed in the structured interview. Workers whose LBP was reportedly caused by motor vehicle accident or other

**TABLE 1.** Classification of Exercises/Physical Activities by Metabolic Equivalents (METS) Level[34]

| Moderate Activities (3–5.9 METs) | Vigorous Activities (>6.0 METs) |
|---|---|
| Brisk walking | Running |
| Dancing | Walking/climbing up a hill |
| Gardening/yard work | Fast cycling |
| Housework | Aerobics |
| Hunting | Fast swimming |
| Playing with children | Competitive sports and games (ie, Tennis, Football, Hockey, Basketball, skiing) |
| General building tasks (ie, painting, roofing) | Heavy shoveling/ditch digging |
| Lifting moderate loads (<20 kg) | Lifting heavy Loads (>20 kg) |

accidents were excluded. Questions included the presence of pain, duration, and severity (worst pain ever felt). Other questions separately addressed history of modified duty (aka, modified duty) and lost time at work due to LBP. Workers were not queried regarding whether the modified duty was prescribed by a healthcare provider, rather this was self-reported.

## Statistical Analyses

All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC). Statistical significance was determined using $\alpha$ level of 0.05. Frequencies, means, and standard deviations were used to describe the population. Only individuals who completed all the data required for these analyses were included.

Workers were grouped into those who had LBP severe enough to cause them to ever miss work and/or be on modified duty ($N = 136$) (MD/LT), and those who may have had LBP, but it was not severe enough for the participant to miss work and/or be on modified duty ($N = 691$) (no MD/LT). Differences in distributions between both groups were assessed using chi-square analyses and the Wilcoxon–Mann–Whitney test when variables were not normally distributed.

To provide approximate quartiles of workers performing exercise, exercise duration was a priori categorized into no exercise (0), 1 to 60, 61 to 150, 151 to 315, and 316+ minutes of exercise/wk. Univariate and multivariate categorical analyses were conducted adjusting for subjective pain rating (0 to 10 scale), sex, BMI (kg/m$^2$), APGAR Composite (for job satisfaction), and age (years).

# RESULTS

## Participant Demographics

Of the 897 workers enrolled in this study, 827 (92.2%) were included in these analyses. Workers who were excluded were missing information regarding their exercise habits and durations. Demographic data are reported in Tables 2 and 3. The majority of the

**TABLE 2.** Bivariate Relationships Between Categorical Variables and Lifetime History of Modified Duty and/or Lost Time From Low Back Pain

| Categorical Variable | Modified Duty or Missed Work (N = 136) N (%) | No Modified Duty or Missed Work (N = 691) N (%) | Total (N = 827) N (%) | P |
|---|---|---|---|---|
| Sex | | | | 0.073 |
| Female | 40 (29.4) | 259 (37.5) | 299 (36.2) | |
| Male | 96 (70.6) | 432 (62.5) | 528 (63.8) | |
| Alcohol problem | | | | 0.817 |
| Yes | 7 (5.2) | 39 (5.6) | 46 (5.6) | |
| No | 129 (94.8) | 652 (94.4) | 781 (94.4) | |
| Smoking status | | | | 0.593 |
| Yes, currently | 31 (22.8) | 147 (21.2) | 178 (21.5) | |
| Yes, but in the past | 27 (19.8) | 165 (23.9) | 192 (23.2) | |
| Never | 78 (57.4) | 379 (54.9) | 457 (55.3) | |
| High blood pressure | | | | 0.702 |
| Yes | 21 (15.4) | 98 (14.2) | 119 (14.4) | |
| No | 115 (84.6) | 593 (85.8) | 708 (85.6) | |
| High cholesterol | | | | 0.185 |
| Yes | 31 (22.8) | 124 (17.9) | 155 (18.7) | |
| No | 105 (77.2) | 567 (82.1) | 672 (81.3) | |
| Diabetes | | | | 0.162 |
| Yes | 3 (2.2) | 34 (4.9) | 37 (4.5) | |
| No | 133 (97.8) | 657 (95.1) | 790 (95.5) | |
| Exercise duration, min/wk | | | | **0.028** |
| 0 | **38 (27.9)** | **176 (25.5)** | **214 (25.9)** | |
| 0–60 | **35 (27.7)** | **129 (18.7)** | **164 (19.8)** | |
| 61–150 | **30 (22.1)** | **122 (17.7)** | **152 (18.4)** | |
| 151–315 | **18 (13.3)** | **125 (18.1)** | **143 (17.3)** | |
| 316+ | **15 (11.0)** | **139 (20.1)** | **154 (18.6)** | |

Bold values within the tables identifies values that are statistically significant at an alpha level of 0.05.

TABLE 3. Bivariate Relationships Between Continuous Variables and Lifetime History of Modified Duty and/or Lost Time From Low Back Pain†

| Continuous Variable | Modified Duty or Missed Work ($N = 136$) Mean ± SD | No Modified Duty or Missed Work ($N = 691$) Mean ± SD | Total ($N = 827$) Mean ± SD | $P$ |
|---|---|---|---|---|
| Age, y | 38.5 ± 11.4 | 38.8 ± 12.1 | 38.8 ± 12.0 | 0.794 |
| Body mass index, kg/m$^2$ | 29.3 ± 5.1 | 29.3 ± 6.7 | 29.3 ± 6.5 | 0.386 |
| Pain rating (0–10 scale) | **7.9 ± 2.1** | **3.7 ± 3.7** | **4.4 ± 3.8**† | **<0.001** |
| APGAR composite score | **0.8 ± 0.5** | **0.7 ± 0.5** | **0.7 ± 0.5** | **0.006** |

Bold values within the tables identifies values that are statistically significant at an alpha level of 0.05.
†Chi-squared analysis used for categorical data. Wilcoxon–Mann–Whitney analysis used for continuous variables.

population was male (63.8%), which was expected in this convenience sample where many workers performed tasks with heavy to very heavy physical demands. Workers had a mean age of 38.8 ± 10.0 years, with a mean body mass index of 29.3 ± 6.5 kg/m$^2$. The majority of these workers were relatively healthy, with only a few reporting disease(s) or illnesses. For example, 119 (14.4%) had hypertension, 155 (18.7%) reported high cholesterol, 37 (4.5%) were diagnosed with diabetes mellitus, 46 (5.6%) indicated ever having a drinking problem, whereas 178 (21.5%) of workers currently smoked.

## MD/LT Versus No MD/LT

A total of 136 (16.4%) workers reported a history of MD/LT due to LBP. Comparisons between MD/LT and no MD/LT groups are shown in Tables 2 and 3. The groups were comparable to one another with only a few statistically significant differences ($\alpha$ = 0.05). The pain rating for LBP was significantly higher in the MD/LT group compared with the no MD/LT group (7.9 ± 2.1 vs 3.7 ± 3.7, respectively, $P < 0.001$). Workers on MD/LT had a higher APGAR score compared with those without MD/LT ($P = 0.006$). There was a nonsignificant difference ($P = 0.073$) in sex within the two groups, with those workers having MD/LT being a majority males ($n = 96$, 70.4%) compared with females ($n = 40$, 29.4%). This pattern is also seen in workers without having MD/LT, as males ($n = 432$, 62.5%) constituted a larger portion compared with females ($n = 259$, 37.5%) ($P = 0.073$).

## Exercise and MD/LT

The durations of self-reported weekly exercise are provided in Table 4. A total of 214 (25.9%) of the workers did not participate in any leisure time exercise, whereas groups 0 to 60 min/wk, 61 to 150 min/wk, 151 to 315 min/wk, and 316+ min/wk accounted for 164 (19.8%), 152 (18.4%), 143 (17.3%), and 154 (18.6%) for the study population, respectively. Workers who reported having been on MD/LT due to LBP performed less leisure time exercise at the recommended level of 150 min/wk compared with those without MD/LT (13% vs 18%, $P = 0.028$). Univariate analyses showed that workers performing 316+ min/wk of leisure time exercise were significantly less likely to have ever been on MD and/or LT due to LBP (OR = 0.46 (95% confidence interval [CI] [0.25 to 0.89]). These odds remained significant after adjusting for pain rating (0 to 10 scale), sex, BMI, APGAR composite, and age in the multivariate model (OR = 0.46 (95% CI [0.23 to 0.98]). The remaining exercise categories did not show statistically significant associations with being or having been on MD and/or LT. However, a categorical test for trend for MD/LT was significant ($P = 0.0016$).

A graphical representation of the adjusted odds ratios and confidence intervals of having MD/LT versus the duration of weekly exercise is in Figure 1. With those reporting not participating in any weekly exercise serving as the reference group (OR = 1.0), all longer weekly exercise duration groups showed trends in reduced OR except for the 1 to 60 min/wk (OR = 1.43 (95% CI [0.77 to 2.89]). Groups 61 to 150 min/wk and 151 to 315 min/wk of exercise showed nonsignificantly reduced ORs of MD/LT with OR = 0.81 (95% CI [0.41 to 1.62]) and OR = 0.73 (95% CI [0.36 to 1.58]), respectively. Workers in the 316+ min/wk of exercise was the only group that showed a statistically significant reduction in OR for MD/LT (OR = 0.46 (95% CI [0.23 to 0.98]) ($P < 0.05$).

## DISCUSSION

There is an inverse correlation between a worker's duration of weekly exercise and odds of incurring MD/LT due to LBP. Workers who complete 316 min/wk or more were 54% less likely to have had LBP-caused MD/LT after adjusting for age, sex, BMI, pain severity, and job satisfaction (APGAR). The modified APGAR composite score was also significantly higher in those who had either missed work or been on MD due to LBP; however, the absolute difference was very small suggesting the potential for either a spurious or biologically insignificant association. Pain ratings were unsurprisingly

TABLE 4. Adjusted Relationships Between Categories of Weekly Exercise Duration (Minutes) and Lifetime History of Modified Duty/Lost Time

| Exercise Duration Group (min) | Crude Analysis (OR [95% CI]) | $P$ | Adjusted for Confounder* (OR [95% CI]) | $P$ |
|---|---|---|---|---|
| 0 | 1.00 (Reference) | | 1.00 (Reference) | |
| 1–60 | 1.26 (0.75–2.10) | 0.382 | 1.43 (0.77–2.89) | 0.283 |
| 61–150 | 1.14 (0.67–1.94) | 0.631 | 0.81 (0.41–1.62) | 0.640 |
| 151–315 | 0.67 (0.37–1.22) | 0.190 | 0.73 (0.36–1.58) | 0.207 |
| 316+ | **0.50 (0.26–0.95)** | **0.033** | **0.46 (0.23–0.98)** | **0.032** |
| Overall model | $R^2 = 0.023$ | 0.032 | $R^2 = 0.049$ | 0.022 |

Bold values within the tables identifies values that are statistically significant at an alpha level of 0.05.
*Adjusted for age (years), sex, pain rating (0 to 10 scale), measured body mass index (kg/m$^2$), and APGAR composite.

 

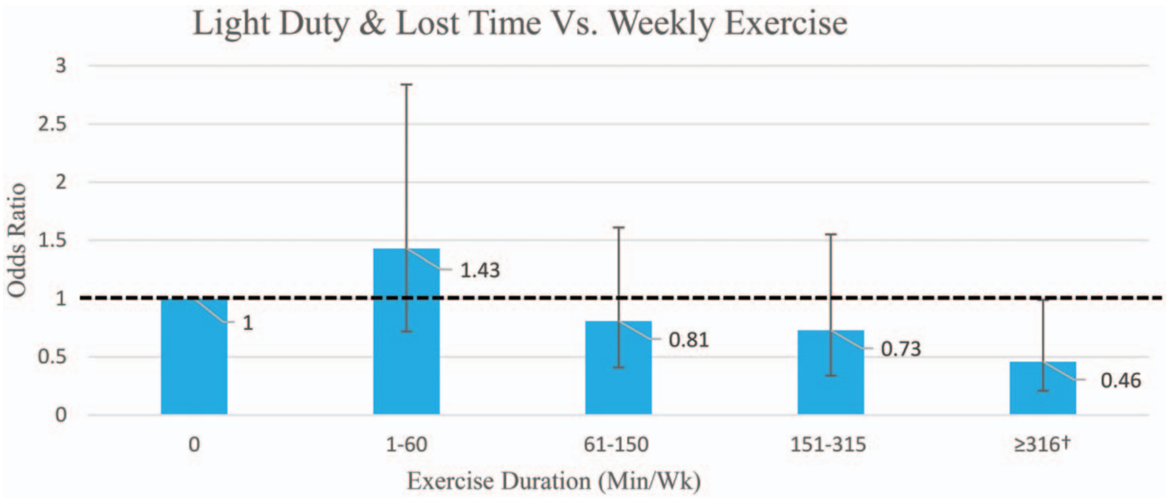


**FIGURE 1.** Adjusted odds ratios and 95% CIs for the relationships between categories of exercise duration and associations with lifetime history of modified duty and/or lost time due to low back pain. †Statistically significant OR and 95% CI group ($P < 0.05$). Adjusted for age (years), sex, pain rating (0 to 10 scale), measured body mass index (kg/m$^2$), and APGAR composite.

correlated with MD/LT history. Somewhat surprisingly, no relationships between age, BMI, and MD/LT were observed. These results suggest that promotion of employee participation in leisure-time exercise activities may reduce MD/LT and therefore indemnity costs—the most costly impacts of LBP.[24–27]

These analyses were cross-sectional, and therefore cannot prove that exercise prevents MD/LT due to LBP. However, it might be reasonable to assume that that a majority of this study's workers, with a history of MD/LT due to LBP, had been informed of the importance of exercises for LBP prevention and management.[16,18–20,28] Such cognizance, if it was present, could result in reporting and/or recall bias(es) that would be expected to overestimate exercise in that group. If such biases were present, then this study's results of the benefits of exercise on MD/LT from LBP may be considerably underestimated.

Most prior studies have found various exercises that effectively treat LBP.[18,20] However, there is considerably less evidence addressing whether there is preventive benefit of exercise for LBP.[20] Contrary to evidence that even a little bit of exercise is better than no exercise at all, this study's data suggest increased odds of MD/LT for workers participating in 1 to 60 min/wk when compared with workers reporting no exercise participation at all. It is possible that the potential recall bias(es) noted above motivated workers with MD/LT to report at least some exercise. However, it is also possible that inconsistent exercise patterns increase risk of more severe LBP-related outcomes.

In this regard, a prior subset of this study's cohort measured physical activity using accelerometers and found that moderate amounts of exercise was associated with lower incidence of LBP, but that both low and high amounts of exercise were associated with increased risk of LBP.[29] It should be noted that those results were for incident cases of LBP, and thus may not accurately reflect LBP-related outcomes such as MD/LT.

This study has many strengths including analyses from a large population of workers ($N = 827$) from many sites (30) in four different states who worked in a variety of industries. The diversity of the population assessed likely increases this study's generalizability. This study utilized computerized questionnaires and structured interviews to collect uniform information and minimize missing data. We also included the APGAR, which is a validated tool for measuring psychosocial variables in workers[30] as well as measured anthropometric measurements.

Limitations of these analyses included those of a cross-sectional analysis. Recall biases may have impacted the results, although such biases are expected to have underestimated the impacts of exercise on MD/LT. Prior evidence also suggests that overweight individuals tend to overestimate or overreport the amount of exercise performed,[31–33] which may have resulted in negative results among those workers.

This study suggests increasing amounts of recreational exercise can reduce MD/LT from LBP. However, additional studies on the preventive effects of exercise on MD/LT due to LBP are needed to both confirm the association and determine appropriate levels and types of exercise. Future studies that include prospective designs and interventional studies should be instructive. Investigations on the relationship(s) between specific types of exercise, including resistance and aerobic exercises, would be particularly helpful, as there is little to guide those preventive efforts. Future studies should also analyze interactions between exercise and job physical exposures as certain jobs already have substantial physical activities and this could affect the association between recreational exercise and LBP-related outcomes such as MD/LT.

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