# Sex Differences in Predictors of Outcome in Selected Physical Therapy Interventions for Acute Low Back Pain

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**Study Design:** Secondary analysis of pooled data from 3 randomized trials.
**Objective:** This study investigated sex differences in response to physical therapy intervention for acute low back pain.
**Background:** Sex differences in experimental pain sensitivity have been consistently described in the literature. However, clinical consequences of these sex differences have not been widely reported.
**Methods and Measures:** Subjects (n = 165) were participants in 3 randomized trials of physical therapy interventions from outpatient physical therapy clinics in the general and military communities. Subjects were randomly assigned spinal manipulation with range-of-motion exercise, lumbar stabilization exercise, or directional-preference exercise. Outcomes were measured at 4 weeks through self-report of pain intensity and pain-related disability. Sex differences were investigated with independent *t* tests (baseline data), 2 × 3 analysis of variance (4-week reductions in pain and pain-related disability), and regression models (predictors of outcome).
**Results:** Men and women had similar reductions of pain intensity (raw mean difference, 0.5; 95% CI, –1.4 to 0.4) and pain-related disability (raw mean difference, 5.3; 95% CI, –0.1 to 10.7) over 4 weeks. Baseline pain intensity, duration of symptoms, and baseline pain-related disability significantly predicted change in pain intensity for women ($r^2$ = 26%, $P<.01$). Baseline pain intensity and stabilization exercise predicted change in pain intensity for men ($r^2$ = 33%, $P<.01$). Baseline pain-related disability, duration of pain, and pain intensity predicted change in disability for women ($r^2$ = 24%, $P<.01$). Baseline pain-related disability, fear-avoidance beliefs, stabilization exercise, and leg pain predicted change in disability for men ($r^2$ = 32%, $P<.01$).
**Conclusion:** For patients with acute low back pain, men and women had similar physical therapy outcomes for reductions in pain intensity and pain-related disability. However, men and women had different factors that predicted treatment outcome. *J Orthop Sports Phys Ther 2006;36(6):354-363.* doi:10.2519/jospt.2006.2270

***Key Words:*** *acute pain, gender differences, lumbar spine, rehabilitation, treatment response*

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Women have consistently reported higher pain sensitivity in studies involving experimental stimuli.[52] Specifically, women have demonstrated lower pain threshold and tolerance levels in response to mechanical, thermal, and electrical stimuli.[52] Individual studies have suggested that women also report higher rates of temporal summation of thermal stimuli, which is believed to be a behavioral measure for central sensitization of pain.[20,57] In addition to measures that rely on subjective response, sex differences have been observed in physiological measures of pain response. Women experienced greater pupil dilation in response to a mechanical stimulus[16] and the spinal cord mediated nociceptive flexion reflex was elicited at lower intensity of electrical stimuli for women.[21] Collectively, this literature provides strong evidence that women have a greater response to pain, at least when stimuli are applied in a standard manner.

The clinical implications of sex differences in pain sensitivity are not as clear, however. Some epidemiological investigations corroborate sex differences observed in response to experimental stimuli, as many chronic pain syndromes

are more commonly experienced by women.[2,3,45,50,67] Women have also reported greater pain intensity following surgical procedures[13,63,65] and greater pain-related disability from arthritis.[1,42] Other reports contradict these findings, with men and women reporting similar amounts of pain, disability, and analgesic use for chronic pain and cancer pain.[66] Men and women seeking care at a tertiary care facility reported similar sensory, affective, and evaluative pain levels for facial, spine, and heterogeneous chronic pain conditions.[59] Furthermore, no sex differences in perceived low back pain (LBP) or pain-related disability were observed in patients with LBP seeking epidural steroid injection at a pain clinic.[35]

While it appears that the sexes differ in pain responses to standard stimuli, less is known regarding sex differences in response to treatment for clinical pain conditions.[19] Specific to the purposes of this study, several studies have characterized sex differences in response to rehabilitation for LBP.[32,37,62] Women with chronic LBP reported significant pain reduction from standardized physical therapy and intensive dynamic back exercises, while men with chronic LBP reported significant pain reduction from standardized physical therapy and hot packs and intermittent traction.[32] Women on sick leave due to chronic LBP who participated in a behavioral-medicine approach (consisting of behavior-oriented physical therapy and cognitive behavioral therapy) reported significant improvements in general and mental health, while men only reported significant improvement in vitality.[37] In addition, men had greater posttreatment multifidus fatigue in response to spinal stabilization exercises.[62] Other studies have reported no sex differences in response to active approaches to LBP rehabilitation that included active physical therapy, muscle reconditioning, and low-impact aerobics,[46,47] physical-therapist–supervised physical exercise, stretching, relaxation, and behavioral support,[41] and manipulation followed by active exercise.[27]

In contrast to the literature investigating sex differences in chronic LBP, sex differences in response to rehabilitation of acute LBP are underreported in the literature. The potential for sex differences in response to acute LBP could be important because surveys of physical therapy practice indicate that physical therapists commonly manage patients with acute LBP.[4,39] Therefore, the purpose of this study was to examine sex differences in response to physical therapy interventions for acute LBP. In this article, we exclusively use the term *sex differences* because it was a better indicator of our direct measure (ie, subjects' biological orientation), in comparison to *gender differences* (ie, subjects' societal, cultural, or behavioral orientation).[56]

First, we investigated sex differences in baseline pain intensity and pain-related disability for patients seeking physical therapy treatment for acute LBP. We hypothesized that women and men would have similar clinical reports of pain intensity and pain-related disability, as is consistent with studies in this area involving patients with chronic LBP.[59,66] Second, we investigated sex differences in changes in pain intensity and pain-related disability in response to 3 common physical therapy approaches for LBP: spinal manipulation, lumbar stabilization exercise, and directional preference exercise. We hypothesized that men and women would have similar reductions in pain intensity and pain-related disability for each of these interventions, consistent with previous studies involving patients with chronic LBP.[32,41,46] Third, we investigated sex differences in demographic and clinical factors that predicted changes in pain intensity and pain-related disability. The third analysis was exploratory in nature, thus we did not perform formal hypothesis testing.

## METHODS

### Subjects

This study is a secondary analysis of data from 3 randomized trials involving common methodologies. All the trials examined patients that were (1) recruited from outpatient physical therapy clinics and (2) received physical therapy for 4 weeks. Two of the trials recruited patients from outpatient physical therapy clinics in large urban areas,[7,31] while patients in the third trial were recruited mostly from within outpatient military health care clinics.[11] All the trials used the same standard methods to collect demographic and clinical information prior to randomization. Patients enrolled in the trials received randomly assigned physical therapy interventions, including various forms of active exercise, and/or manipulation, with 1 trial including randomization to a fear-avoidance supplement to physical therapy intervention. Patients were then reassessed on pain intensity and pain-related disability measures 4-weeks later by assessors that were unaware of treatment assignment. All 3 trials received approval from the Institutional Review Board at the appropriate participating institution, and all subjects provided informed consent before enrolling in the respective studies. Patients were recruited into the clinical trials if they were between the ages of 18 and 55 years, reported LBP and/or leg pain, and were English-speaking. Patients were excluded from the clinical trials if they had clinical examination signs consistent with nerve root compression, had low-back surgery in the past 6 months, were diagnosed with spinal tumor, fracture, or osteoporosis, or were pregnant. Patients enrolled

in the trials completed 4 weeks of randomly assigned physical therapy intervention after the baseline assessment.

A total of 301 patients participated in all 3 clinical trials. Patients were eligible for this secondary analysis based on having (1) acute LBP (defined as having symptoms for 30 days or less) and (2) receiving either manipulation with exercise, lumbar strengthening and stabilization exercise, or direction-specific exercise as their primary physical therapy intervention. Patients receiving the fear-avoidance supplement were excluded from this analysis. Patients included in this analysis (n = 165) did not significantly differ from patients excluded (n = 136) based on age, sex, initial pain intensity, and initial pain-related disability ($P > .05$ for all comparisons). The pooled sample for this analysis consisted of 70 (47.9%) patients from the study by Brennan et al,[7] 71 (43.0%) from the study by Childs et al,[11] and 15 (9.1%) from the study by George et al.[31] Table 1 summarizes key variables involved with this analysis by each clinical trial.

## Measures

All patients received a standard baseline examination for collection of demographic (age, sex, duration and location of symptoms, and prior history of LBP) and clinical (physical impairment, pain intensity, pain disability, and fear-avoidance beliefs) characteristics. All demographic information was obtained through a standard questionnaire. The clinical information was collected through a standard physical examination or by validated self-report questionnaires. Specifically, physical impairment was assessed through measurement of total flexion range of motion (ROM) and straight leg raise ROM (average of right and left lower extremities) using a single inclinometer technique with high interrater reliability.[69] Pain intensity was assessed using a numeric rating scale (NRS), which has a range of 0 to 10, with 0 representing no pain and 10 the worst pain imaginable. The patient was asked to rate current pain intensity for the purposes of this study, a method that has demonstrated acceptable reliability and validity in the literature.[38,53] Pain-related disability was assessed with the Modified Oswestry Disability Questionnaire (ODQ) and was reported as a percentage ranging from 0 (no disability) to 100 (maximum disability).[18] The ODQ used in this study was modified from the original by substituting a section regarding employment/homemaking ability for the section related to sex life, and has been found to have high levels of test-retest reliability, validity, and responsiveness.[18,26,60] The Fear-Avoidance Beliefs Questionnaire (FABQ) was used to assess fear-avoidance beliefs.[68] The FABQ contains 2 subscales: a 7-item subscale assessing fear-avoidance beliefs about work (FABQW; score range, 0-42), and a 4-item subscale assessing fear-avoidance beliefs about physical activity (FABQPA; score range, 0-24). The FABQ subscales have been found to have acceptable reliability,[36,49,61,68] and to be predictive of disability and work loss in patients with LBP.[24,25,61] The NRS for pain intensity and the ODQ for pain-related disability were readministered during the 4-week reassessment.

## Data Analysis

The alpha level was set a priori to be .05 for all analyses. Sex differences in baseline demographic and clinical characteristics were explored by independent *t* tests or chi-square tests, as appropriate. Raw change scores were then computed for pain intensity and disability by subtracting the initial scores from the 4-week scores. We used raw change scores for subsequent analyses because our purposes involved detecting sex differences in response to physical therapy intervention. Before performing the planned analyses, 1-sample Kolmogorov-Smirnov tests determined if the calculated change scores approximated a normal distribution.

Separate 2 × 3 ANOVA models were created to investigate sex differences in 4-week change scores for pain intensity and pain-related disability. For both models, the between-group factors were sex (2 levels) and type of physical therapy intervention (3 levels). Covariates for the ANOVA models were considered, based on observed sex differences in baseline demographic and clinical measures.

**TABLE 1.** Comparison of individual clinical trials on key variables included in secondary analysis. All values are reported as mean (SD), or n, %.

| Variable | Trial 1 (n = 15)[7] | Trial 2 (n = 71)[11] | Trial 3 (n = 79)[31] | *P* Value* |
|---|---|---|---|---|
| Sex (n female, %) | 8, 53.3% | 28, 39.4% | 47, 59.5% | .048 |
| Initial pain intensity (range, 0-10) | 5.2 (1.8) | 5.8 (1.7) | 5.5 (2.0) | .463 |
| Initial pain-related disability (range, 0%-100%) | 37.1 (12.3) | 41.6 (10.7) | 44.6 (12.4) | .050 |
| 4-week change in pain intensity (range, 0-10) | 2.7 (2.5) | 3.0 (2.7) | 3.9 (2.5) | .093 |
| 4-week change in pain-related disability (range, 0%-100%) | 17.7 (17.0) | 21.8 (19.8) | 26.1 (15.4) | .135 |

* Significance level for between-trial comparisons made by analysis of variance (continuous data) or chi-square test (categorical data).

**TABLE 2.** Sex differences in baseline demographic and clinical characteristics for pooled sample. All values are reported as mean (SD), or n, %.

| Variable | Total Sample (n = 165) | Women (n = 83) | Men (n = 82) | *P* Value* |
|---|---|---|---|---|
| Age (y) | 36.2 (10.3) | 35.4 (11.0) | 37.0 (9.5) | .302 |
| Symptom duration (d) | 13.3 (8.0) | 14.0 (8.1) | 12.7 (7.8) | .318 |
| Prior episodes of LBP (n, %) | 111, 67.3% | 54, 65.1% | 57, 69.5% | .542 |
| Leg pain and LBP (n, %) | 53, 32.3% | 24, 28.9% | 29, 35.4% | .404 |
| Average straight leg raise ROM (°) | 71.8 (14.4) | 71.6 (16.0) | 72.0 (12.7) | .871 |
| Total lumbar flexion ROM (°) | 74.8 (26.6) | 75.2 (25.8) | 74.5 (27.6) | .852 |
| Fear-avoidance beliefs, work (range, 0-42) | 15.1 (10.5) | 14.6 (11.8) | 15.5 (9.2) | .593 |
| Fear-avoidance beliefs, physical activity (range, 0-24) | 16.6 (4.6) | 16.4 (4.7) | 16.8 (4.6) | .633 |
| Pain intensity (range, 0-10) | 5.6 (1.8) | 5.2 (1.8) | 6.0 (1.8) | .006 |
| Pain-related disability (range, 0%-100%) | 42.6 (11.9) | 43.0 (11.6) | 42.3 (12.2) | .717 |
| Treatment received | | | | .213 |
| Manipulation with exercise | 75, 45.5% | 35, 42.2% | 40, 48.8% | |
| Stabilization exercise | 59, 35.8% | 28, 33.7% | 31, 37.8% | |
| Direction-specific exercise | 31, 18.8% | 20, 24.1% | 11, 13.4% | |
| Number of therapy appointments | 5.5 (1.9) | 5.7 (2.0) | 5.3 (1.9) | .225 |
| Time until follow-up examination (d) | 28.1 (9.3) | 29.2 (9.5) | 26.9 (9.0) | .114 |

Abbreviation: ROM, range of motion.
* Significance level for male to female between-group comparisons made by independent *t* test (continuous data) or chi-square test (categorical data).

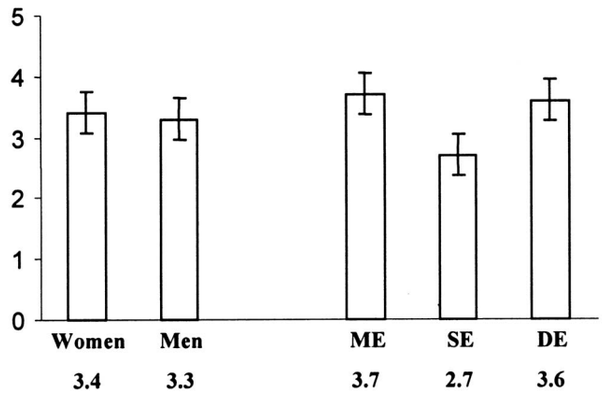
Stepwise regression models were created to investigate sex differences in demographic and clinical measures that predicted 4-week change scores in pain intensity and pain-related disability. Separate regression models were created for each sex to predict changes in pain intensity and pain-related disability. Stepwise regression was used because we had no a priori hypotheses about sex differences in demographic and clinical predictors. To predict changes in pain intensity, all baseline demographic and clinical measures listed in Table 1 were considered in the regression models. The criterion for an individual variable entering the regression model was $P = .05$, and the criterion for remaining in the regression model was $P = .05$. The same procedure was performed for the regression model to predict changes in pain-related disability.

Last, we assessed each created regression model for potential confounding due to clinical trial by entering the clinical trial source variable into each final model and observing its effect on regression coefficients.[43]

## RESULTS

Baseline descriptive information and sex differences for the pooled sample are reported in Table 2. There were no statistically significant sex differences noted in the demographic and clinical data, with the exception of men reporting higher pain intensity (mean difference, 0.8; 95% CI, 0.2 to 1.4). The 4-week reassessment rate was 96.2% and subjects with missing 4-week data did not significantly differ on baseline demographic and clinical variables from those completing the 4-week reassessment ($P > .05$). The mean 4-week reductions for the entire sample in pain intensity and pain-related disability were 3.3 (95% CI, 2.9 to 3.8) and 23.5 (95% CI, 20.8 to 26.2), respectively. The 1-sample Kolmogorov-Smirnov tests indicated change scores for pain intensity and pain-related disability approximated a normal distribution ($P > .05$).

The ANOVA models for changes in pain intensity and pain-related disability are summarized in Figures 1 and 2, respectively. Because men reported higher baseline pain intensity, that variable was added as a covariate to both ANOVA models. There was no significant interaction between sex and intervention for pain intensity, indicating that the sexes responded similarly to the 3 types of physical therapy intervention included in this study. Therefore, only main effects for reductions in pain intensity are depicted in Figure 1. Women and men had similar reductions in pain intensity from selected interventions for acute LBP (raw mean difference, 0.5; 95% CI, –1.4 to 0.4). There was also no significant interaction between sex and intervention for pain-related disability, indicating that the sexes responded similarly to the 3 types of physical therapy intervention included in this study. Therefore, only main effects are depicted in Figure 2. These results indicated that women and men had similar reductions in pain-related disability from interventions for acute LBP (raw mean difference, 5.3; 95% CI, –0.1 to 10.7). Of interest, larger reductions were observed from manipulation with exercise when compared to lumbar strengthening and stabilization

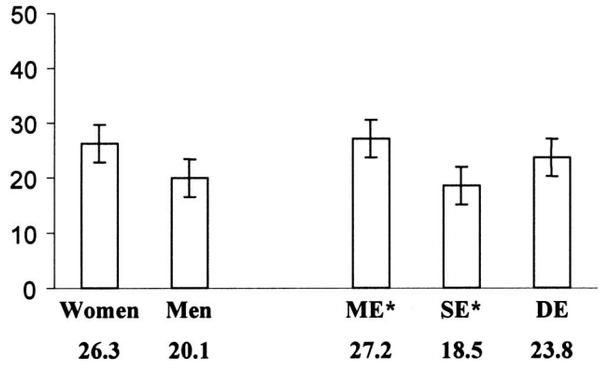



B

*Dependent variable = 4-week change in pain intensity*

| Source | *df* | Mean-Square | F | *P* Value |
|---|---|---|---|---|
| Corrected model | 6 | 41.63 | 7.85 | <.001 |
| Intercept | 1 | 2.45 | 0.46 | .498 |
| Covariate | 1 | 192.00 | 36.18 | <.001 |
| Baseline pain intensity | | | | |
| Intervention | 2 | 15.89 | 2.99 | .053 |
| Sex | 1 | 0.00 | 0.00 | .994 |
| Intervention x Sex | 2 | 4.10 | 0.77 | .462 |
| Error | 134 | 5.31 | | |

**FIGURE 1.** (A) No sex differences for 4-week reduction in pain intensity. Data are reduction in pain intensity using a 0-to-10 numeric rating scale. (B) Summary of analysis of covariance model. Baseline pain intensity used as a covariate. Error bars indicated 1 standard error. Estimated marginal means are reported. Abbreviations: DE, direction specific exercise; ME, manipulation and exercise; SE, lumbar stabilization exercise.




B

*Dependent variable = 4-week change in pain disability*

| Source | *df* | Mean-Square | F | *P* Value |
|---|---|---|---|---|
| Corrected model | 6 | 681.16 | 2.26 | .040 |
| Intercept | 1 | 5140.33 | 17.08 | <.001 |
| Covariate | 1 | 245.62 | 0.82 | .368 |
| Baseline pain intensity | | | | |
| Intervention | 2 | 1195.59 | 3.97 | .021 |
| Sex | 1 | 1168.48 | 3.88 | .051 |
| Intervention × sex | 2 | 198.09 | 0.66 | .519 |
| Error | 154 | 300.99 | | |

**FIGURE 2.** (A) No sex differences for 4-week reduction in pain-related disability. Data are change in pain-related disability (% 1-100 scale). (B) Summary of analysis of variance (ANOVA) model. Baseline pain intensity used as a covariate. Error bars indicate one standard error. Estimated marginal means are reported. Abbreviations: DE, directional preference exercise; ME, manipulation and exercise; SE, lumbar stabilization exercise. *Statistically significant ($P<.05$) difference in means for intervention.

exercise interventions (mean difference, 8.6; 95% CI, 1.4 to 15.9), regardless of sex.

The final regression models for predicting change in pain intensity by sex are summarized in Table 3. Baseline pain intensity, duration of symptoms, and baseline pain-related disability significantly predicted change in pain intensity for women ($r^2$ = 26%, $P<.01$). Baseline pain intensity and lumbar strengthening and stabilization exercise significantly predicted changes in pain intensity for men ($r^2$ = 33%, $P<.01$). The final regression models for predicting changes in pain-related disability by sex are summarized in Table 4. Baseline pain-related disability, pain intensity, and duration of symptoms significantly predicted change in pain disability for women ($r^2$ = 24%, $P<.01$). Baseline pain-related disability, fear-avoidance beliefs about work, leg pain, and lumbar strengthening and stabilization exercise significantly predicted changes in pain-related disability for men ($r^2$ = 32%, $P<.01$). There was no evidence to suggest confounding from clinical trial sources, as addition of that variable did not meaningfully affect the regression coefficients for any of the final regression models.[43]

## DISCUSSION

This study examined sex differences in pain intensity and pain-related disability for patients receiving physical therapy for acute LBP. Although experimental studies have shown females to have higher pain sensitivity,[20,52,57] these findings have not been consistently corroborated by clinical studies. These results partially refuted our first hypothesis that men and women would have similar clinical pain reports. There were no statistically significant sex differences in baseline pain-related disability, supporting our first hypothesis. However, men had significantly higher baseline pain intensity reports. The statistical evidence for a sex difference was quite strong ($P$ = .006), but the clinical relevance of this finding can be questioned. While the magnitude of the difference was moderate (effect size, 0.44), the absolute difference was less than 1.0 on an 11-point scale. For reference, a 1.0 difference in pain intensity does not exceed a clinically important difference for determining individual change (approximately 2.0 on an 11-point NRS[9,12]). This study suggests that men and

women have similar reports of pain-related disability and provides preliminary statistical evidence that men have higher baseline reports of pain intensity. Future research is necessary to replicate this apparent sex difference, as it is in the opposite direction from sex differences reported in the previously cited experimental literature.

The previously reported sex differences in response to physical therapy treatment for chronic LBP were pain intensity reduction for intensive back exercises (favoring women) and hot packs and intermittent traction (favoring men),[32] general and mental health improvements (favoring women) and vitality improvement (favoring men) from a behavioral medicine approach that included physical therapy,[37] and multifidus fatigue (favoring women) from spinal stabilization exercises.[62] Other studies involving physical therapy have reported similar outcomes for the sexes in reductions in pain intensity or disability.[27,32,37,41,46] Our results converge with the latter studies, as men and women with acute LBP had similar decreases in pain intensity and pain-related disability after 4-weeks of physical therapy. It is important to note that the observed sex differences in this study for reductions in pain intensity and pain-related disability were neither statistically significant nor clinically meaningful.[6,9,12,26] Collectively, these studies suggest consistency in the way the sexes respond to standard regimens of manipulation, lumbar stabilization, and directional preference for treatment of acute LBP. However, additional research is necessary to confirm this assertion and to address the remaining inconsistencies with previous reports in the literature.

We also investigated sex-specific predictors of change in clinical pain intensity and pain-related disability. This topic has been the subject of recent studies. For example, ischemic pain tolerance was a significant predictor of outcome from multidisciplinary treatment for chronic pain for females, but not males.[15] Also, emotion-focused avoidance was predictive of change in pain disability after epidural steroid injection for women with LBP, while pain-related anxiety was predictive of change in pain-related disability for men.[35] In the same study, problem-focused avoidance was predictive of change in pain intensity for men, while no factors predicted change in pain intensity for women.[35]

Our analysis provides further evidence that the sexes may differ on clinical factors predictive of pain intensity or pain-related disability outcome following treatment of acute LBP. Baseline pain intensity was predictive of 4-week reduction in pain intensity for women and men. For women, symptom duration and baseline pain-related disability were also predictive of changes in pain intensity. In contrast, receiving stabilization exercise was negatively predictive of reduction in pain intensity for men only. Baseline pain-related disability was predictive of 4-week reduction in pain-related disability for women and men, but the sexes differed considerably on other factors. For women, duration of symptoms and pain intensity were also predictive of 4-week change in pain-related disability. For men, baseline fear-avoidance beliefs, presence of

**TABLE 3.** Sex differences in predictors of 4-week reduction in pain intensity.

| Variables | $r^2$ | B (95% CI)* | Beta* | *P* Value* |
|---|---|---|---|---|
| Final model, women | 0.26 | | | <.001 |
| Baseline pain intensity | | .52 (0.24, 0.80) | .44 | <.001 |
| Baseline pain-related disability | | –.06 (–0.10, –0.01) | –.31 | .010 |
| Duration of symptoms | | –.09 (–0.16, –0.03) | –.35 | .003 |
| Final model, men | 0.33 | | | <.001 |
| Baseline pain intensity | | .90 (0.57, 1.23) | .55 | <.001 |
| Stabilization exercise | | –1.26 (–2.43, –0.08) | –.21 | .037 |

* Reported values are from the final model.

**TABLE 4.** Sex differences in predictors of 4-week reduction in pain disability.

| Variables | $r^2$ | B (95% CI)* | Beta* | *P* Value* |
|---|---|---|---|---|
| Final model, women | 0.24 | | | <.001 |
| Baseline pain-related disability | | .33 (0.04, 0.61) | .23 | .025 |
| Baseline pain intensity | | –1.92 (–3.77, –0.07) | –.18 | .042 |
| Duration of symptoms | | –.55 (–0.95, –0.14) | –.29 | .009 |
| Final model, men | 0.32 | | | <.001 |
| Baseline pain-related disability | | .65 (0.34, 0.97) | .35 | <.001 |
| Fear-avoidance beliefs about work | | –.43 (–0.83, –0.02) | –.21 | .039 |
| Stabilization exercise | | –9.17 (–16.73, –1.61) | –.21 | .018 |
| Leg pain | | –9.74 (–17.48, –2.00) | –.21 | .014 |

* Reported values are from the final model.

leg pain, and stabilization exercise were predictive of 4-week change in pain-related disability.

These findings corroborate previous studies that have been reported in the literature. For example, it has been well established that initial clinical reports of pain intensity and pain-related disability are strong predictors of pain-related outcome measures.[5,8,29,34] Our findings converge with those reports and suggest that there is no obvious sex difference in pain intensity and pain-related disability as predictors of outcome. Stabilization exercise was a significant predictor of improvements in pain intensity and pain-related disability for men, with a negative association observed. This finding suggests that men receiving stabilization exercise can be expected to have worse outcomes for pain intensity and pain-related disability. Interestingly, this finding converges with a recently published clinical prediction rule, as females were more likely to have improved with stabilization exercise (62% versus 38%).[33] Therefore, there is consistent evidence in the literature suggesting that the response to stabilization exercise may be sex specific, although replication of this finding is needed in additional studies.

Another clinical study suggests that for chronic pain, the sexes have different psychological associations with pain reports.[51] Our finding that fear-avoidance beliefs were predictive of pain disability for men converges with the previously cited study,[51] providing general evidence that different psychological associations with the reporting of pain exist with the experience of acute pain. There are also several studies suggesting that anxiety is closely correlated to pain report for men, but less so for women.[28,40,54] This study also converges with those studies, providing additional evidence that men may have a stronger association between anxiety-related constructs (like fear-avoidance beliefs) and clinical pain reports.

These findings also suggest potential directions for prognostic studies involving physical therapy treatment of acute LBP. Early identification of patients that are at risk for developing chronic pain is a key component of a secondary prevention strategy in managing LBP. Leg pain,[10,64] duration of symptoms,[5,34,48] and fear-avoidance beliefs,[24,25,44] are well-established prognostic factors for increasing the probability of experiencing chronic LBP. This study adds to the existing literature by suggesting these factors may be better predictors of outcome based on sex, which is something previous studies did not explicitly consider. If common prognostic factors had differing predictive abilities based on sex of the patient, it could influence the manner in which patients with acute LBP are screened for developing chronic LBP. Of course, this assertion is speculative at this time and it is difficult to determine if the findings from our regression models have any immediate clinical relevance. Independent research is necessary to confirm and modify whether the sex-specific prognostic factors are accurate outcome predictors.

## Limitations

This study has several limitations that should be considered when interpreting the results. The primary limitation is that this was a secondary analysis of 3 different randomized trials. We felt the trials were appropriate for pooling because each was based on a validated treatment-based classification system,[14,17,22,23,30] and used standard assessment and treatment techniques. Another potential limitation is that there was some variability among the trials in key variables, which could potentially influence the results by introducing a separate ''clinical trial effect.'' However, there was also evidence that it was appropriate to pool these trials. For example, the reductions in pain intensity and pain-related disability were statistically similar (Table 1) and a sensitivity analysis indicated that a clinical trial variable did not confound the regression coefficients for the final regression models. The difference in sex distribution was expected because 1 trial primarily involved recruitment from the military. We do not feel this difference biased our results because there is no available evidence to suggest that military personnel responded differently to the physical therapy interventions included in these studies. Another limitation to consider is that the regression models reported in this study explained relatively low amounts of variance, ranging from 24% to 33%. Therefore, it is reasonable to conclude that factors not included in this study could potentially make meaningful contributions to predicting changes in pain intensity and pain-related disability. For example, we only considered the biological orientation of subjects, and did not directly measure the subjects' gender role expectations of pain. Experimental studies have suggested that gender role expectations of pain independently influence response to standard pain stimuli.[55,58,57] The influence that gender role has on clinical musculoskeletal pain conditions has not been widely investigated, but inclusion of this variable could potentially have affected our regression models. Last, the 4-week follow-up period is also a limitation that does not allow the sex differences in predictors of outcome to be generalized to more distal time points commonly associated with the development of chronic LBP (ie, 6 months and greater).

## CONCLUSIONS

Men and women had similar reductions in pain intensity and pain-related disability after 4-weeks of manipulation and exercise, lumbar stabilization exer-

cise, or directional preference exercise. However, there were sex differences in factors that predicted treatment response. Baseline pain intensity predicted change in pain intensity for women and men. Baseline pain-related disability and duration of symptoms predicted change in pain intensity for women only. In contrast, stabilization exercise predicted change in pain intensity for men. Baseline pain-related disability predicted change in disability for women and men. Duration of symptoms and baseline pain intensity also predicted change in pain-related disability for women. Fear-avoidance beliefs, stabilization exercise, and leg pain also predicted change in pain-related disability for men.

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