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A Comparison of the Effects of 2 Types of Massage and Usual Care on Chronic Low Back Pain

A Randomized, Controlled Trial

Daniel C. Cherkin, PhD; Karen J. Sherman, PhD, MPH; Janet Kahn, PhD; Robert Wellman, MS; Andrea J. Cook, PhD; Eric Johnson, MS; Janet Erro, RN, MN; Kristin Delaney, MPH; and Richard A. Deyo, MD, MPH

Background: Few studies have evaluated the effectiveness of massage for chronic low back pain.

Objective: To compare the effectiveness of 2 types of massage and usual care for chronic back pain.

Design: Parallel-group randomized, controlled trial. Randomization was computer-generated, with centralized allocation concealment. Participants were blinded to massage type but not to assignment to massage versus usual care. Massage therapists were unblinded. The study personnel who assessed outcomes were blinded to treatment assignment. (ClinicalTrials.gov registration number: NCT00371384)

Setting: An integrated health care delivery system in the Seattle area.

Patients: 401 persons 20 to 65 years of age with nonspecific chronic low back pain.

Intervention: Structural massage (n = 132), relaxation massage (n = 136), or usual care (n = 133).

Measurements: Roland Disability Questionnaire (RDQ) and symptom bothersomeness scores at 10 weeks (primary outcome) and at 26 and 52 weeks (secondary outcomes). Mean group differences of at least 2 points on the RDQ and at least 1.5 points on the symptom bothersomeness scale were considered clinically meaningful.

Results: The massage groups had similar functional outcomes at 10 weeks. The adjusted mean RDQ score was 2.9 points (95% CI, 1.8 to 4.0 points) lower in the relaxation group and 2.5 points (CI, 1.4 to 3.5 points) lower in the structural massage group than in the usual care group, and adjusted mean symptom bothersomeness scores were 1.7 points (CI, 1.2 to 2.2 points) lower with relaxation massage and 1.4 points (CI, 0.8 to 1.9 points) lower with structural massage. The beneficial effects of relaxation massage on function (but not on symptom reduction) persisted at 52 weeks but were small.

Limitation: Participants were not blinded to treatment.

Conclusion: Massage therapy may be effective for treatment of chronic back pain, with benefits lasting at least 6 months. No clinically meaningful difference between relaxation and structural massage was observed in terms of relieving disability or symptoms.

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For author affiliations, see end of text.

Massage is one of the most popular complementary and alternative medical therapies for neck and back pain (1), conditions that account for more than one third (2) of the more than 100 million annual visits to massage therapists in the United States (3). Almost all massage therapists in the United States use Swedish massage techniques aimed at relaxation, but only a minority take courses in such techniques as structural massage for treatment of chronic low back pain. Recent reviews have found limited evidence that massage is an effective treatment of chronic back pain (4, 5), and no studies have compared relaxation massage with structural massage, which focuses on correcting soft-tissue abnormalities. We therefore conducted a trial to determine whether relaxation massage reduces pain and improves function in patients with chronic low back pain and compared relaxation and structural massage for treating this condition.

METHODS

Study Design

Study procedures are described in detail elsewhere (6). In brief, we used advertisements in the health plan magazine of the Group Health Cooperative and mailings to invite members of the plan who were aged 20 to 65 years and had outpatient visit diagnoses suggesting nonspecific chronic low back pain to participate in the trial. Invitation letters were mailed 3 to 12 months after visits. Study staff phoned respondents to determine their eligibility; criteria were low back pain lasting at least 3 months without 2 or more pain-free weeks and pain bothersomeness rated at least 3 on a scale of 0 to 10. Exclusion criteria were 1) specific causes of back pain (for example, cancer, fractures, or spinal stenosis), 2) complicated back problems (for example, sciatica, back surgery in the past 3 years, or medicolegal issues), 3) conditions making treatment difficult

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Context

Massage therapy is widely used for back pain.

Contribution

Patients with chronic low back pain who received 10 weekly sessions of structural or relaxation massage therapy experienced clinically important improvements in symptoms and disability compared with patients who received usual care. There was no apparent difference in effect between the 2 types of massage.

Caution

Participants assigned to usual care knew that they were not receiving massage therapy and may have been more likely to report less improvement.

Implication

Massage therapy seemed to be an effective short- and longer-term treatment for chronic low back pain. There was no apparent difference between relaxation and structural massage, the latter of which may be more expensive and requires specialized techniques.

—The Editors

(for example, paralysis or psychoses), 4) conditions that might confound treatment effects or interpretation of results (for example, severe fibromyalgia or rheumatoid arthritis), 5) inability to speak English, 6) massage within the past year, or 7) plans to visit a provider for back pain. Eligible respondents were administered a baseline questionnaire and randomly assigned to a treatment group. All participants gave written informed consent, and the study was approved by the institutional review board of Group Health Cooperative.

Randomization and Interventions

The randomization schedule was created by a biostatistician and was blocked on massage therapist; allocation was centrally generated and concealed. Participants were randomly allocated in a 1:1:1 ratio to receive usual care, relaxation massage, and structural massage. Therapists were not blinded to the type of massage that they provided. Participants knew whether they received massage but were blinded to type; usual care recipients were aware that they had enrolled in a trial of massage. Study personnel assessing trial outcomes were blinded to study assignment.

Study Treatments

Massage was provided by 27 licensed therapists with at least 5 years of experience who were comfortable following the study protocol and had experience in the permitted techniques. Therapists received 1.5 days of protocol training (6). Treatment fidelity was promoted by monitoring treatment forms that the therapists completed at each visit, along with corrective feedback and a midstudy meeting.

Both massage techniques were provided in the therapists' offices at no cost. Both massage protocols prescribed 10 weekly treatments, with first visits lasting 75 to 90 minutes and follow-up visits lasting 50 to 60 minutes. We defined "adherence" as completion of at least 8 visits. At each visit, therapists could recommend up to 3 home exercises from a predefined list of 7 exercises, 6 of which were common to both treatments (6).

Relaxation massage, which is intended to induce a generalized sense of relaxation, comprised effleurage, petrissage, circular friction, vibration, rocking and jostling, and holding. Therapists were given time limits for each body region, including 7 to 20 minutes on the back and buttocks (6). Therapists could provide a compact disk of a 2.5-minute relaxation exercise to be done at home to enhance and prolong treatment benefits.

Structural massage, which is intended to identify and alleviate musculoskeletal contributors to back pain, comprised myofascial, neuromuscular, and other soft-tissue techniques (6). Myofascial techniques are intended to engage and release identified restrictions in myofascial tissues. Neuromuscular techniques are used to resolve soft-tissue abnormalities by mobilizing restricted joints, lengthening constricted muscles and fascia, balancing agonist and antagonist muscles, and reducing hypertonicity. The areas of the body that were treated varied across patients and treatment sessions. Therapists could recommend a home exercise consisting of psoas stretch to enhance and prolong any benefits of structural massage.

Usual care participants received no special care but were paid $50. Actual care was determined from medical records and interviews.

Outcomes and Follow-up

Outcomes were measured at baseline and at 10, 26, and 52 weeks by interviewers who were masked to treatment assignment. Prespecified primary outcomes were back pain–related dysfunction and symptoms at 10 weeks, immediately after treatment completion.

Dysfunction was measured by using the modified Roland Disability Questionnaire (RDQ), a reliable, valid, and sensitive measure with substantial construct validity (7, 8). A between-group difference in improvement in mean values of at least 2 points on this scale of 0 to 23 points was considered clinically meaningful (8, 9).

Symptoms were assessed by asking participants to rate the bothersomeness of their pain during the past week from 0 ("not at all") to 10 ("extremely"). A between-group difference in improvement in mean values of at least 1.5 points was considered clinically meaningful (8, 9).

Secondary outcomes were 1) 26- and 52-week measures of the primary outcomes; 2) percentage of participants with prespecified clinically meaningful, individual-level reductions in dysfunction (≥3-point decrease in RDQ score) and symptoms (≥2-point decrease in symptom bothersomeness score); 3) physical and mental health Short Form-12 Health Survey component summary scores (10); 4) self-reported medication use for back pain in the

previous week; 5) days spent in bed, home from work or school, or cutting down on usual activities because of back problems during the past week (11); 6) global improvement in back pain–related dysfunction, rated on a 7-point scale from "completely gone" to "much worse"; 7) the patient's feelings about spending the rest of his or her life with the back pain experienced in the past week (7-point scale ranging from "delighted" to "terrible"); 8) satisfaction with back care, rated by using a 5-point Likert scale (ranging from "very satisfied" to "very dissatisfied"); and 9) total costs of back pain–related visits, imaging studies, and medications during the follow-up year, as ascertained from electronic medical records. Visits not covered by the health plan were identified from interviews. Finally, participants were asked open-ended questions about adverse experiences on the 10-week interview and at each massage visit.

Statistical Analysis

Sample size was calculated to ensure adequate power at 10 weeks to detect a clinically meaningful 2-point mean difference between the structural massage and usual care groups in RDQ scores, assuming that the structural massage group would have scores that were 1 point better than the relaxation massage group. Assuming 10% loss to follow-up and SDs that were derived from our pilot study of 92 participants (SD, 4.65 for RDQ score and 2.71 for symptom bothersomeness score), we estimated that a target sample of 399 persons (133 per group) was needed. For RDQ scores, this provided 85% power to detect a significant difference among the 3 treatment groups by using an omnibus Wald test and 91% power to detect a pairwise difference of 2 points; for symptom bothersomeness scores, it provided greater than 99% power to detect a significant difference among the 3 treatment groups and 99% power to detect a pairwise difference of 1.5 points.

Analyses were conducted according to the original randomized treatment assignment regardless of adherence to protocol. Analyses were conducted by using regression through generalized estimating equations (12) with an independent working correlation structure and robust SE estimates taking into account multiple outcomes per participant. Follow-up times were treated as categorical variables using dummy variables for each treatment, each time point, and all 2-way interactions between follow-up time and treatment. Adjusted models included baseline covariates that were prespecified, were imbalanced at baseline (that is, potential confounders), or were associated with a primary outcome (that is, precision variables): age, group, sex, baseline RDQ and symptom bothersomeness scores, education level, body mass index, type of work, original cause of back pain, more than 7 days of reduced activities because of back pain, and medication use in the previous week. We prespecified the adjusted analysis as the primary analysis. For continuous and binary outcome measures, we applied linear and modified Poisson regression, respectively, with robust SEs. Modified Poisson regression allows estimation of relative risks for nonrare outcomes using Poisson regression and corrects the misspecification of the variance using robust SEs in a generalized estimating equation framework (13).

To control for multiple comparisons, we used the least-significant-difference approach, in which pairwise treatment comparisons were evaluated at a given time only if the overall omnibus P value was statistically significant at 0.05. Mean differences, 95% CIs, and omnibus P values for treatment group effect and pairwise significance are presented.

To assess effects of individual providers on the RDQ outcome, we fitted an adjusted mixed-effects model with a random intercept for each provider by using only data from the 2 massage groups. The intraclass correlation coefficient was calculated to quantify the degree of variability due to providers relative to the overall variability of the outcome. Analyses were performed by using SAS software, version 9.2 (SAS Institute, Cary, North Carolina), and 2-sided P values were calculated.

The proportions of missing data for the primary outcome measures were 5% at 10 weeks, 7% at 26 weeks, and 9% at 52 weeks. We used Stata, version 10.1 (StataCorp, College Station, Texas) (14), to perform multiple imputation by chained equations to account for missingness. We imputed both missing outcomes and baseline covariates. Estimates from each imputed data set were combined by following rules outlined by Rubin (15, 16). Imputed analysis did not yield appreciable differences from the unadjusted and adjusted complete-case analyses (results not shown). Specifications for missing data imputation are shown in the **Appendix** (available at www.annals.org).

Role of the Funding Source

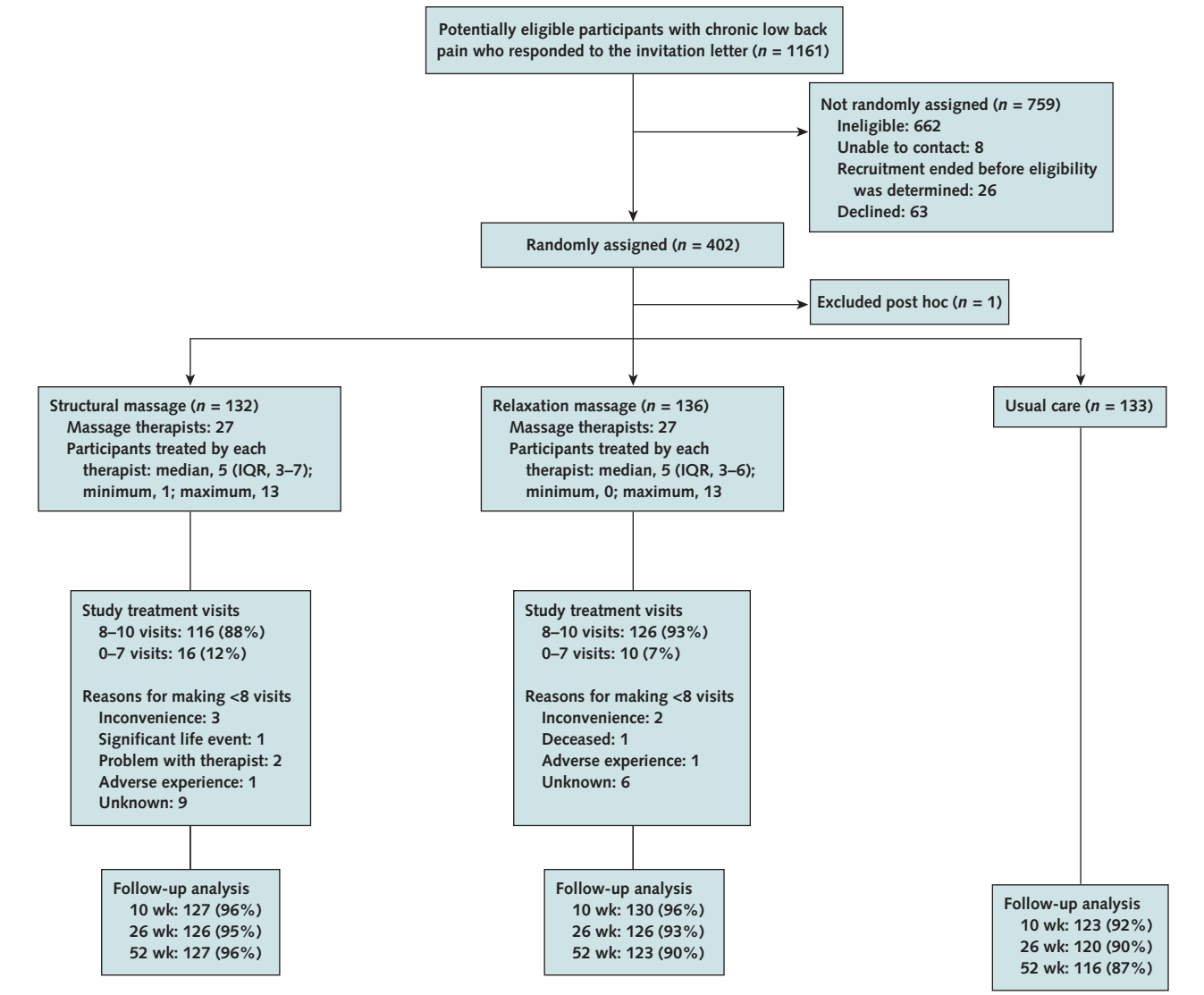
This trial was funded by the National Center for Complementary and Alternative Medicine (NCCAM) and was approved their Office of Clinical and Regulatory Affairs. The NCCAM did not participate in the research.

RESULTS

Study Recruitment and Follow-up

We mailed 9127 invitations and evaluated 1161 responses; 402 persons (35%) were eligible and were randomly allocated (**Figure 1**). The main reasons for ineligibility were massage in previous year (22%), less than 3 months of back pain (20%), sciatica (14%), medical contraindications (12%), and planned visits for back pain (10%). One participant with an abdominal aortic aneurysm was excluded after randomization. Analyses included 401 participants assigned to relaxation massage ($n = 136$), structural massage ($n = 132$), or usual care ($n = 133$). Follow-up was 95% at 10 weeks, 93% at 26 weeks, and 91% at 52 weeks. Interviewers reported that treatment group (massage or usual care) had been revealed to them by fewer than 10% of participants.

Figure 1. **Study flow diagram.**



IQR = interquartile range.

Baseline Characteristics

Participants were mostly middle-aged, female, and white; 51% were college graduates (**Table 1**). Mean scores of 10.8 on the RDQ and 5.7 for symptom bothersomeness indicated moderately severe back problems. Participants assigned to relaxation massage had greater dysfunction (RDQ score >1 point higher), but there were no other clinically or statistically significant differences among the groups at baseline.

Study Treatments

Treatment adherence was 93% in the relaxation massage group and 88% in the structural massage group. Therapist recommendations for the 6 home exercise options available to both treatments were similar (**Appendix Table 1**, available at www.annals.org). For relaxation massage participants, therapists recommended the relaxation CD at 41% of first visits. For structural massage participants, therapists recommended the psoas stretch exercise at 8% of first visits. Therapists rated participants' mean level of adherence to self-care recommendations (mostly stretching exercises) in both groups as 7.0 on a scale of 0 to 10. After the first visit, therapists had similar expectations of the helpfulness for participants of relaxation and structural massage (6.5 and 7.2, respectively, on a scale of 0 to 10).

Primary Outcomes

All groups showed improved function and decreased symptoms at 10 weeks (**Figure 2** and **Table 2**), but improvement was greater with either type of massage. Com-

pared with those of usual care recipients, RDQ scores were 2.9 points (95% CI, 1.8 to 4.0 points) lower among relaxation massage recipients and 2.5 points (CI, 1.4 to 3.5 points) lower among structural massage recipients ($P < 0.001$ for both adjusted estimates). There was no difference in function between the 2 types of massage (adjusted difference, 0.5 point [CI, −0.5 to 1.5 points]; $P = 0.35$), and the confidence bounds around the adjusted estimate of absolute difference between massage groups excluded values large enough to be considered clinically relevant (2-point difference in RDQ score and 1.5-point difference in symptom bothersomeness score [8, 9]). Similar results were found for symptom bothersomeness.

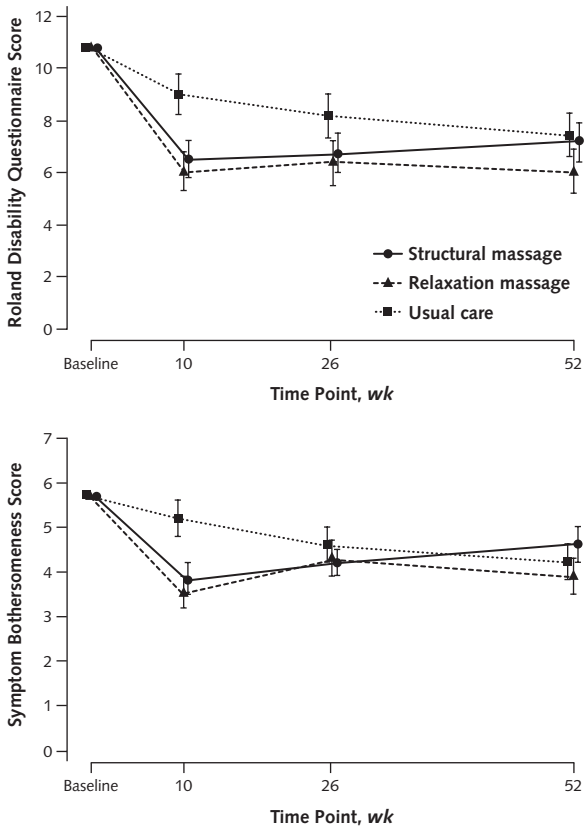
Effects decreased after the 10-week treatment (**Figure 2**), although differences in functional improvement among the groups remained statistically significant at 26 and 52 weeks (**Table 2**). At 26 weeks, participants in the usual care group continued to function less well than recipients of relaxation massage (by 1.8 RDQ points [CI, 0.6 to 3.0 points]) and structural massage (by 1.4 RDQ points [CI, 0.3 to 2.6 points]). There were no clinically or statistically significant differences between types of massage. At 52 weeks, relaxation massage was modestly more effective than structural massage (by 1.1 RDQ points [CI, 0.02 to 2.2 points]). No significant differences in symptoms were observed among the 3 groups at 26 or 52 weeks.

Table 1. **Participant Characteristics at Baseline***

Characteristic	Treatment Group		
	Structural Massage ($n = 132$)	Relaxation Massage ($n = 136$)	Usual Care ($n = 133$)
Demographic			
Women, %	66	65	62
White race, %	86	87	86
Mean age (SD), *y*	46 (12)	47 (11)	48 (11)
Mean body mass index (SD), kg/m^2	29 (7)	28 (6)	29 (6)
Married, %	74	71	74
Completed at least some college, %	51	53	49
Annual household income <$45 000, %	31	26	30
Physical demands of job, %			
Not employed	13	21	17
Work is mainly sedentary	37	36	42
Work requires lifting up to 20 lb	21	13	17
Work requires lifting >20 lb	29	29	23
Mean SF-12 physical health scale score (SD)	40 (9)	38 (8)	39 (8)
Mean SF-12 mental health scale score (SD)	50 (9)	50 (10)	50 (9)
LBP			
Original cause of LBP unknown, %	23	13	14
LBP for at least 1 y, %	77	72	78
Mean days with LBP in past the 6 mo (SD)	133 (51)	128 (50)	131 (55)
Pain below knee, %	11	15	19
Mean RDQ score (scale of 0–23) (SD)	10.1 (5.0)	11.6 (5.0)	10.5 (5.3)
Mean LBP bothersomeness in past week (scale of 0–10) (SD)	5.6 (1.5)	5.6 (1.8)	5.8 (1.6)
Medication use in past week for LBP, %			
Any	68	70	74
NSAIDs	50	57	55
Nonnarcotic analgesics	16	15	20
Narcotic analgesics	17	17	13
Sedatives	9	11	13
Effect of LBP on activity, %			
Decreased activity ≥7 d in the past 4 wk	22	35	29
Kept in bed ≥1 d in past 4 wk	20	22	26
Missed work or school ≥1 d in past 4 wk	18	21	20
Very satisfied with LBP care, %	14	9	15
Expect at least moderate improvement in LBP in 1 y, %	36	33	31
Did back exercises for ≥3 d in past week, %	52	51	50
Did active exercises for ≥3 d in past week, %	65	56	59
Massage experience and expectation			
Number of prior visits to massage therapists, %			
0 visits	26	32	31
1–9 visits	43	38	44
≥10 visits	31	30	25
Previous back or neck massage, %	46	39	34
Mean expected helpfulness of massage for LBP (scale of 0–10) (SD)	7.1 (2.0)	7.0 (1.9)	6.8 (2.2)

LBP = low back pain; NSAID = nonsteroidal anti-inflammatory drug; RDQ = Roland Disability Questionnaire; SF-12 = Short Form-12 Health Survey.
* Less than 2% of data were missing for all variables except income (4%) and expected helpfulness of massage (5%–6%).

Figure 2. **Mean Roland Disability Questionnaire (*top*) and symptom bothersomeness (*bottom*) scores.**



Estimates were computed by using generalized estimating equation models with covariates set to the overall sample mean. Higher scores for both outcomes signify greater disability or symptom bothersomeness.

Results were similar when primary outcomes were measured as the percentage of participants who had clinically meaningful improvement. At 10 weeks, 62% to 65% of massage recipients and 38% of usual care recipients had clinically meaningful improvement (adjusted overall $P < 0.001$) (**Figure 3**). The benefits of massage decreased over time and were not statistically significant at 52 weeks. Massage recipients were more likely than participants in the usual care group to experience clinically meaningful reductions in symptom bothersomeness at 10 weeks.

Secondary Outcomes

At 10 weeks, the groups differed significantly in limitations in activities (days in bed, reduced activity, and days off work), patient global rating of improvement, use of nonsteroidal anti-inflammatory medications, satisfaction with current level of back pain, satisfaction with back pain care, and mental health (Short Form-12 Health Survey) (**Appendix Table 2**, available at www.annals.org). The 2 massage treatments had similar effects that were generally greater than those of usual care. Most notably, 36% to 39% of participants receiving massage and only 4% receiving usual care claimed that their back pain was much better or gone at 10 weeks. Massage did not affect use of narcotic analgesics. Massage benefits persisted at 52 weeks for days of reduced activity, global improvement, and satisfaction.

Practitioner Effects

Analysis of massage therapist effect yielded an intraclass correlation coefficient of 0.007, indicating little variability among therapists compared with the overall variability of the RDQ outcome.

Co-interventions and Subsequent Use of Massage

At 10 weeks, 33% of usual care recipients and 18% to 20% of massage recipients reported visiting a provider for back pain since randomization. Eight percent of usual care participants reported a massage visit. Between 10 and 26 weeks, 13% of usual care recipients, 21% of relaxation massage recipients, and 8% of structural massage recipients reported back pain–related massage visits. At 52 weeks, use of massage for back pain during the previous 6 months was

Table 2. **Mean Roland Disability Questionnaire and Symptom Bothersomeness Scores and Pairwise Comparisons**

Outcome and Time Point in Adjusted Analysis*	Mean Value (95% CI)				Between-Group Differences (95% CI)		
	Structural Massage Group	Relaxation Massage Group	Usual Care Group	Omnibus *P* Value†	Structural Massage vs. Usual Care	Relaxation Massage vs. Usual Care	Structural Massage vs. Relaxation Massage
Roland Disability Questionnaire							
10 wk	6.5 (5.8 to 7.2)	6.0 (5.3 to 6.8)	9.0 (8.2 to 9.8)	<0.001	–2.5 (–3.5 to –1.4)	–2.9 (–4.0 to –1.8)	0.5 (–0.5 to 1.5)
26 wk	6.7 (6.0 to 7.5)	6.4 (5.5 to 7.2)	8.2 (7.3 to 9.0)	0.007	–1.4 (–2.6 to –0.3)	–1.8 (–3.0 to –0.6)	0.4 (–0.8 to 1.5)
52 wk	7.2 (6.4 to 7.9)	6.0 (5.2 to 6.9)	7.4 (6.6 to 8.3)	0.049	–0.3 (–1.4 to 0.9)	–1.4 (–2.6 to –0.2)	1.1 (0.02 to 2.2)
Symptom bothersomeness							
10 wk	3.8 (3.5 to 4.2)	3.5 (3.2 to 3.9)	5.2 (4.8 to 5.6)	<0.001	–1.4 (–1.9 to –0.8)	–1.7 (–2.2 to –1.2)	0.3 (–0.2 to 0.8)
26 wk	4.2 (3.9 to 4.5)	4.3 (3.9 to 4.7)	4.6 (4.2 to 5.0)	0.31	–	–	–
52 wk	4.6 (4.2 to 5.0)	3.9 (3.5 to 4.3)	4.2 (3.8 to 4.6)	0.097	–	–	–

* Adjusted for baseline value of outcome, age group, sex, baseline Roland Disability Questionnaire and symptom bothersomeness scores, education, body mass index, physical work demands, original cause of pain, days on which the patient cut down on usual activities, and medication use. Higher scores for both outcomes indicate greater disability or symptom bothersomeness. Between-group comparisons were calculated only if the omnibus *P* value was <0.05 after the least-significant-difference approach was used to control for multiple comparisons.
† Wald *P* value.

18%, 26%, and 22%, respectively, for these groups. Two participants receiving usual care and 1 receiving structural massage had back surgery.

Cost of Back Pain–Related Health Care After Randomization

The massage treatments received by the average participant would have cost about $540 in the community. There is no evidence that these treatments reduced costs of back pain–related health care services during the 1-year posttreatment period. Median health care costs were $25 (range, $0 to $8082) for usual care recipients, $78 (range, $0 to $3764) for relaxation massage recipients, and $38 (range, $0 to $1443) for structural massage recipients.

Adverse Effects

Five of 134 (4%) relaxation massage recipients and 9 of 131 (7%) structural massage recipients reported adverse events possibly related to massage, mostly increased pain. One event in the structural massage group (nausea, shortness of breath, and chest pain) was classified as serious and considered unrelated to treatment.

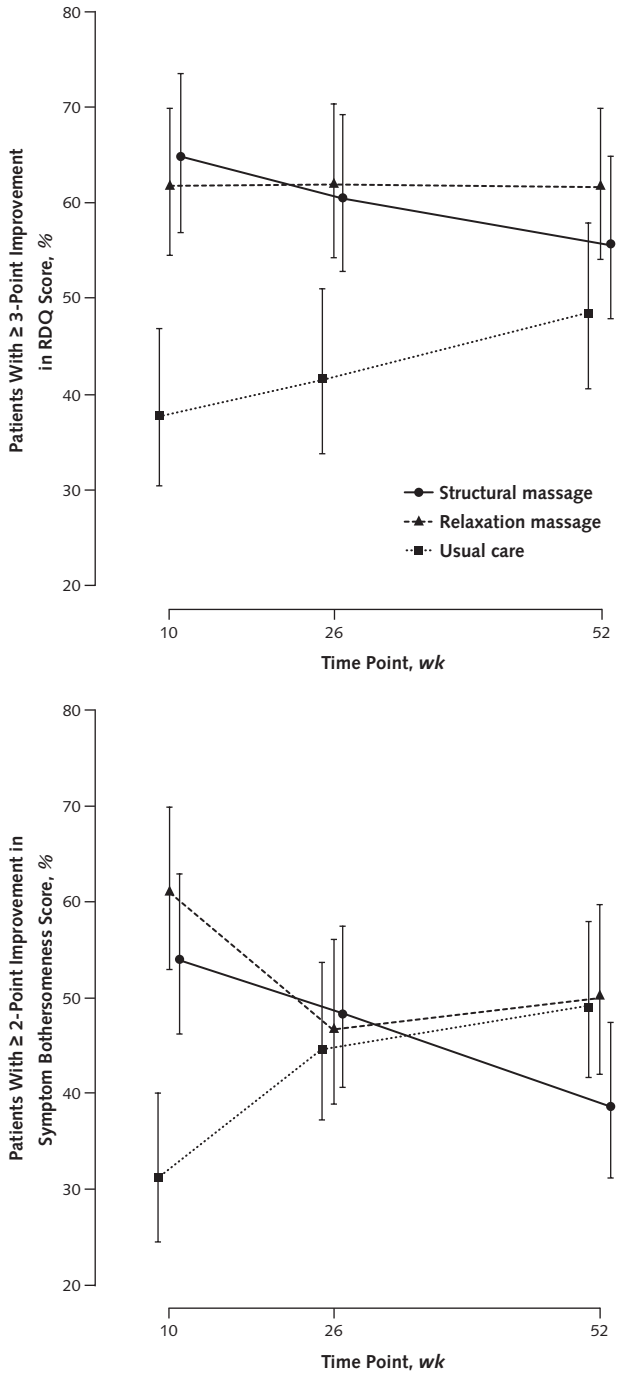
DISCUSSION

We found that massage therapy improved function and decreased pain more than usual care in patients with uncomplicated chronic lower back pain after 10 weeks. A course of relaxation massage, using techniques commonly taught in massage schools and widely used in practice, had effects similar to those of structural massage, a more specialized technique. Both types of massage were associated with improved function at 26 weeks; benefits at 1 year were of questionable clinical significance. We found no evidence of differential effectiveness among the massage therapists, and both relaxation and structural massage had very low rates of adverse effects.

A recent review identified 13 trials published before May 2008 (5) that evaluated the effect of massage on nonspecific back pain. We identified 2 additional trials (17, 18) in MEDLINE as of February 2011. Four trials (19–22) were conducted in North America and evaluated only techniques that were similar to the structural massage treatment in our trial; all found positive results. None of the previous trials evaluated relaxation massage techniques that are commonly taught in massage schools and widely practiced in North America.

The mechanisms explaining the beneficial effects of relaxation and structural massage remain unclear. These distinct forms of massage may trigger similar physiologic effects (for example, through local stimulation of tissue or a generalized central nervous system response) or may work through different mechanisms (for example, structural massage may foster beneficial changes in the treated soft tissues, whereas relaxation massage may operate through the central nervous system). It is also possible that improvements in pain and function are due to nonspecific

Figure 3. **Proportion of participants who improved by at least 3 points on the RDQ (*top*) and by at least 2 points on the symptom bothersomeness scale (*bottom*).**



Estimates were computed by using generalized estimating equation models with covariates set to the overall sample mean. Higher scores for both outcomes signify greater disability or symptom bothersomeness. RDQ = Roland Disability Questionnaire.

effects, such as time spent in a relaxing environment, being touched, receiving care from a caring therapist, being given self-care advice, or increased body awareness (19). A combination of these explanations is also possible.

Our study has limitations. Participants assigned to usual care were told that they were enrolling in a trial of massage therapy, and they often received no additional treatment. This potential failure of blinding to treatment assignment may have led to less favorable self-assessments of function and symptoms, making massage therapy seem more superior than it really is. The exercises recommended in the 2 massage groups differed slightly, which could have contributed to differences in outcomes even though we could not detect a clinically meaningful difference between the 2 types. The massage therapists in our study may have been atypical, having practiced for at least 5 years and learned structural massage techniques. We believed that the study therapists might have provided treatment in a way that favored structural massage because that form of therapy requires more specialized training, but the apparent absence of a difference between massage types makes this possibility unlikely. The trial included mostly women with nonspecific chronic low back pain who were enrolled in a single health care system that serves a mostly white and employed population, which limits the generalizability of our findings. Finally, persons with specific causes of back pain, such as disc herniation, who conceivably could benefit more from structurally focused massage were excluded.

The uncertainties associated with these limitations make it difficult to determine the true magnitude of the benefits of massage observed in this trial. However, our trial also has strengths, including a large sample size, comparison of 2 massage techniques, inclusion of a control group, having the same therapists deliver both treatments, high rates of treatment adherence and follow-up, and long-term follow-up.

In summary, our findings suggest that both relaxation massage and structural massage are reasonable treatment options for persons with chronic low back pain. The findings may suggest a relative advantage for relaxation massage because it is based on techniques that are taught in almost all massage schools and is thus more readily accessible and slightly less expensive than structural and other more specialized forms of massage, which require additional training. Future research should explore the relative contributions of nonspecific context effects and specific treatment effects on outcomes for patients with low back pain who are receiving practitioner-based therapies, such as massage; whether different forms of massage produce benefits through the same or through different physiologic pathways; whether less experienced therapists would produce similar results; whether fewer treatments could have achieved the same outcomes; and whether education and self-care recommendations contribute to the effectiveness of massage.

From Group Health Research Institute and University of Washington, Seattle, Washington; University of Vermont, Burlington, Vermont; and Oregon Health & Science University, Portland, Oregon.

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Reproducible Research Statement: *Study protocol:* Available at www.trialsjournal.com/content/10/1/96. *Statistical code*: Available from Dr. Cook (e-mail, cook.aj@ghc.org). *Data set:* Not available.

Requests for Single Reprints: Daniel C. Cherkin, PhD, Group Health Research Institute, 1730 Minor Avenue, Suite 1600, Seattle, WA 98101.

Current author addresses and author contributions are available at www.annals.org.

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Current Author Addresses: Drs. Cherkin, Sherman, and Cook; Mr. Wellman; Mr. Johnson; Ms. Erro; and Ms. Delaney: Group Health Research Institute, 1730 Minor Avenue, Suite 1600, Seattle, WA 98101. Dr. Deyo: Department of Family Medicine, Oregon Health & Science University, Mail Code FM, 3181 SW Sam Jackson Park Road, Portland, OR 97239-3098.

Author Contributions: Conception and design: D.C. Cherkin, K.J. Sherman, J. Kahn.
Analysis and interpretation of the data: D.C. Cherkin, K.J. Sherman, J. Kahn, R. Wellman, A.J. Cook, E. Johnson, J. Erro, K. Delaney, R.A. Deyo.
Drafting of the article: D.C. Cherkin, K.J. Sherman, R. Wellman, A.J. Cook, K. Delaney.
Critical revision of the article for important intellectual content: D.C. Cherkin, K.J. Sherman, J. Kahn, R. Wellman, A.J. Cook, E. Johnson, J. Erro, R.A. Deyo.
Final approval of the article: D.C. Cherkin, K.J. Sherman, J. Kahn, R. Wellman, E. Johnson, R.A. Deyo.
Statistical expertise: R. Wellman, A.J. Cook, E. Johnson.
Obtaining of funding: D.C. Cherkin, K.J. Sherman.
Administrative, technical, or logistic support: J. Kahn, J. Erro, K. Delaney.
Collection and assembly of data: K.J. Sherman, R. Wellman, J. Erro, K. Delaney.

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Appendix: Specifications for Missing Data Imputation

Description of Missing Data

Overall, data were complete at all 3 follow-up time points for 356 (89%) participants (**Appendix Table 3**). However, 385 (96%) participants had complete data for at least 1 follow-up time point. Of the 45 participants with missing values for primary outcomes, 21 were missing values only at 1 time point, 8 were missing values at 2 time points, and 16 were missing values at all 3 time points (**Table 1**). Only 3 participants were missing covariate information for the subset of variables used in adjusted models; none of those participants was missing data on primary outcomes. Missing outcome data seemed to be primarily related to age, education, assigned treatment group, and baseline RDQ score (**Appendix Table 4**).

Imputation Methods and Models

We used imputation by chained equations, which was originally proposed by van Buuren and colleagues (14) and coded for use in Stata 10 (23–25). Imputation was performed for both outcome variables and covariates used for adjustment. Twenty imputed data sets were generated by using 100 cycles per imputation and the bootstrap option, which relaxes the assumption of normality on the variable estimates. The 20 imputed data sets were imported into SAS, version 9.2, for analysis by using the rules of Rubin for combining results from separate analyses on each imputed data set. Omnibus hypothesis tests were conducted by using an F reference distribution as specified by Li and colleagues (16). All scalar variables were tested by using a t reference distribution as specified by Rubin (25).

Appendix Table 1. **Home Practices Assigned by Massage Therapists at the First and Penultimate Visits**

Home Practice Assignment	First Visit, *n* (%)		Penultimate Visit, *n* (%)	
	Structural Massage Group (*n* = 131)	Relaxation Massage Group (*n* = 133)	Structural Massage Group (*n* = 119)	Relaxation Massage Group (*n* = 129)
Low back resting position	31 (24)	31 (23)	30 (25)	31 (24)
Morning stretch in bed	43 (33)	38 (29)	49 (41)	58 (45)
Cat–cow stretch	25 (19)	23 (17)	42 (35)	51 (40)
Lateral bend	12 (9)	8 (6)	38 (32)	36 (28)
Walking to help lower back	35 (27)	22 (17)	49 (41)	50 (39)
Golf ball roll for plantar fascia	18 (14)	21 (16)	21 (18)	18 (14)
Conscious relaxation (relaxation massage group only)		55 (41)		27 (21)
Psoas stretch (structural massage group only)	10 (8)		30 (25)	

Appendix Table 2. Secondary Outcomes*

Outcome and Time Point	Structural Massage Group	Relaxation Massage Group	Usual Care Group	Omnibus *P* Value†	Structural Massage vs. Usual Care	Relaxation Massage vs. Usual Care	Structural Massage vs. Relaxation Massage
	Adjusted Mean Value (95% CI)				Mean Difference (95% CI)		
Continuous variables							
Short Form-12 mental health scale score							
10 wk	53.7 (52.5 to 55.0)	55.3 (54.2 to 56.5)	50.9 (49.5 to 52.2)	<0.001	2.9 (1.0 to 4.8)	4.5 (2.7 to 6.3)	−1.6 (−3.3 to 0.1)
52 wk	52.4 (50.9 to 53.8)	53.5 (52.2 to 54.8)	51.9 (50.2 to 53.6)	0.27	–	–	–
Short Form-12 physical health scale score							
10 wk	37.2 (36.4 to 38.0)	36.6 (35.7 to 37.5)	37.9 (37.1 to 38.8)	0.110	–	–	–
52 wk	37.7 (36.8 to 38.7)	37.9 (37.0 to 38.7)	37.7 (36.8 to 38.6)	0.96	–	–	–
	Adjusted Percentage (95% CI)				Relative Risk (95% CI)‡		
Binary variables							
Any medication use in the past week for LBP							
10 wk	40.7 (33.9 to 48.7)	50.0 (42.8 to 58.5)	57.4 (50.3 to 65.5)	0.006	0.7 (0.6 to 0.9)	0.9 (0.7 to 1.1)	0.8 (0.6 to 1.0)
26 wk	52.9 (45.9 to 60.9)	52.6 (45.2 to 61.2)	53.7 (46.6 to 61.9)	0.98	–	–	–
52 wk	50.4 (43.0 to 59.1)	46.5 (39.2 to 55.3)	48.5 (41.3 to 57.0)	0.79	–	–	–
NSAID use in the past week for LBP							
10 wk	28.2 (22.2 to 35.9)	30.4 (24.2 to 38.2)	40.0 (33.4 to 48.1)	0.027	0.7 (0.5 to 0.9)	0.8 (0.6 to 1.0)	0.9 (0.7 to 1.3)
26 wk	34.0 (27.3 to 42.2)	33.2 (26.5 to 41.6)	37.1 (30.5 to 45.2)	0.69	–	–	–
52 wk	34.3 (27.4 to 42.9)	25.4 (18.9 to 34.3)	29.7 (23.3 to 37.9)	0.26	–	–	–
Narcotic analgesic use in the past week for LBP							
10 wk	4.6 (3.0 to 7.3)	5.0 (3.0 to 8.5)	5.8 (3.4 to 9.9)	0.69	–	–	–
26 wk	5.0 (3.4 to 7.5)	4.6 (2.7 to 8.1)	5.2 (3.1 to 8.7)	0.93	–	–	–
52 wk	4.8 (3.1 to 7.3)	4.9 (3.1 to 7.9)	4.9 (2.7 to 8.7)	0.99	–	–	–
Kept in bed ≥1 d in the past 4 wk because of LBP							
10 wk	2.4 (1.0 to 5.6)	2.9 (1.7 to 5.1)	6.9 (4.6 to 10.5)	0.041	0.3 (0.1 to 0.9)	0.6 (0.3 to 1.1)	0.6 (0.2 to 1.5)
26 wk	8.1 (5.2 to 12.6)	4.3 (2.4 to 7.8)	5.7 (3.4 to 9.7)	0.153	–	–	–
52 wk	7.0 (4.4 to 11.2)	4.7 (2.7 to 8.1)	5.5 (3.3 to 9.1)	0.50	–	–	–
Cut down on usual activities on ≥7 d in the past 4 wk because of LBP							
10 wk	2.8 (1.3 to 6.1)	3.6 (1.9 to 6.7)	9.2 (5.9 to 14.5)	0.001	0.3 (0.1 to 0.7)	0.4 (0.2 to 0.7)	0.8 (0.3 to 2.0)
26 wk	2.7 (1.3 to 5.6)	3.2 (1.7 to 6.1)	7.1 (4.3 to 11.8)	0.008	0.4 (0.2 to 0.9)	0.5 (0.3 to 0.8)	0.9 (0.3 to 2.1)
52 wk	3.1 (1.4 to 6.9)	5.0 (2.9 to 8.8)	8.3 (5.3 to 13.0)	0.041	0.4 (0.2 to 0.9)	0.6 (0.3 to 1.1)	0.6 (0.2 to 1.6)
Missed work or school ≥1 d in the past 4 wk because of LBP							
10 wk	2.9 (1.5 to 5.8)	5.1 (2.7 to 9.5)	8.0 (4.5 to 14.4)	0.018	0.4 (0.2 to 0.7)	0.6 (0.3 to 1.2)	0.6 (0.3 to 1.3)
26 wk	4.8 (2.6 to 8.6)	4.8 (2.2 to 10.5)	6.7 (3.4 to 12.9)	0.53	–	–	–
52 wk	4.9 (2.5 to 9.8)	4.3 (2.4 to 7.9)	5.5 (2.9 to 10.6)	0.84	–	–	–
Patient global rating of improvement (much better or gone)							
10 wk	36.1 (28.8 to 45.3)	39.4 (31.8 to 48.7)	3.8 (1.6 to 9.0)	<0.001	9.6 (3.9 to 23.5)	10.5 (4.3 to 25.4)	0.9 (0.7 to 1.2)
26 wk	27.4 (21.0 to 35.7)	29.4 (22.7 to 38.2)	10.9 (6.5 to 18.1)	0.002	2.5 (1.4 to 4.5)	2.7 (1.5 to 4.8)	0.9 (0.6 to 1.3)
52 wk	26.1 (19.8 to 34.6)	36.2 (29.1 to 45.0)	20.5 (14.5 to 29.0)	0.013	1.3 (0.8 to 2.0)	1.8 (1.2 to 2.6)	0.7 (0.5 to 1.0)
Would be pleased or delighted if LBP remained at the current level for the rest of life							
10 wk	15.1 (10.2 to 22.5)	20.6 (15.0 to 28.3)	7.1 (3.9 to 12.7)	0.007	2.1 (1.1 to 4.3)	2.9 (1.5 to 5.7)	0.7 (0.4 to 1.2)
26 wk	9.7 (6.2 to 15.4)	15.9 (10.7 to 23.6)	11.9 (7.9 to 18.0)	0.25	–	–	–
52 wk	13.1 (8.6 to 19.7)	21.2 (15.4 to 29.1)	18.7 (13.1 to 26.6)	0.179	–	–	–
Very satisfied with LBP care							
10 wk	41.4 (34.0 to 50.4)	43.2 (35.5 to 52.4)	6.2 (3.5 to 11.1)	<0.001	6.7 (3.6 to 12.3)	7.0 (3.7 to 12.9)	1.0 (0.7 to 1.3)
26 wk	37.6 (30.8 to 45.9)	40.7 (33.2 to 49.8)	9.4 (5.8 to 15.2)	<0.001	4.0 (2.4 to 6.7)	4.3 (2.6 to 7.3)	0.9 (0.7 to 1.2)
52 wk	29.6 (23.2 to 37.7)	37.4 (30.2 to 46.4)	12.3 (7.7 to 19.6)	<0.001	2.4 (1.4 to 4.1)	3 (1.8 to 5.1)	0.8 (0.6 to 1.1)

LBP = low back pain; NSAID = nonsteroidal anti-inflammatory drug.

* Between-group comparisons were calculated only if the omnibus *P* value was <0.05 after the least-significant-difference approach was used to control for multiple comparisons.

† Wald *P* value.

‡ Calculated by using modified Poisson regression with robust SEs, adjusted for baseline value of outcome, age group, sex, baseline Roland Disability Questionnaire and symptom bothersomeness scores, education, body mass index, physical work demands, original cause of pain, days on which the patient cut down on usual activities, and medication use.

Appendix Table 3. Missing Data Patterns for Primary Outcomes and Covariates Used for Adjustment

Missing Data Pattern*					Treatment Group, *n (%)*			
Baseline	10 wk	26 wk	52 wk	Covariates	Structural Massage (*n* = 132)	Relaxation Massage (*n* = 136)	Usual Care (*n* = 133)	Total (*n* = 401)
0	0	0	0	0	121 (92.0)	121 (89.0)	111 (83.5)	353 (88.0)
0	0	0	0	1	2 (1.5)	1 (0.7)	0 (0.0)	3 (0.8)
0	1	0	0	0	1 (0.8)	0 (0.0)	1 (0.8)	2 (0.5)
0	0	1	0	0	2 (1.5)	1 (0.7)	2 (1.5)	5 (1.3)
0	0	0	1	0	2 (1.5)	4 (2.9)	8 (6.0)	14 (3.5)
0	1	1	0	0	1 (0.8)	0 (0.0)	2 (1.5)	3 (0.8)
0	0	1	1	0	0 (0.0)	3 (2.2)	2 (1.5)	5 (1.3)
0	1	1	1	0	3 (2.3)	6 (4.4)	7 (5.3)	16 (4.0)

* 0 = not missing; 1 = missing. Missing data patterns were the same for Roland Disability Questionnaire and symptom bothersomeness scores.

Appendix Table 4. Patients With Any Missing Data

Covariate	Patients, *n (%)*			Patients With Missing Data at Any Time Point, *n (%)*
	10 wk	26 wk	52 wk	
Treatment group				
Usual care	10 (8)	13 (10)	17 (13)	22 (17)
Relaxation massage	6 (4)	10 (7)	13 (10)	14 (10)
Structural massage	5 (4)	6 (5)	5 (4)	9 (7)
Age				
<30 y	6 (15)	9 (22)	8 (20)	9 (22)
30–39 y	6 (10)	5 (8)	9 (14)	11 (17)
40–49 y	5 (24)	9 (9)	14 (13)	18 (17)
50–59 y	4 (3)	4 (3)	4 (3)	5 (4)
≥60 y	0 (0)	2 (3)	0 (0)	2 (3)
Education				
Less than college	13 (7)	19 (10)	24 (12)	30 (15)
College graduate	8 (4)	10 (5)	11 (5)	15 (7)
Sex				
Male	8 (6)	13 (9)	18 (13)	19 (13)
Female	13 (5)	16 (6)	17 (7)	26 (10)
Baseline RDQ score				
<7 points	4 (4)	5 (5)	7 (7)	8 (8)
7–10 points	4 (4)	4 (4)	6 (6)	6 (6)
11–13 points	7 (8)	10 (11)	10 (11)	13 (15)
≥14 points	6 (5)	10 (8)	12 (10)	18 (15)

RDQ = Roland Disability Questionnaire.