A Randomized, Controlled Trial of Massage Therapy as a Treatment for Migraine

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ABSTRACT

Background: *Migraine is a distressing disorder that is often triggered by stress and poor sleep. Only one randomized controlled trial (RCT) has assessed the effects of massage therapy on migraine experiences, which yielded some promising findings.* ***Purpose:*** *An RCT was designed to replicate and extend the earlier findings using a larger sample, additional stress-related indicators, and assessments past the final session to identify longer-term effects of massage therapy on stress and migraine experiences.* ***Methods:*** *Migraine sufferers (N = 47) who were randomly assigned to massage or control conditions completed daily assessments of migraine experiences and sleep patterns for 13 weeks. Massage participants attended weekly massage sessions during Weeks 5 to 10. State anxiety, heart rates, and salivary cortisol were assessed before and after the sessions. Perceived stress and coping efficacy were assessed at Weeks 4, 10, and 13.* ***Results:*** *Compared to control participants, massage participants exhibited greater improvements in migraine frequency and sleep quality during the intervention weeks and the 3 follow-up weeks. Trends for beneficial effects of massage therapy on perceived stress and coping efficacy were observed. During sessions, massage induced decreases in state anxiety, heart rate, and cortisol.* ***Conclusions:*** *The findings provide preliminary support for the utility of massage therapy as a nonpharmacologic treatment for individuals suffering from migraines.*

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INTRODUCTION

Migraine is a prevalent and distressing disorder that can profoundly affect well-being and general functioning (1). Approximately 18% of women and 7% of men in the United States experience migraine headaches (2), which typically involve pulsating pain on one side of the head that is aggravated by physical activity and accompanied by nausea, vomiting, and photo- and phonophobia (3,4). Migraine attacks are extremely variable in their frequency, intensity, and duration. Stress is a primary trigger for migraine attacks, and it can exacerbate their intensity and duration as well as their frequency. Migraine attacks usually are the most frequent between the ages of 25 and 55, which are often considered to be an individual's most productive work years (2). According to data from the American Migraine Study II (2), 53% of respondents reported that their migraines caused substantial impairment in activities and that they required bed rest during attacks. Approximately 30% reported missing at least 1 day of work or school in the previous 3 months because of migraines, and 50% reported that work or school activity was reduced. Migraine clearly poses a significant burden to individuals, their families, and society.

Although many pharmacologic treatments are available, migraine sufferers may choose to use nonpharmacologic treatments because they cannot take specific medications due to poor tolerance, medical contraindications, pregnancy or breastfeeding, high cost, or the interference of side effects with daily routines. Migraineurs with significant stress, poor coping skills, or a history of excessive medication use (which can aggravate migraines) may also benefit from nonpharmacologic therapy (5). Massage is one of several behavioral techniques to receive attention as a potential treatment for migraine (5–7). As a relaxation technique, massage may assist in preventing migraines by reducing sympathetic arousal and other physiological responses that can contribute to their onset (8). Massage may also promote changes in cognitive appraisals of events, and these appraisals may reduce stress in the days following the massage and thus add further protection from migraine attacks.

Research investigating the therapeutic effects of massage therapy for migraine headaches is scarce. To date, only one randomized controlled trial (RCT) of massage therapy for migraine treatment has been conducted (9). Although the trial revealed that massage reduced migraine frequency and some physiological factors associated with stress, it used a small sample and evaluated only a limited number of the cognitive, behavioral, and physiological factors involved in stress regulation that may be responsible for the massage effects on migraine experiences. This study represents a further, preliminary step in evaluating the impact of massage on migraine experience as well as on sympathetic arousal, stress and coping processes, and sleep behavior in individuals with migraine conditions.

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Massage is defined as the conscious manipulation of soft tissue (muscles, fat, connective tissue, and skin) for therapeutic purposes (10), and there is growing evidence of its health benefits (11,12). Although research on the therapeutic effects of massage for migraines and other stress-related illnesses remains limited, there is accumulating evidence of its effects on physiological processes that may underlie migraine experiences. For example, massage has been found to influence a variety of stress indicators, and the pattern of findings suggests that massage induces a shift from a state of sympathetic activation to a state of parasympathetic activation (12). By stimulating a relaxation response, these changes may lead to reductions in stress-related emotions such as anxiety (12). These findings suggest that massage therapy may reduce physiological stress responses that can trigger migraine attacks.

Massage therapy is also likely to promote migraine control via its effects on pain (by altering serotonin and Substance P [13–15]) and muscle tension. Muscle tension can involve ischemia, resistance to stretch, and irritation of nociceptors (16), and these sensations often induce escalations in tightness in associated muscles and regional pain (17). Massage manipulations may reduce muscle tension contributing to migraine attacks by breaking down subcutaneous adhesion, preventing fibrosis, and promoting circulation of blood and lymph (18).

Massage therapy may also aid in migraine control through its impact on sleep behavior (19–21). Deprivation of deep sleep may induce increases in Substance P and other neuroendocrine changes that exacerbate pain, and these neuroendocrine changes may partially explain why poor sleep can be a trigger for migraine (22). Two RCTs of massage therapy for the treatment of fibromyalgia, a condition involving musculoskeletal pain, revealed that massage improved sleep, reduced salivary levels of Substance P, and reduced pain and stiffness for this chronic illness group (21).

Massage therapy may also promote cognitive appraisals of events that reduce stress responses, and, in turn, inhibit migraine attacks. Although currently there is no evidence that massage alters coping appraisals, it is plausible that these effects occur. Massage-induced relaxation may promote reappraisals of stressful events as relatively less threatening and more manageable. Moreover, for individuals who are aware that stress can trigger migraine attacks that will interfere with efforts to meet goals, massage-induced relaxation may enhance coping efficacy by reducing the perceived likelihood of migraine attacks in the subsequent time period. Moreover, massage-induced reductions in migraine attacks and improved sleep can promote progress toward meeting goals and daily demands. Massage therapy effects on appraisals of coping efficacy may therefore play a critical role in the relationship between stress and migraine attacks, particularly when the individual learns through experience that massage is an effective emotion regulation strategy.

An initial RCT yielded promising evidence that massage may be an effective treatment for migraine and it identified physiological mechanisms that may be responsible for its effects. Hernandez–Reif, Dieter, and Field (9) randomly assigned adults to a waitlist control group ($n = 13$) or to a massage therapy group ($n = 13$) in which they received two 30-min massages per week for 5 weeks. Compared with the control group, the massage group reported more headache-free days, fewer symptoms, and lower anxiety levels over the 5-week period. When experiencing migraines, massage participants (relative to control participants) rated the pain as milder, used fewer analgesics, and reported having slept longer and with fewer disturbances. The massage group exhibited lower salivary cortisol and higher urinary serotonin (5-HIAA) levels from before the first session to after the last session. No assessments were conducted after the last session, and so the duration of the massage effects remains unknown.

This RCT aims to replicate and extend the findings of Hernandez–Reif and colleagues (9) by utilizing a larger sample, a broader range of stress-related indicators, and assessments past the final treatment session to identify any longer term effects of massage therapy on stress and migraine experiences. Given the paucity of research in this area, this study represents a preliminary but essential step in providing empirical support for massage therapy for migraine treatment. By providing evidence of its potential efficacy, it can justify the development of larger scale RCTs designed to establish its efficacy relative to alternative treatments. Migraine sufferers who were randomly assigned to a massage condition or a control condition completed daily diaries of headache frequency, intensity, medication use, and sleep behavior for 4 weeks prior to the start of the massage therapy, for the duration of the intervention period, and for 3 weeks postintervention. Massage participants attended six weekly sessions of massage, and their state anxiety and heart rates were assessed immediately before and after each massage session; their salivary cortisol was assessed before and after the first and last session. Both massage and control participants completed assessments of perceived stress and coping efficacy at baseline and again 1 day and 3 weeks after the massage sessions ended. It was hypothesized that, compared with the control participants, massage participants would report greater improvements in perceived stress and coping efficacy; greater reductions in migraine frequency, intensity, and medication use; and greater improvements in sleep quantity and quality.

METHOD

Study Design

A RCT with a mixed 2 × 3 design included the between-subjects factor of intervention condition (massage therapy or control) and the within-subjects factor of assessment time. For the measures of perceived stress and coping efficacy, the assessments included Time 1 (corresponding to 1 day before the first massage session), Time 2 (1 day after the last massage session), and Time 3 (3 weeks after the last session). For the daily diary measures of migraine frequency and intensity, medication use, and sleep behavior, the assessment phases included the baseline phase (the 4 weeks prior to the first massage session), the intervention phase (the 6 weeks during which the massage sessions took place), and the follow-up phase (the 3 weeks after the last massage session). Average ratings for each phase were used so that the units of assessment were comparable across the phases.

In assessments of the immediate effects of massage on stress arousal, massage participants completed measures of heart rate and state anxiety before and after each of the six massage sessions, and salivary cortisol was assessed before and after the first and last sessions.

Participants

Participants were recruited from March 2003 to July 2003 through notices posted on public notice boards at the University of Auckland campuses and published in the newsletter of the New Zealand Migraine Support Group. Figure 1 presents a flow diagram of participant progression through the study. During recruitment, 69 people expressed interest in the study, of whom 67 met the diagnostic criteria for migraine set by the International Headache Society (3) and so were invited to participate. A total of 48 individuals (40 women and 8 men) consented (72% of the eligible individuals). Ages ranged from 12 to 60 years (M = 41.3, SD = 13.45). Of the sample, 90% were New Zealand–European and 10% identified with other ethnicities (Indian and South African). Consenting participants were randomly assigned to either the massage therapy or control condition using random number tables. Blinding of participants was not possible due to the obvious nature of the intervention conditions. One woman in the massage condition dropped out after randomization because a change in employment conditions prevented her attendance at the massage sessions.

Massage Therapy Intervention

Massage sessions were conducted in clinics at the New Zealand College of Massage in Auckland. Massage Therapy Diploma students received training in the massage protocol and practiced the sequence until their performance reached the criteria for standardization. The massage routine was a 45-min massage developed by a registered therapist and tutor at the New Zealand College of Massage. The protocol was specifically designed for the treatment of migraines using the neuromuscular and trigger-point framework of the back, shoulders, neck, and head. It included myofascial release (3 min), deep ischaemic compression and cross-fibre work of the erector spinae (5 min), upper and lower trapezius (9 min), levator scapulae, lamina groove, suboccipital muscles (14 min), and the sternocleidomastoid, masseter, and temporalis muscles (8 min); a full copy of the sequence is available from the authors. The remaining 6 min were for warm-up and turning the client over. The participant lay on a standard massage table during the massage, and scent-free oil (almond oil) was used. The massage therapists were instructed not to converse with the participants for the duration of the massage, except for standardized questions about pain levels, comfort, and warmth. Protocol compliance was checked by the registered therapists who designed the sequence, who made random checks on the therapists when they were completing a session. Each therapist was randomly checked once in the first and last week of the sessions, and all therapists

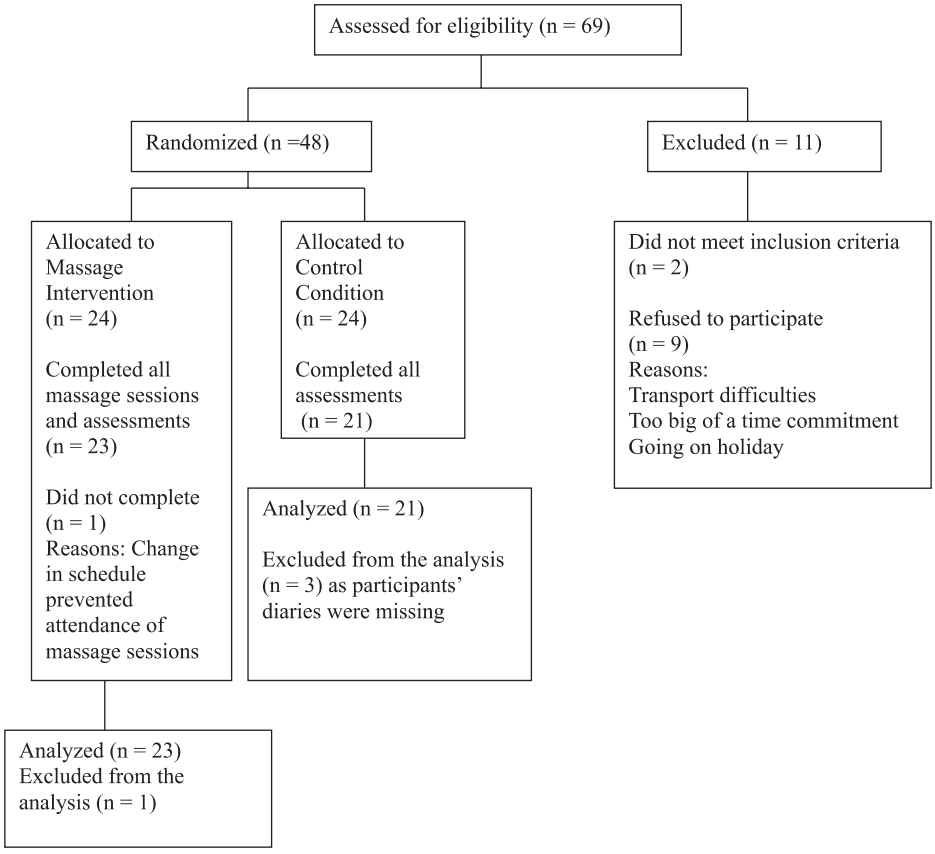

FIGURE 1 Flow diagram of participant progression.

were found to be adherent and with no variations in protocol. Two participants did not complete one of their massage sessions at the scheduled time due to having a migraine attack at that time; these sessions were rescheduled so that they still attended a massage session for that week.

Control Condition

Control condition participants were instructed to keep the daily diaries of headache frequency and intensity, medication use, and sleep behavior. They were told that keeping a diary of headache activity was highly advocated by migraine experts as an aid in migraine control, as it could enhance understanding of potential triggers and medication outcomes.

Baseline Measures of Migraine Characteristics

Background information on migraine frequency, average length of migraine, migraine classification, and medication used was collected (see Table 1). The Headache History Inventory (3) was used to verify that participants met the diagnostic criteria for migraine. The eight-item measure assesses the location and quality of headache, accompanying symptoms (e.g., sensitivity to light and visual changes), and receipt of a medical diagnosis of migraine. A measure of common triggers for migraine was adapted from a list developed by Martin and colleagues (23). Participants rated the extent to which they experienced migraines during or after each of 16 triggers relating to physical stress, emotional stress, diet or food and environmental factors; the response options were *never, sometimes,* or *often.* A final question asked whether the participant had used massage therapy in the previous year; the response options were *yes* or *no.* If participants responded *yes,* they were asked how many massages they had received in the previous year, and when their most recent massage occurred.

Premassage and Postmassage Measures

State anxiety. The STAI-sf (24) is a shortened version of the State Anxiety scale of the State Trait Anxiety Inventory (STAI). The six items (e.g., "I am relaxed," "I am worried") are rated from 0 (*not at all*) to 4 (*extremely*) to indicate how one is feeling "at the moment." Item ratings are summed to produce scores ranging from 0 to 24. This measure has been demonstrated to exhibit satisfactory validity and internal consistency (24). In this study, the internal consistency was high; for the first assessment, Cronbach's $\alpha = .82$.

Heart rate. Using a stopwatch, a trained assistant took the participant's pulse at the wrist for a period of 60 sec.

Cortisol. Measures of salivary cortisol (nanomoles per liter) were taken before and after the first and last massage sessions. The samples were obtained by placing a cotton dental swab in the mouth (along the gumline) for 40 sec. The swab was then placed in a syringe and frozen until the time of assay.

TABLE 1
Migraine Characteristics at Baseline

Variable	*Massage*[a]	*Daily Diary*[b]	*Total*[c]
Migraine type (*n*)			
Migraine without aura	13	15	28
Migraine with aura	10	9	19
Frequency of attacks (*n*)			
6–11 times per year	7	5	12
Once a month	4	6	10
More than once a month	12	13	25
Length of attack (hr)			
M	43.45	51.13	47.30
SD	28.02	44.22	36.79

[a]$n = 23$. [b]$n = 24$. [c]$N = 47$.

Daily Diary Measures

Migraine headache was rated four times a day: at breakfast, lunch, dinner, and bedtime. As migraine headaches can last from 4 to 72 hr, these intervals are sufficient to detect any migraine occurring during the day (3). The respondents rated their migraines on a scale ranging from 0 (*no migraine or headache*) to 5 (*intense, incapacitating headache*). When giving a rating of 1 or more, respondents ticked a box to indicate whether it was a migraine headache or some other form of headache. One migraine was considered as a string of ratings of 1 or more, followed by a 0 rating. The respondents were also asked to list any migraine medication(s) and quantity of medication(s) taken during the day. For sleep quantity, respondents wrote down how many hours they had slept for the previous night; sleep quality was rated on a scale from 0 (*very poor*) to 5 (*very good*) (25–27). For each of the three time phases, the data was used to calculate the average number of migraines per week, the average number of other headaches per week, the average number of days per week on which medications were used, the average ratings of migraine intensity, the average number of hours of sleep, and the average sleep quality rating. These daily diary measures are comparable to those used in prior studies of migraine (25,26).

Longer-Term Measures

Stress. The Perceived Stress Scale (PSS) is a 14-item measure assessing the "degree to which situations in one's life are appraised as stressful" during the last week (28). The items are rated from 0 (*never*) to 4 (*very often*). The scores can range from 0 to 56. Internal consistencies have been found to be fairly high, with Cronbach's α ranging from .75 to .86 (28,29). For this study, internal consistency was high; Cronbach's $\alpha = .82$. The PSS has been shown to have test–retest reliability of $r = .85$ over a 2-day period as well as good predictive validity (28).

Coping efficacy. The coping efficacy measure, developed for use in a previous study of stress and coping (30), assesses how well people perceive themselves to be coping with and controlling their current problems over the last 3 days. Seven items (e.g., "I feel good about the way I am handling my problems and

challenges," "I am coping well with the problems and challenges facing me," and "My life is going well") are rated on a scale ranging from 0 (*not at all*) to 4 (*extremely*); summed scores can range from 0 to 28. Internal consistency was high in this study, Cronbach's $\alpha = .83$.

Procedure

Ethics approval was obtained from the University of Auckland Human Participants Ethics Committee. On contacting the researchers for information about the study, interested persons were sent an information pack containing an information sheet, Headache History Inventory, migraine triggers measure, consent form, and return envelope. Those individuals who consented and who met the diagnostic criteria for migraine were sent the baseline daily diaries, and they were phoned on a weekly basis to ensure that they were completing the daily diaries as directed. Participants were requested not to use any other form of massage for the duration of the study. One week prior to the massage therapy phase, participants were sent a questionnaire including the perceived stress and coping efficacy measures and returned it using the envelope provided. Participants in the massage group were then scheduled to attend the massage therapy sessions at the same time and day for each of the 6 weeks. These participants were informed that a supervisor would be randomly checking on the therapists during the massage sessions. Reminder calls were made to participants the night before the scheduled session to minimize attrition.

Participants in the massage condition completed assessments of heart rate and state anxiety immediately before and after each of the six massage sessions. At the first and last sessions, salivary cortisol assessments were also taken before and after the massage. These measures were administered by trained research assistants.

Two follow-up questionnaires containing the stress and coping efficacy measures were completed by both groups, the first 1 day after the final massage session and the second 3 weeks following the final massage session, with each control participant matched to a massage participant to ensure group equivalence in the assessment times. Participants were extensively debriefed about the study on completion of the second follow-up questionnaire. At the end of the study, participants were invited to attend an information session to discuss their study experiences and receive training in thermal biofeedback therapy. In addition to training, participants were given equipment (a finger temperature band and an audiotape of relaxation instructions) for home use. Participants had been informed at the study's onset that they would receive a full explanation of the study in an information session, but they had not been informed that they would receive thermal biofeedback training. Control participants therefore were not susceptible to developing expectations that only lack of improvement would enable them to obtain the thermal biofeedback training.

Statistical Analyses

Independent samples *t* tests and chi-square analyses were used to assess group differences on the demographic and baseline variables. Intention-to-treat analyses were not used as only one participant did not complete the study after randomization, and, given the paucity of research in this area, this preliminary study focused on evaluating efficacy rather than effectiveness (27). Paired-samples *t* tests were conducted to assess changes from premassage to postmassage in heart rate, state anxiety, and salivary cortisol. The sample size had sufficient power (77%) to detect an effect size of .27 for change in migraine frequency from Baseline to Intervention, and an effect size of .33 from Baseline to Follow-Up. Two sets of repeated measures analyses of variance (ANOVAs) were used to assess group differences in changes in outcome measures over time: One set assessed group differences in changes from Time 1 (baseline) to Time 2 (at the end of massage therapy), and the second set compared group differences in changes from Time 1 to Time 3 (3 weeks after the end of therapy). These planned comparisons were conducted because Time 2 effects were predicted, whereas the Time 3 effects were of an exploratory nature as the potential for massage effects to endure beyond the end of therapy has not received attention. For the daily diary variables, two similar sets of repeated measures ANOVAs and analyses of covariance (ANCOVAs) assessed group differences in changes from Baseline to Intervention phases and from Baseline to Follow-Up phases. Age was significantly correlated with Baseline Phase scores of migraine ($r = .41$, $p < .05$), medication ($r = .42$, $p < .01$), and other types of headache ($r = -.41$, $p < .01$), and so it was used as a covariate in the repeated measures analyses of these variables. Normality plots, skewness statistics, Levene's test, and assessments of sphericity revealed no violations of ANOVA assumptions, with the exception that migraine frequency scores were skewed for 5 of the 13 weeks. Analyses using both truncated data (correcting for skewness) and untruncated data revealed no differences in the significance of effects, and so the untruncated data was used in the final analyses.

RESULTS

Comparisons of the two intervention conditions (massage therapy and daily diary control) revealed no group differences in age, $t(43) = 1.97$, *ns*; gender, $\chi^2(1, N = 47) = 0.48$, *ns;* marital status, $\chi^2(1, N = 47) = 0.94$, *ns*; or ethnicity, $p = .34$, Fisher's exact test. Comparisons of the migraine characteristics (see Table 1) revealed no group differences in experiences of migraines with versus without aura, $\chi^2(1, N = 47) = 0.17$, *ns*; frequency of migraine, $\chi^2(2, N = 47) = 2.94$, *ns*; or average length of migraine, $t(43) = -0.69$, *ns.* Most participants (29% massage and 22% control) reported using over-the-counter analgesics (e.g., acetaminophen) for treatment of headache pain; the groups did not differ in their reports of analgesics use, $t(42) = -.69$, *ns*. One participant in the massage group was taking a daily dose of an amitryptaline, and one control participant was taking a daily dose of a calcium antagonist. Five participants (two massage and three control) reported using Imigran (a serotonin antagonist) as a treatment. Two massage and two control participants reported having used massage in the previous year, and only one of these participants reported having had a massage in the previous 3 months. Preliminary analyses revealed no condition dif-

ferences in either the Time 1 measures of perceived stress and coping efficacy or the Baseline Phase measures of migraine frequency, migraine intensity, medication use, other type of headache, sleep quality, and sleep quantity.

Evaluations of reported migraine triggers revealed that physical and emotional stress are among the most common triggers of attacks. The most common triggers (as indicated by the proportion of participants with ratings of "often") were the end of a busy or stressful time (64%), overtiredness (62%), long gaps between meals or insufficient food (55%), worry (53%), muscle tension in the neck and shoulders (53%), depression (40%), alcohol (38%), bright lights, (34%), and flashing or flickering lights (34%).

Premassage to Postmassage: Heart Rate, State Anxiety, and Cortisol

Table 2 shows the mean heart rate, state anxiety, and salivary cortisol levels before and after the massage for each of the six sessions. Heart rates and state anxiety scores decreased significantly from premassage to postmassage in all six sessions. Cortisol decreased over time in both Session 1 and Session 6, which were the only times when it was measured.

Daily Diary: Migraine Frequency and Intensity, Medication Use, Sleep Behavior, and Other Types of Headache

Diary data from 44 participants were used in the final analyses, as three control participants reported sending back the baseline diaries but they were never received. Four participants (3 massage and 1 control) had missing values for 22% of the data in either the Intervention or the Follow-Up phase, so a conservative approach was used whereby their missing data were replaced with their baseline values. Analyses were run with the original data set ($n = 40$) and the data set with the missing values replaced ($n = 44$). There were no differences in statistical significance of the effects, and final analyses were conducted on the dataset with the missing values replaced with baseline values.

Figure 2 depicts the average migraine frequency scores (Panel A) for each group across the three phases. The repeated measures ANCOVA (with age as a covariate) of group differences in changes from Baseline to Intervention phases revealed a nonsignificant Time effect, and, as predicted, a significant Group × Time effect, $F(1, 41) = 8.44$, $p < .01$; $d = .27$. Simple effects analyses revealed that the massage group exhibited decreases in migraine frequency (Baseline $M = 1.52$, $SE = 0.26$; Intervention $M = 1.00$, $SE = 0.24$; $p < .01$) whereas the control group did not (Baseline $M = 1.76$, $SE = 0.27$; Intervention $M = 1.64$, $SE = 0.25$; *ns*). The repeated measures ANCOVA of group differences in changes from Baseline to Follow-Up phases also revealed a significant Group × Time interaction effect, $F(1, 42) = 4.09$, $p < .05$; $d = .33$. Simple effects analyses revealed that the massage group exhibited decreases in migraine frequency (Baseline $M = 1.52$, $SE = 0.26$; Follow-Up $M = 1.07$, $SE = 0.28$; $p < .05$), whereas the control group showed no change (Baseline $M = 1.65$, $SE = 0.27$; Intervention $M = 1.72$, $SE = 0.29$; *ns*).

For group differences in migraine intensity, the repeated measures ANOVA of changes from Baseline to Intervention revealed no significant Group × Time interaction effect, $F(1, 42) = 1.58$, *ns*; $d = .13$. Similarly, the repeated measures ANOVA of changes from Baseline to Follow-Up revealed no significant Group × Time interaction effect, $F(1, 42) = .82$, *ns*; $d = .11$. In both analyses, the overall Time effects were not significant.

For medication use, the repeated measures ANOVA of group differences in changes from Baseline to Intervention revealed no significant Group × Time interaction effect, $F(1, 42) = .03$, *ns*; $d = .02$. Similarly, the analysis of group differences in changes from Baseline to Follow-Up revealed a nonsignificant

TABLE 2
Change Scores for Heart Rate, Blood Pressure, State Anxiety, and Fatigue from Pre- to Postsessions for Massage Therapy Participants

	Session 1	*Session 2*	*Session 3*	*Session 4*	*Session 5*	*Session 6*
Heart rate (beats per minute)						
Pre	76.00	73.33	72.89	72.63	73.63	74.55
Post	67.83	67.56	62.11	66.32	66.73	66.55
Effect size	.83[c]	.63[c]	.64[c]	.64[c]	.54[b]	.85[c]
t	6.09**	2.85**	2.71**	3.63**	3.74**	4.22**
State anxiety						
Pre	10.41	9.22	8.56	7.50	7.82	8.64
Post	4.77	4.28	3.72	3.67	2.68	4.27
Effect size	.96[c]	.92[c]	1.02[c]	.74[c]	1.05[c]	.95[c]
t	6.60**	5.62**	6.33**	4.81**	6.13**	5.58**
Cortisol						
Pre	6.25	—	—	—	—	6.22
Post	3.86	—	—	—	—	3.40
Effect size	.47[b]	—	—	—	—	.95[c]
t	4.23**	—	—	—	—	4.85**

[a]Small effect size. [b]Moderate effect size. [c]Large effect size.
**$p < .01$ for significance of pre- to postmassage differences.

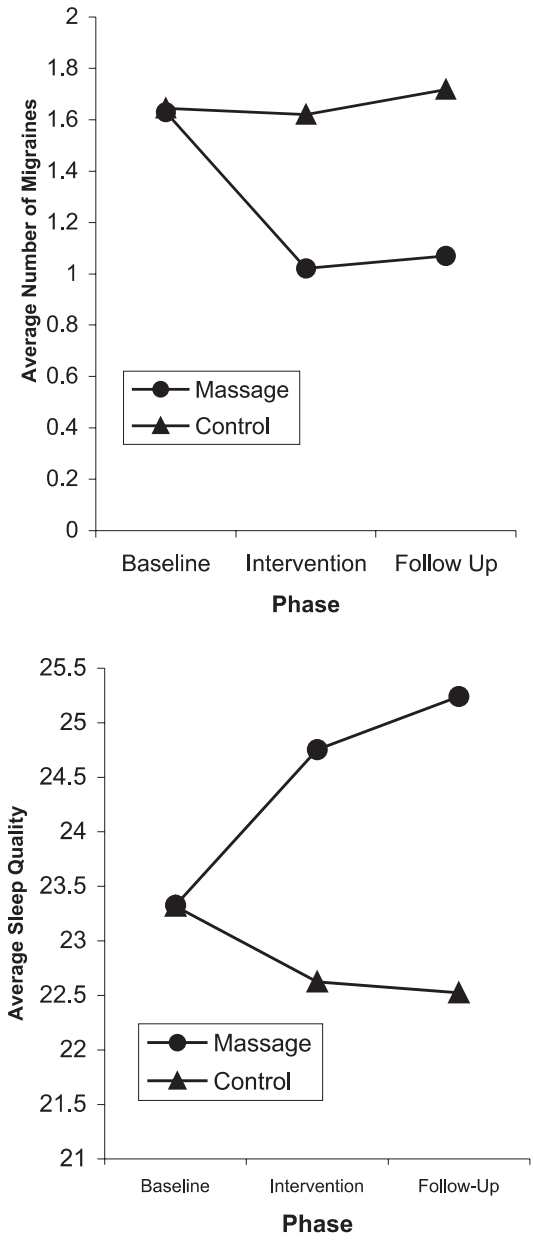

FIGURE 2 Scores of average number of migraines (Panel A), and average sleep quality (Panel B) for the massage group and control group across the three phases.

Group × Time interaction effect, $F(1, 42) = .02$, *ns*; $d = .04$. The Time effect was not significant in either analysis.

Repeated measures ANCOVAs of sleep quantity, with age as a covariate, revealed no significant Group × Time interaction effects from Baseline to Intervention, $F(1, 41) = 1.75$, *ns*; $d = .18$, or from Baseline to Follow-Up, $F(1, 41) = 1.75$, *ns*; $d = .16$; neither of the Time effects was significant, indicating that sleep quantity generally remained stable over the study period. For sleep quality (Figure 2, Panel B), a repeated measures ANOVA revealed a nonsignificant Time effect and a significant Group × Time effect from Baseline to Intervention, $F(1, 42) = 10.50$, $p < .005$; $d = .30$. The massage group exhibited an increase in sleep quality (Baseline $M = 23.33$, $SE = 0.86$; Intervention $M = 24.75$, $SE = 0.88$; $p < .01$) whereas the control group did not (Baseline $M = 23.32$, $SE = 0.90$; Intervention $M = 22.62$, $SE = 0.92$; $p = .45$). The analysis of group differences in changes from Baseline to Follow-Up also yielded a significant Group × Time interaction effect; $F(1, 42) = 12.54$, $p < .005$; $d = .41$. The massage group exhibited increases in sleep quality (Baseline $M = 23.33$, $SE = 0.86$; Follow-Up $M = 25.24$, $SE = 0.87$; $p < .005$) whereas the control group did not (Baseline $M = 23.32$, $SE = 0.90$; Follow-Up $M = 22.52$, $SE = 0.91$; $p = .47$).

Repeated measures ANOVAs of group differences in other types of headaches, with age as a covariate, revealed no group differences in changes from Baseline to Intervention, $F(1, 42) = .94$, *ns*; $d = .20$. Similarly, there were no group differences in changes in other headache experiences from Baseline to Follow-Up, $F(1, 42) = .03$, *ns*; $d = .13$. Nonsignificant Time effects in both analyses indicated that experiences of other types of headaches remained stable over the study period.

Perceived Stress and Coping Efficacy

Table 3 presents the means and standard deviations of perceived stress and coping efficacy at Time 1 (corresponding to 1 day before the first massage session), Time 2 (corresponding to 1 day after the last massage session), and Time 3 (corresponding to 1 month after the last massage session). Repeated measures ANOVAs of group differences in changes in perceived stress from Time 1 to Time 2 revealed a trend for a Group × Time interaction effect, although it did not reach statistical significance, $F(1, 40) = 3.50$, $p < .10$; $d = .26$. Simple effects analysis revealed that the massage group reported no change, $F(1, 41) = 0.40$, *ns,* whereas the control group exhibited increases in perceived stress, $F(1, 41) = 3.94$, $p < .05$. In the analyses of group differences in changes in perceived stress from Time 1 to Time 3, the Group × Time interaction effect was not significant, $F(1, 41) = .16$, *ns*; $d = .14$.

The repeated measures ANOVA of group differences in changes in coping efficacy from Time 1 to Time 2 revealed a significant Group × Time interaction effect, $F(1, 41) = 5.13$, $p < .05$; $d = .49$. Simple effects analysis revealed that the massage group reported no change, $F(1, 41) = .63$, *ns,* whereas the control group reported decreases in coping efficacy over this time, $F(1, 41) = 4.64$, $p < .05$. The repeated measures ANOVA of changes in coping efficacy from Time 1 to Time 3 also revealed a significant Group × Time interaction effect; $F(1, 41) = 5.13$, $p < .05$; $d = .51$. The massage group reported no change, $F(1, 41) = .29$, *ns,* whereas the control group reported decreases in coping efficacy, $F(1, 41) = 3.87$, $p = .05$.

DISCUSSION

This preliminary study provides evidence that massage therapy can have beneficial effects on migraine experience, stress arousal, and sleep for individuals with migraine. This study contributes to the very small RCT literature on massage therapy effects. Most notably, massage therapy significantly reduced migraine frequency both during the 6 weeks of massage therapy as well as during the 3 weeks following the end of therapy. This is the first evidence that massage therapy may reduce

TABLE 3
Means and Standard Deviations of the Perceived Stress and Coping Efficacy for Massage and Daily Diary Groups

	Experimental Condition					
	Massage[a]			*Daily Diary*[b]		
Dependent Measures	*Time 1*	*Time 2*	*Time 3*	*Time 1*	*Time 2*	*Time 3*
Coping Efficacy						
M	15.70	16.52	17.35	17.86	15.50	15.84
SD	6.12	5.98	6.52	5.28	6.57	7.13
Perceived Stress						
M	24.55	25.13	24.60	22.76	25.20	24.21
SD	7.94	8.31	8.56	7.69	8.08	10.62

Note. Time 1 = 1 day before the first session; Time 2 = 1 day post the last session; Time 3 = 1 month post the last session.
[a]$n = 23$. [b]$n = 24$.

migraine frequency beyond the end of treatment, and research is now needed to further evaluate the durability of these effects. Massage participants did not report reductions in other types of headaches, suggesting that the therapeutic effects of the protocol, developed to target migraine pathways, were specific to migraine.

In contrast with the results of the earlier RCT (9), these findings indicate that the massage therapy did not lead to changes in migraine intensity and medication use. One possible reason for the difference in intensity effects may relate to differences in the measures used. Hernandez–Reif and colleagues used a scale from 0 (*no pain*) to 10 (*worse pain*) with descriptors such as *happy, contented, somewhat distressed,* and *very distressed* placed along it. Intensity ratings thus may have been confounded by evaluations of mood. The measure used in this study focused solely on intensity and so may be a more valid measure. Further research using larger samples to enhance statistical power and more in-depth assessments of migraine intensity and medication use is warranted.

These findings suggest that the massage therapy effects on migraine frequency may be at least partially due to its impact on stress arousal. The migraine triggers most commonly cited by participants included those involving physical and emotional stress. Moreover, massage participants exhibited decreases in heart rate, anxious mood, and salivary cortisol during the massage sessions, suggesting that this massage sequence targeting migraine pathways effectively induces a relaxation response. It is notable that the study found moderate to strong effects of massage on changes in these indexes over a short time period and despite considerable variation in time of day, food consumption, and other factors known to influence these processes. In future research, it would be useful to assess these variables at multiple times during the hours following the massage to establish the duration of the relaxation effects. Further research could also explore variations in the impact of massage on cortisol at different times of the day and under different dietary conditions.

Because this study did not include a group who underwent an alternative procedure, such as a sham massage or quiet resting, it is not possible to determine the extent to which the reductions in stress responses during the massage session are attributable to the unique effects of the massage rather than to placebo effects or quiet rest. However, previous research has determined that comparison activities involving quiet rest do not induce comparable reductions in cardiovascular arousal, cortisol, and anxiety (31,32).

Contrary to predictions, the massage therapy group did not report improvements in perceived stress or coping efficacy and instead reported sustained levels of these factors over the study. In contrast, the control group reported a significant decrease in coping efficacy at the end of the intervention, which was sustained at follow-up. One explanation for the detrimental change in coping efficacy is that daily monitoring of headaches and medication use may have enhanced perceptions that their migraines were not under control. That similar effects were not observed for the massage group suggests that massage therapy mitigated the detrimental impact of the diary activity. It also may be that stress and coping efficacy were not assessed at times when massage effects occurred, or that the effects are too small to detect with the limited sample size. Further research is needed to explore whether massage induces changes in the cognitive representation of the stressor and problem-solving abilities and whether these, in turn, lead to changes in coping behaviors.

Although massage therapy did not influence sleep quantity, it led to improvements in sleep quality during the intervention and follow-up phases. Research has shown that, relative to sleep quantity, sleep quality has stronger associations with healthy outcomes as well as lower levels of negative mood, fatigue, and confusion (33). This massage therapy effect on sleep quality suggests another potential set of mechanisms through which massage reduces migraines. For example, massage may induce longer periods of deep sleep, thereby reducing levels of Substance P and inflammatory agents that trigger migraine pain (34).

Several methodological and practical limitations warrant comment. First, both this study and the previous RCT utilized no-treatment control groups. It is possible that the group differences are at least partly due to negative effects induced by disap-

pointment over assignment to the control condition. The stability in migraine and sleep measures over time for the control group contradicts this alternative explanation, although demoralization effects may have contributed to the group's decrease in coping efficacy over time. Although the findings support the efficacy of massage therapy in relation to no treatment, further research that includes a comparison treatment (e.g., thermal biofeedback therapy) is needed to establish that it is efficacious and specific in its mechanisms of action . Research establishing the possible efficacy of a therapy is needed to rule out the possibility that a therapy has null or even detrimental effects and to justify research using conditions in which migraine sufferers undergo lengthy sham or attention control procedures. RCTs that include placebo conditions are now warranted as it is possible that the attention, therapeutic expectations, and rituals involved with massage are responsible for at least some of its effects. This possibility is demonstrated by a recent trial in which both acupuncture and sham acupuncture (in which nonacupuncture points were needled) were found to be equally effective in reducing migraine (35). Given the paucity of RCTs for massage and the uncertainties regarding physiological effects of sham interventions and placebo effects, further research that includes rival treatments or "placebo" massage (e.g., light pressure massage) (36) can establish whether massage therapy meets the criteria for an efficacious and specific treatment for migraine.

The use of pen-and-paper diaries to assess migraine and sleep experiences, although a common practice in headache research, prevents verification that entries were completed at the appropriate times. Participants' documentation of entry times indicated reliable completion, and their reports that the diaries were noninvasive and helpful suggest strong motivations to complete the daily records. Yet the potential for participants to make delayed entries increases the probability of measurement error, which would reduce the sensitivity of the analyses in detecting treatment effects. Electronic methods of assessment may provide more accurate data. The generalizability of the findings may be limited to adults with migraine conditions who live in cultures similar to New Zealand. Finally, although the sample size is larger than those of many previous massage studies (11), it is still relatively small. Larger samples may be needed to detect small- to moderate-sized effects.

To conclude, this study provides empirical support for the utility of massage therapy as a nonpharmacologic treatment for individuals suffering from regular migraines. Further research is needed to establish a more comprehensive picture of how massage influences the cognitive, affective, behavioral, and physiological processes involved in stress regulation, muscle tension, and sleep in ways that assist in migraine control.

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