Effectiveness of Specific Neck Stabilization Exercises or a General Neck Exercise Program for Chronic Neck Disorders: A Randomized Controlled Trial

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ABSTRACT. ***Objective.*** In a cohort of primary care patients with chronic neck pain, to determine whether specific neck stabilization exercises, in addition to general neck advice and exercise, provide better clinical outcome at 6 weeks than general neck advice and exercise alone.

Methods. This was a multicenter randomized controlled trial in 4 physical therapy departments. Seventy-four participants (mean age 51.3 yrs) were randomized to specific neck stabilization exercises with a general neck advice and exercise program (n = 37) or a general neck advice and exercise program alone (n = 37). They attended a 1-hour clinical examination, followed by a maximum of 4 treatment sessions. Assessments were undertaken at baseline, 6 weeks, and 6 months. The primary outcome was the Neck Pain and Disability Scale (NPDS). Analysis was by intention to treat.

Results. Seventy-one (96%) participants received their allocated intervention. There was 91% followup at 6 weeks and 92% followup at 6 months. The mean (SD) 6-week improvement (reduction) in NPDS score was 10.6 (20.2) for the specific exercise program and 9.3 (15.7) for the general exercise program. There were no significant between-group differences in the NPDS at either 6 weeks or 6 months. For secondary outcomes, participants in the specific exercise group were less likely to be taking pain medication at 6-week followup (p = 0.02). There were no other significant between-group differences.

Conclusion. Adding specific neck stabilization exercises to a general neck advice and exercise program did not provide better clinical outcome overall in the physical therapy treatment of chronic neck pain. (First Release Dec 15 2008; J Rheumatol 2009;36:390–7; doi:10.3899/jrheum.080376)

Key Indexing Terms:
CHRONIC NECK PAIN
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Neck pain is a common musculoskeletal problem and most people suffer from it at some point in their lives[1,2]. Neck disorders affect 13% of adults at any one time and up to 30% of men and 50% of women in a lifetime[2–5]. Of these, 14% to 19% may go on to develop chronic pain[6,7]. Precise diagnosis by clinical examination is problematic[7], because signs and symptoms are frequently nonspecific, with poor reproducibility. One approach in primary care is to use "red flags" to identify potentially serious disease[8]; once these have been excluded, patients are classified as having "simple" or "nonspecific" neck pain.

In the UK, direct referral to physical therapy is popular, because of reduced wait times, lower costs, and potentially quicker recovery compared with referral to medical specialists in secondary care[9]. Various treatments are used in the conservative management of neck pain including electrotherapy, exercise, and manual therapy[10,11]. Systematic reviews have identified a paucity of high-quality trials in this field, and also the lack of conclusive evidence for any particular treatment[12]. Even in the field of exercise therapy, there does not seem to be any evidence to support one particular approach over another[13].

Weakness or fatigue of the neck musculature has been linked to neck pain[14–16], indicating a role for strengthening exercise, and several studies have explored the role of general exercises in the management of neck pain. In Finland, Ylinen, *et al*[17] have shown that both strength and endurance exercises are superior to a control intervention in chronic neck pain in women, and Viljanen, *et al*[18] demonstrated an improvement in range of motion, although no difference in pain, following either dynamic muscle training or relaxation, compared to control. Taimela, *et al*[19] found some evi-

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dence favoring a multimodal treatment program over both home exercises and a control intervention.

In recent years there has been a resurgence in the use of specific spinal strengthening programs[20]. The theoretical basis of such programs is that pain causes inhibition of deep stabilizing muscles, creating imbalance around the spine and leaving it vulnerable to further strain and hence pain[20]. While the focus of these programs has been on low back pain, studies have also investigated the proposed stability role of the deep anterior neck muscles[21–23]. However, there has been limited investigation into the role of specific neck stabilization exercises in the management of neck pain[11] in UK clinical practice. These muscles are difficult to assess because of their position. However, Jull[24] proposed that the movement of head-neck flexion can be used to test the strength of the deep cervical flexor group. One randomized controlled trial has investigated the effects of manual therapy and specific cervical stability strengthening exercises on cervical headache, but found no difference between the active intervention groups[25].

There is thus little evidence for the role of specific spinal stabilization exercises in relation to neck pain. We studied whether specific neck stabilization exercises, in addition to a general neck advice and exercise program, were better than a general neck advice and exercise program alone, in the treatment of chronic neck pain. We adopted a pragmatic approach, which addressed the comparative effectiveness of broad treatment packages — rather than individual treatment techniques or modalities — in everyday practice, where tight experimental control and blinding of the therapist and patient were not feasible[26].

The primary objective was to compare at 6 weeks the effect of adding specific neck stabilization exercises to a program of posture correction techniques and neck range of movement exercises in patients with chronic neck pain. The secondary objective was a comparison of the effects of the treatment programs at 6 months.

MATERIALS AND METHODS

Study participants. This was a single-blind randomized controlled trial. Participants were recruited from 4 outpatient sites across one region of the UK (one acute hospital and 3 community hospital sites). The local research ethics committee approved the study. Eligible participants were aged 18 years and over with neck pain symptoms for longer than 3 months, and had been referred by their general practitioner to physical therapy with a new episode of neck pain. Exclusion criteria were "red flags," for example, inflammatory conditions (e.g., rheumatoid arthritis), worsening neurological signs, severe bone disease (e.g., osteoporosis), or nonmechanical pain.

Participants recruited to the trial were identified by the trial coordinator from the non-urgent waiting lists at each center. Participants were sent a trial information letter and screened by telephone a few days later for eligibility and willingness to participate. Participants not wishing to enter the trial but still requiring physical therapy were offered a routine treatment appointment. Written informed consent was obtained before baseline data collection and participants were assigned a unique study number.

Randomization. A computer-generated randomization list with random permuted blocks (block size: 2, 4, or 6), stratifying for center, was devised by the Birmingham Clinical Trials Unit (BCTU). Participants were then allocated using telephone randomization at BCTU. Once contacted by the trial coordinator, BCTU allocated each participant to Group A or Group B.

Blinding. Only the treating clinicians knew which treatment group was A or B at each site, thereby ensuring that the trial coordinator (CG), who was responsible for data entry, and the statistician (JS) remained blind to patient allocation. A copy of the randomization sheet was attached to the therapy record sheet. Patients were aware that they had an equal chance of being allocated to one of the 2 interventions and that these were both exercise programs, but were unaware of the specific difference in content between the interventions, and thus were blind to the study hypothesis.

Interventions. Eleven musculoskeletal outpatient physical therapists were involved in treating the trial participants. They had a mean of 8 years' musculoskeletal experience and were experienced physical therapists (i.e., all employed at Senior II or Senior I level). In the month prior to the beginning of the trial, they all attended a study session that presented the rationale for the study and outlined the trial protocol. To monitor the delivery of the interventions and check for any contamination, we performed an audit of treatment notes after 20 participants had been recruited. This was carried out by 2 assessors independent of the clinical centers (KD, JW) and showed good standardization of the study interventions. The results of this audit were conveyed to the treating therapists.

Posture correction techniques and active range of movement exercises were delivered in both arms of the trial. In the general exercise group, the active range of movement exercises prescribed were at the therapist's discretion, but could include flexion, extension, side flexion, and rotation. Posture correction was taught in the context of functional and work activities. The general exercise group received an intervention based on this program alone. The specific exercise group were additionally taught a program of specific neck stabilization exercises. These included an isometric craniocervical flexion exercise, performed sitting, standing or lying, and an isometric craniocervical flexion exercise in an inclined sitting position with a head-lift off the supporting surface. The treating therapists were asked to aim for an isometric hold of up to 10 seconds, and up to 10 repetitions. Participants were also taught to use their deep flexor muscles during functional activities. The hold time, repetitions, and progression of the exercises were at the discretion of the treating therapist. Participants received a 1-hour clinical examination, and the study interventions were subsequently delivered over a maximum of four 30-minute treatment sessions within the first 6 weeks; the number of sessions up to this maximum was at the treating therapist's discretion.

We asked participants in both groups to perform their exercises 5–10 times daily, and the interventions were reinforced with written exercise sheets; these were generated through the Physiotools computer program, which produces customized diagramatic illustrations of individual exercises. All treatments were recorded on case report forms. We validated these forms against therapy treatment records in a convenience sample of 20 participants.

At 6 weeks, the therapist could discharge the patient from treatment or continue with other treatment modalities if appropriate. The criterion for discharge was either if the participant reported being symptom-free, or if in the opinion of the treating therapist further treatment would not affect short- or longterm outcome. The trial protocol was designed to replicate clinical practice at all trial sites and therefore a minimal amount of therapy equipment was used. The therapists were given written patient exercise sheets to reinforce the treatment program.

Outcome measures. Outcome measurement was undertaken by the trial coordinator at baseline, and by postal self-completed questionnaires at 6 weeks and 6 months. The primary outcome measure was the Neck Pain and Disability Scale (NPDS)[27,28]. The NPDS is a 20-item scale covering pain and functional, social, and emotional aspects of neck pain. The scale uses a 0–5 visual analog scale (VAS) with the addition of incremental line points. We replaced the VAS with a 0–10 numerical rating scale to enhance data collection in the self-completed questionnaires. Prior to analysis, scores

were rescaled to 0–100. Secondary outcome measures included the Northwick Park Neck Pain Questionnaire (NPQ)[29], pain affect (11-point numerical scale of how distressing the patient feels the pain is), severity (11-point numerical scale) of patient-identified worst problem (elicited by the question: "Because of your neck, which one thing gives you the most problems?"), self-reported use of pain relief medications over the preceding 48 hours, patient's global improvement (5-point numerical scale of how much the patient feels symptoms have improved from baseline), uptake of further treatment, and the Medical Outcomes Study Short Form-36 health status measure[30]. A 5-point Likert item ("I was able to do my exercise as often as I was told to") was used to measure adherence to the exercise program (response categories: strongly disagree, disagree, not sure, agree, strongly agree). Similar items were used to measure the clarity of the information sheets ("The information sheets were clear and easy to follow") and the perceived ease of performance of the exercise regimens ("I found the exercise easy to do"). The presence of chronic widespread pain, according to the American College of Rheumatology criteria[31], was determined by a self-completed blank body manikin. The questionnaire package was successfully piloted on a sample of 20 patients prior to the trial.

Sample size. The sample size calculation was based on the NPDS. The banding system described in the validation study for the NPDS[27] suggests that a change in scores between baseline and 6 weeks of 12 points is a clinically important change. To detect a 12-point difference in 0–6 week change on the NPDS between 2 groups — assuming a standard deviation of 16.5[27], a 2-tailed significance level of $p \leq 0.05$, 80% power, and equal group sizes — a total sample of 62 patients was required. We aimed to recruit at least 70 participants to allow for loss to followup.

Statistical analysis. Analysis was undertaken on an intention-to-treat basis. Where values were missing, these were estimated by multiple imputation (with the assumption that values were missing at random).

Estimates of between-group differences on numerical outcomes were derived through analysis of covariance, including treatment center as blocking factor and controlling for sex, chronicity (natural log-transformed), and baseline values on the outcome measure. These control variables were selected a priori in terms of clinical or prognostic importance[32]. For categorical outcome data, multiple logistic regression was used, controlling for the same variables. For ordinal data, unadjusted between-group differences were analyzed by the Wilcoxon rank-sum test. For all analyses, p values and confidence intervals were adjusted for the number of imputed values[33]. A sensitivity analysis was performed on the primary outcome measure, the NPDS, using complete data only.

Statistical significance was set at $p \leq 0.05$ (2-tailed). Analyses were carried out using SPSS version 14 and SOLAS 3.2. No interim analyses were undertaken.

RESULTS

Recruitment and followup. One hundred seventy-one consecutive patients with chronic neck pain were approached for possible recruitment, of whom 74 (mean age 51.3 yrs) were randomized (Figure 1). The most frequent reasons for patients not entering the trial (n = 97) were unable to contact (n = 30; 31%) and not wishing to be recruited (n = 27; 28%). There were no differences between those recruited and those not recruited in age ($p = 0.84$; t test) or sex ($p = 0.17$; chi-square test).

Baseline characteristics are shown in Table 1. Somewhat higher numbers of participants were not working and had received previous physical therapy in the general exercise group, whereas median chronicity was slightly higher in the specific exercise group. Otherwise, characteristics were similar across groups. The physical therapy clinical diagnoses were also similar, although a diagnosis of spondylosis was more common in the general exercise group. Overall, spondylosis (n = 23) was the most common diagnosis, followed by whiplash (n = 9), nonspecific neck pain (n = 8), and discogenic pain (n = 7). Seven participants were lost to followup at 6 weeks, and 6 participants at 6 months, giving 91% and 92% followup, respectively (Figure 1). For 2 participants, data were unavailable at both followup dates.

One patient in the general exercise group and 2 patients in the specific exercise group were randomized and completed baseline measures, but subsequently either failed to receive any treatment or received fewer treatments than the therapist intended.

Interventions. Nearly all patients received their allocated intervention, 36 (97%) in the general exercise group, 35 (95%) in the specific exercise group. Participants in the general exercise group received a median (interquartile range) of 3 (3, 3) treatments within the trial, compared to 4 (3, 4) in the specific exercise group; in both groups, the range of treatments received was from 0 to 4.

Compliance with home exercises, as assessed by the treating therapist during the period of delivery of the intervention, was judged to be good to excellent for 84% of participants (on a 3-category scale of poor, good, excellent). The response to the Likert item measuring adherence ("I was able to do my exercise as often as I was told to") differed somewhat between groups. In the general exercise group, more patients (27/33; 82%) agreed or strongly agreed with this statement than in the specific exercise group (20/32; 63%). Additionally, more patients (28/33; 85%) agreed or strongly agreed with the statement "I found the exercise easy to do" in the general exercise group than in the specific exercise group (19/32; 59%), while a similar number of patients agreed or strongly agreed with the statement "The information sheets were clear and easy to follow" in the specific exercise group (31/32; 97%) as in the general exercise group (28/33; 85%).

Outcome measures. Raw scores for all outcome measures are given in Table 2. For the raw scores on the primary outcome, the NPDS, the mean (SD) 6-week improvement (i.e., reduction) from baseline was 9.3 (15.7) points for the general exercise group and 10.6 (20.2) points for the specific exercise group. The mean (SD) 6-month improvement from baseline was 9.0 (20.2) points for the general exercise group and 14.7 (22.1) points for the specific exercise group. In both groups, therefore, the raw mean within-group change was not clinically important (< 12 points) at 6 weeks. At 6 months, however, mean within-group change was clinically important (≥ 12 points) for the specific exercise group. At 6 weeks, more participants in the general exercise group had achieved a clinically important change (17/37; 46%) than in the specific exercise group (14/37; 38%), although this difference was not significant ($p = 0.48$; chi-square test). At 6 months, the number achieving a clinically significant

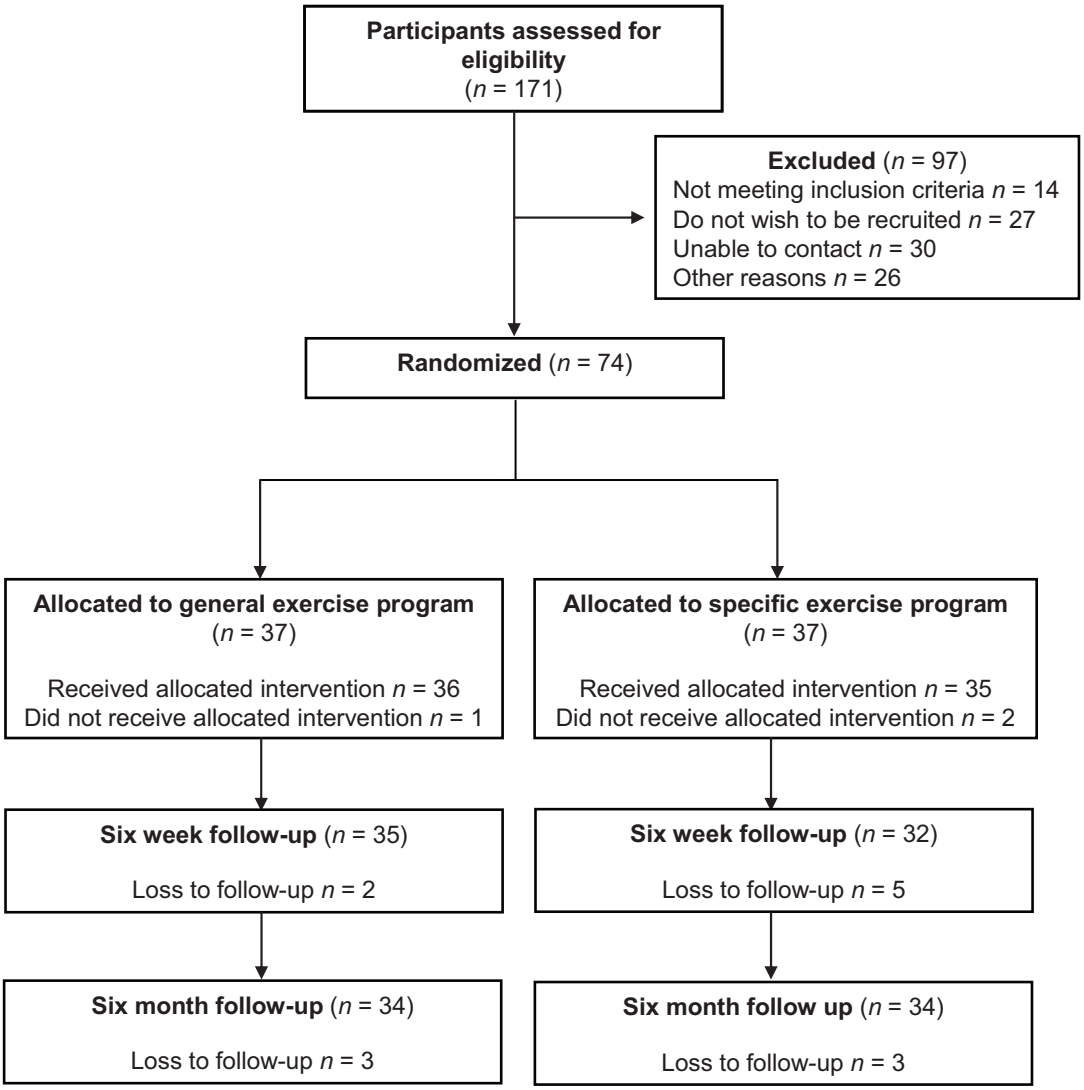

Figure 1. Trial profile — baseline to 6 months.

change was higher in the specific exercise group (22/37; 60%) than in the general exercise group (15/37; 41%), although again not significantly (p = 0.10; chi-square test).

Figure 2 shows the scores on the NPDS adjusted for baseline values, sex, treatment center, and chronicity, and with missing values imputed. Table 3 shows the results of the primary intention-to-treat analysis, with missing values imputed. Between-group differences on the NPDS were statistically nonsignificant at both 6 weeks and 6 months, and were not clinically important (< 12 points). Table 3 also shows the sensitivity analysis on the complete data: estimated differences remained statistically nonsignificant and clinically unimportant.

Results of the analyses of the secondary outcomes are presented in Table 4. No between-group differences were found, other than for use of pain relief medications; at 6 weeks, participants in the specific exercise group were about 30% as likely as those in the general exercise group to be taking pain relief medications (p = 0.02). The magnitude of the treatment effects on the secondary outcomes was otherwise generally small.

Cointerventions. More participants received additional treatment in the general than in the specific exercise group: 7 versus 2 at 6-week followup, and 10 versus 5 at 6-month followup. These differences were not statistically significant (p = 0.11 and p = 0.13, respectively; chi-square test). The additional treatment modalities used were similar across the 2 groups.

DISCUSSION

We report the findings from a randomized controlled trial in 5 UK physical therapy centers, investigating the effectiveness of adding a specific cervical strengthening exercise program to a general cervical exercise program in the treatment of chronic neck pain. Although the specific exercise group showed clinically significant improvement at 6-month

Table 1. Baseline characteristics of participants. Lower scores are better on Neck Pain and Disability Scale, Northwick Park Neck Pain Questionnaire, pain affect, and rating of worst problem. Higher scores are better on anticipated improvement and SF-36 physical and mental component summaries.

	General Exercise, n = 37	Specific Exercise, n = 37
Age, yrs*	51.5 (13.6)	51.1 (14.00)
Sex, n (%)		
Male	11 (30)	17 (46)
Female	26 (70)	20 (54)
Employment status, n (%)		
Working	20 (54)	24 (65)
Not working	17 (46)	13 (35)
Clinical center, n (%)		
1	13 (35)	13 (35)
2	3 (8)	5 (14)
3	6 (16)	6 (16)
4	15 (41)	13 (35)
Duration of symptoms, mo**; median (IQR)	24 (14, 60)	30 (12, 72)
Physical therapists' clinical diagnosis, n (%)		
Spondylosis	15 (41)	8 (22)
Whiplash	4 (11)	5 (13)
Discogenic	3 (8)	4 (11)
Cervical dysfunction	3 (8)	2 (5)
Cervical headache	2 (5)	1 (3)
Other	10 (27)	17 (46)
Patient's first episode of symptoms, n (%)		
Yes	9 (24)	10 (27)
No	28 (76)	27 (73)
Chronic widespread pain†, n (%)		
Yes	14 (38)	14 (38)
No	23 (62)	23 (62)
Previous physical therapy, n (%)		
Yes	20 (54)	17 (46)
No	17 (46)	20 (54)
Neck Pain and Disability Scale* (0–100)	50.14 (17.85)	52.43 (18.58)
Northwick Park Neck Pain Questionnaire* (0–100)	40.02 (13.27)	39.06 (13.27)
Pain affect* (0–10)	5.32 (1.99)	5.05 (2.46)
Rating of patient-identified worst problem* (0–10)	5.95 (1.67)	5.68 (2.58)
Anticipated improvement (0–5); median (IQR)	4 (3, 4)	4 (3, 4)
Taking pain medications; median (IQR), n (%)		
Yes	24 (65)	21 (57)
No	13 (35)	16 (43)
SF-36 physical component summary*†† (0–100)	30.45 (10.91)	30.66 (11.69)
SF-36 mental component summary*†† (0–100)	46.96 (11.09)	49.08 (12.88)

* Mean (standard deviation). ** Based on n = 34 for general treatment group, n = 34 for specific treatment group. † Classified according to the American College of Rheumatology definition[31]. †† Based on n = 36 for general treatment group, n = 36 for specific treatment group. IQR: interquartile range; SF-36: Medical Outcomes Study Short Form-36.

followup, in terms of between-group comparisons we were unable to demonstrate additional benefit from adding specific neck exercises to a package of general neck exercises, except in relation to the use of pain relief medications at 6 weeks. Moreover, observed between-group treatment effects — with the exception of the use of pain relief medications at 6 weeks — were small, and unlikely to be clinically important. The sensitivity analyses on the primary outcome, based on participants with complete data, did not produce different conclusions.

The strengths of this study include achievement of the recruitment target, remote third-party randomization, and high followup (91% at 6 weeks, 92% at 6 months). The allocated treatment was received by 96% of the participants and was delivered in accord with the protocol. Outcomes were analyzed blind to treatment allocation and by intention to treat. We chose a primary outcome measure of neck-specific disability that is recognized as appropriate in this population[34].

Use of broad eligibility criteria enabled participants with a wide range of nonspecific neck pain problems to be recruited. The size of the study does not, however, allow us

Table 2. Raw values of outcome measures at followup. Lower scores are better on Neck Pain and Disability Scale, Northwick Park Neck Pain Questionnaire, pain affect, and worst problem. Higher scores are better on SF-36 physical and mental component summaries and subjective improvement.

	6 Weeks			6 Months		
	General Exercise	Specific Exercise	n_1, n_2**	General Exercise	Specific Exercise	n_1, n_2**
Neck Pain and Disability Scale (0-100)*	43.16 (22.00)	45.60 (23.39)	32, 25	44.22 (23.66)	40.05 (27.74)	29, 29
Northwick Park Neck Pain Questionnaire (0–100)*	38.01 (15.74)	37.6 (14.73)	32, 30	20.16 (10.97)	20.10 (14.30)	28, 33
Pain affect (0–10)*	4.15 (2.44)	4.66 (2.60)	34, 32	4.03 (2.56)	4.29 (3.05)	31, 31
Worst problem (0–10)*	4.37 (2.40)	4.41 (2.90)	30, 27	4.26 (2.67)	4.00 (3.00)	27, 29
SF-36 physical component summary (0-100)*	41.08 (16.21)	38.90 (15.02)	30, 25	37.99 (15.18)	35.23 (15.06)	26, 23
SF-36 mental component summary (0–100)*	41.19 (16.17)	43.54 (16.97)	30, 25	45.28 (17.53)	46.33 (16.10)	26, 23
Subjective improvement (1–5 score)†	4.0 (3.0, 4.5)	4.0 (3.0, 4.0)	35, 32	4.0 (3.0, 4.0)	3.5 (3.0, 4.0)	33, 34
Taking pain medications††						
Yes	23 (68)	13 (41)	34, 32	16 (52)	17 (53)	31, 32
No	11 (32)	19 (59)		15 (48)	15 (47)	

* Mean (standard deviation). † Median (interquartile range). †† Count (column percentage). ** Number of values for general exercise group (n_1) and specific exercise group (n_2).

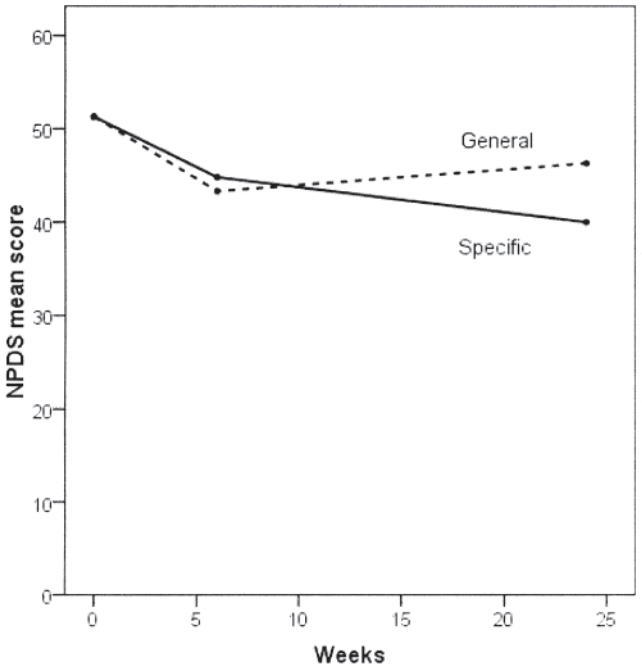

Figure 2. Profile plot for mean scores on the Neck Pain and Disability Scale (NPDS) for the general exercise group and the specific exercise group, adjusted for baseline value, sex, treatment center, and chronicity.

to identify which subgroups of patients respond best to specific approaches.

The trial interventions were designed to reflect usual clinical practice, and were delivered over a maximum of 4 sessions within a 6-week period. The neck exercises were selected from a menu of exercises previously used in a protocol for a neck pain randomized controlled trial[26]. The selection of exercises was based on the subjective history and objective findings. However, there was no evaluation of the physiotherapists' clinical decision-making in arriving at this choice. The number, repetition, and progression of exercises were recorded and were at the therapist's discretion. Accommodating the natural variation in physical therapy treatment is one of the hallmarks of pragmatic studies, where allowing clinicians the flexibility to reflect clinical practice needs to be balanced against ensuring validity of the trial protocol[34,35]. As in other studies[17–19], lack of effectiveness may be attributable to dose. However, in our study fewer treatments were given on average than were permitted by the protocol, suggesting that the treating therapists did not feel constrained in terms of the treatment they provided. While the therapists judged compliance with the exercises overall to be good, how frequently patients performed them was not directly measured. It is possible that one approach to exercising was easier to undertake than another. The comparative benefit of a new exercise approach may not be fully realized if participants follow the prescribed program less easily than an established one. While we cannot therefore link adherence with exercise to outcome, it may be that the lack of superiority of the specific exercise program is related to a lack of adherence. Such an interpretation is supported by the observation that fewer patients reported being able to do their exercises as often as they were told to in the specific exercise group than in the general exercise group. This suggests that patients in the specific exercise group may have performed too few exercises, and coupled with the greater reported ease of performance of the general exercise regimen, highlights the need to ensure that exercises are taught in such a way as to maximize adherence.

Although the difference in the numbers of patients in each group achieving a clinically important change at each timepoint was not significant, this finding may tentatively suggest that general and specific exercise regimens achieve their effects over differing time periods. This hypothesis could usefully be explored in future studies.

The intended sample size was achieved. However, variability of NPDS scores was in the event greater than the estimate used in the sample size calculation, which might sug-

Table 3. Results on primary outcome measure: the Neck Pain and Disability Scale. All estimates adjusted for treatment center, sex, chronicity, and baseline value. Lower scores are better on the Neck Pain and Disability Scale.

	6 Weeks				6 Months			
	General Exercise	Specific Exercise	Difference* (95% CI)	p	General Exercise	Specific Exercise	Difference* (95% CI)	p
Primary analysis								
Intention to treat analysis†	43.31	44.81	–1.50 (–9.00, 6.00)	0.69	46.30	39.99	6.31 (–3.67, 16.29)	0.21
Sensitivity analysis								
Analysis on complete data	45.44	45.02	0.42 (–8.77, 9.61)	0.93	49.06	43.00	6.06 (–4.99, 17.10)	0.28

* Difference calculated as general exercise group score minus specific exercise group score. † Missing values imputed: 17 at 6 weeks, 16 at 6 months.

Table 4. Intention to treat analyses for secondary outcomes. Data are means and mean difference, except for Subjective improvement (medians and median difference) and Taking pain medications (frequencies and odds ratio). All estimates, except that for Subjective improvement, adjusted for treatment center, sex, chronicity and baseline value (odds ratio for Taking pain medications is adjusted, but raw cell frequencies are shown). Lower scores are better on Neck Pain and Disability Scale, Northwick Park Neck Pain Questionnaire, pain affect, worst problem, and anticipated improvement. Higher scores are better on SF-36 physical and mental component summaries and subjective improvement.

	6 Weeks				6 Months			
	General Exercise	Specific Exercise	Difference (95% CI)	p	General Exercise	Specific Exercise	Difference (95% CI)	p
Northwick Park Neck Pain Questionnaire (0–100)[a]*	37.91	38.69	–0.78 (–5.81, 4.26)	0.76	18.42	19.19	–0.77 (–5.96, 4.42)	0.77
Pain affect (0–10)[b]*	4.00	4.74	–0.74 (–1.78, 0.31)	0.16	4.01	4.41	–0.4 (–1.49, 0.69)	0.47
Worst problem (0–10)[c]*	4.42	4.75	–0.33 (–1.40, 0.74)	0.53	4.23	4.37	–0.14 (–1.19, 0.92)	0.80
SF-36 physical component summary (0–100)[d]*	38.83	34.72	4.11 (–1.71, 9.92)	0.16	37.21	34.90	2.31 (–3.19, 7.82)	0.72
SF-36 mental component summary (0–100)[d]*	43.64	42.43	1.21 (–4.83, 7.25)	0.69	45.40	43.51	1.89 (–4.24, 8.00)	0.54
Subjective improvement (1–5 scale)*	4.0	4.0	0.0 (0.0, 0.0)	0.94	4.0	3.5	0.0 (0.0, 1.0)	0.35
Taking pain medications[f]†								
Yes	25 (68)	14 (38)	0.29 (0.10, 0.84)	0.02	19 (51)	18 (49)	1.16 (0.37, 3.59)	0.80
No	12 (32)	23 (62)			18 (49)	19 (51)		

* Difference calculated as general exercise group score minus specific exercise group score. † Reference category for odds ratio: General exercise. Missing values imputed by multiple imputation: [a] 12 at 6 weeks, 13 at 6 months; [b] 8 at 6 weeks, 12 at 6 months; [c] 17 at 6 weeks, 18 at 6 months; [d] 19 at 6 weeks, 25 at 6 months; [e] no data available for imputation at 6 weeks, 5 at 6 months (no data available for 2 cases); [f] 8 at 6 weeks, 11 at 6 months. SF-36: Medical Outcome Study Short Form-36.

gest, in retrospect, that our study was underpowered. However, as the magnitude of the observed between-group effects on the NPDS was at best just over half that deemed clinically important, and secondary outcomes also predominantly showed very small effects, the clinical implications would be very unlikely to differ had the trial been larger.

Comparison of our study with others is difficult because few have examined the effectiveness of specific stabilization exercises, or have done so in relation to pain elsewhere in the spine[20,36]. Although it seems that alteration in specific muscle groups may occur with stability muscle training, studies have been limited by their small size. In a study of cervicogenic headache, Jull, *et al*[25] evaluated manipulative therapy and a low-load exercise program used alone and in combination, compared with a control group. Participants (n = 200) were randomized to manipulative therapy, specific exercise therapy, combined therapy, and a no-treatment control group. At 12-month followup, the manipulative therapy and specific exercise groups both showed statistically significant improvement in headache frequency and intensity and in neck pain and disability, compared to the control group; there was no additive effect when the 2 treatments were combined. Effect sizes for these outcomes were deemed clinically relevant. It appears, therefore, that specific exercise can produce longterm reduction in the symptoms of cervicogenic headache and neck pain.

Our study was not designed to provide evidence for the effectiveness of general exercise, our comparator group, for nonspecific neck pain. However, we have previously shown that advice and exercise seems an attractive approach to the management of nonspecific neck disorders[35].

We demonstrated no overall additional benefit from adding specific neck stabilization exercises to a package of general neck exercises. There would seem, therefore, to be no clear benefit of including specific neck exercises in the treatment of chronic neck pain generally. However, future

studies may reveal subgroups of these patients for whom this approach is beneficial.

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REFERENCES

1. Makela M, Heliovaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinants, and consequences of chronic neck pain in Finland. Am J Epidemiol 1991;134:1356–67.
2. Croft PR, Lewis M, Papageorgiou AC, et al. Risk factors for neck pain: a longitudinal study in the general population. Pain 2001;93:317–25.
3. Valkenburg HA, Laar A, van Hofman A, Haanen HCM. Nek-en lage rugklachten. Jaarverslag Instituut Epidemiologie en Zesde Voortgangsverslag van het Epidemiologisch Preventief Onderzoek Zoetermeer. Maastricht, Netherlands: Maastricht University; 1980:99-109.
4. Aker PD, Gross AR, Goldsmith CH, Peloso P. Conservative management of mechanical neck pain: a systematic overview and meta-analysis. BMJ 1996;313:1291–6.
5. Borghouts JAJ, Koes BW, Bouter LM. The clinical course and prognostic factors of non-specific neck pain: a systematic review. Pain 1998;77:1–13.
6. Brattberg G, Thorslund M, Wikman A. The prevalence of pain in a general population. The results of a postal survey in a county of Sweden. Pain 1989;37:215–22.
7. Bovim G, Schrader H, Sand T. Neck pain in the general population. Spine 1994;19:1307–9.
8. Croft P. Diagnosing regional pain: the view from primary care. Baillieres Best Pract Res Clin Rheumatol 1999;13:231–42.
9. Robert G, Stevens A. Should general practitioners refer patients directly to physical therapists? Br J Gen Pract 1997;47:314–8.
10. David J, Modi S, Aluko AA, Robertshaw C, Farebrother J. Chronic neck pain: a comparison of acupuncture treatment and physiotherapy. Br J Rheumatol 1998;37:1118–22.
11. Moffett J, McLean S. The role of physiotherapy in the management of non-specific back pain and neck pain. Rheumatology Oxford 2006;45:371–8.
12. Gross AR, Aker PD, Goldsmith CH, Peloso P. Conservative management of mechanical neck disorders. Part two: physical medicine modalities (Cochrane Review). The Cochrane Library. Oxford: Update Software; 1998.
13. Randlov A, Østergaard M, Manniche C, et al. Intensive dynamic training for females with chronic neck/shoulder pain. A randomized controlled trial. Clin Rehabil 1998;12:200–10.
14. Silverman JL, Rodriquez AA, Agre JC. Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain. Arch Phys Med Rehabil 1991;72:679–81.
15. Gogia PP, Sabbahi MA. Electromyographic analysis of neck muscle fatigue in patients with osteoarthritis of the cervical spine. Spine 1994;19:502–6.
16. Barton PM, Hayes KC. Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. Arch Phys Med Rehabil 1996;77:680–7.
17. Ylinen J, Takala E-P, Nykänaen M, et al. Active neck muscle training in the treatment of chronic neck pain in women. JAMA 2003;289:2509–16.
18. Viljanen M, Malmivaara A, Uitti J, et al. Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomized controlled trial. BMJ 2003;327:475.
19. Taimela S, Takala E-P, Asklöf T, Seppälä K, Parviainen S. Active treatment of chronic neck pain: a prospective randomized intervention. Spine 2000;25:1021–7.
20. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine 1996;21:2763–9.
21. Vitti M, Fujiwara M, Basmajian JV, Iida M. The integrated roles of longus colli and sternocleidomastoid muscles: an electromyographic study. Anat Rec 1973;177:471–84.
22. Fountain FP, Minear WL, Allison RD. Function of longus colli and longissimus cervicis muscles in man. Arch Phys Med Rehabil 1966;47:665–9.
23. Mayoux-Benhamou MA, Revel M, Vallée C, Roudier R, Barbet JP, Bargy F. Longus colli has a postural function on cervical curvature. Surg Radiol Anat 1994;16:367–71.
24. Jull G. Deep cervical flexor muscle dysfunction in whiplash. J Musculoskelet Pain 2000;8:143–54.
25. Jull G, Trott P, Potter H, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine 2002;27:1835–43.
26. Dziedzic K, Jordan JL, Sim J, Hay EM. Treatment options for regional musculoskeletal pain: what is the evidence? In: Breivik H, Shipley M, editors. Pain: best practice and research compendium. Edinburgh: Elsevier; 2007:183–97.
27. Wheeler A, Goolkasian P, Baird A, Darden B. Development of the neck pain and disability scale. Item analysis, face, and criterion-related validity. Spine 1999;24:1290–4.
28. Goolkasian P, Wheeler AH, Gretz SS. The Neck Pain and Disability Scale: test-retest reliability and construct validity. Clin J Pain 2002;18:245–50.
29. Leak A, Cooper J, Dyer S, Williams K, Turner-Stokes L, Frank A. The Northwick Park Neck Pain Questionnaire, devised to measure neck pain and disability. Br J Rheumatol 1994;33:469–74.
30. Ware J. SF-36 health survey update. Spine 2000;25:3130–9.
31. Wolfe F, Smythe HA, Yunus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia: report of the Multicenter Criteria Committee. Arthritis Rheum 1990;33:160–72.
32. Raab GM, Day S, Sales J. How to select covariates to include in the analysis of a clinical trial. Control Clin Trials 2000;21:330–42.
33. Wright CC, Sim J. Intention-to-treat approach to data from randomized controlled trials: a sensitivity analysis. J Clin Epidemiol 2003;56:833–42.
34. Laurence DJ. Manual therapy or pulsed shortwave diathermy provide no additional benefit over advice and exercise in the treatment of neck disorders: commentary. Focus Altern Complement Ther 2005;10:307–8.
35. Dziedzic K, Hill J, Lewis M, Sim J, Daniels J, Hay EM. Effectiveness of manual therapy or pulsed shortwave diathermy in addition to advice and exercise for neck disorders: A pragmatic randomized controlled trial in physiotherapy clinics. Arthritis Rheum 2005;53:214–22.
36. O'Sullivan P, Twomey L, Allison G. Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiologic diagnosis of spondylolysis or spondylolisthesis. Spine 1997;22:2959–67.