ORIGINAL ARTICLE

Effects of Home Exercise Program on Pain and Neck Functions in Individuals With Non- Specific Neck Pain

Siew Kuan Chua, Nurul Fakhriah Abdul Muthalib, Nur Sharina Md Shukri, Zarina Zahari

Centre of Physiotherapy, Faculty of Health Sciences, Universiti Teknologi MARA Selangor Branch, Puncak Alam Campus, 42300 Puncak Alam Selangor Malaysia.

ABSTRACT

Introduction: Home exercise programme in combination with other interventions provide some benefits to patients with neck pain. This study aimed to examine the effects of a home exercise programme (HEP) on pain, neck muscle function and disability among individuals with nonspecific neck pain (NSNP). **Methods:** A quasi-experimental study of a 6-week HEP on 36 participants from a university was conducted. The HEP group (n = 18) received 15 minutes of postural educational programme (PED) and performed neck muscle stretching, neck extensor strengthening, and deep neck flexor endurance exercises thrice every week for 6 weeks. The control group (n = 18) received a similar PED. Pain intensity was measured using a numerical pain rating scale. Neck function was assessed using Northwick Park neck pain questionnaire (NP). Joint mobility was assessed using a goniometer. Neck extensor muscle strength was evaluated using manual muscle testing. Deep cervical flexor endurance was gauged via a pressure biofeedback unit. **Results:**No significant difference ($p > 0.05$) was observed between the HEP and the control group in all outcomes at baseline. After 6 weeks, both groups displayed a significant improvement in neck flexion ($p < 0.05$), pain intensity and NP score (both $p < 0.001$). Neck side flexion to right ($p < 0.05$), side flexion to left, extension and rotation, extensor muscle strength significantly improved (all $p < 0.001$) in the HEP group only. **Conclusion:** A 6-week of HEP, including neck muscle stretching, strengthening and endurance exercises, may effectively improve neck mobility, muscle strength and endurance among individuals with NSNP.

Keywords: Deep neck flexor, Home exercise, Neck pain, Neck extensor muscle strength.

Corresponding Author:
Chua Siew Kuan ,PhD
Email: : chuasiewkuah@uitm.edu.my
Tel:+603 32584492/ 019-2790111

INTRODUCTION

The prevalence of neck pain is increasing worldwide (1,2). The annual prevalence of this condition is estimated to be between 30% and 50% (3). Neck pain peaks between the ages of 30 and 45 years (4) and increases with age (1,5). College students are at a higher risk of neck pain than primary school students (6,7). Neck pain among college students is relatively high: 38.5% (N=365) and 33% (N= 684) in Malaysia and Thailand, respectively (8). Neck pain has a negative effect on students' concentration and academic performance (9), altering their emotional state, mood and psychological well-being (10).

Neck pain may result in reduced muscle strength and endurance, and neck stiffness may lead to neck muscle dysfunctions (8, 11). Prolonged hours spent sitting, reading, writing or computer work (6,8) continuously increase the static load on neck muscles (12). Poor posture increases calcium accumulation, homeostatic disturbances, impairs blood circulation and hampers the mechanism of metabolic waste removal, resulting in strains on biomechanical and stabilising systems, and tears along deep muscles and ligaments.

Individuals with neck pain may develop shortened and hyperactive superficial muscles, such as suboccipital, sternocleidomastoid, pectoral and rotator cuff muscles (13). For instance, neck stretching exercises can reportedly increase muscle extensibility (14) by modifying sensation (15). Instead of pharmacological treatment, specific neck exercises are recommended to alleviate pain and improve neck muscle functions (16). Moreover, neck muscle exercise that target the levator scapulae and upper trapezius muscles improve posture and pain symptoms in individuals with neck dysfunctions (17,18) and enhance daily tasks, especially carrying heavy objects (19).

Previous studies demonstrated that supervised exercises (20), combined neck muscle strengthening and mobility exercises (21), and neck muscle strength and endurance exercises (22) have a positive effect on recurrent neck pain. A home exercise programme (HEP) shows similar effects on pain symptoms and neck functions (3, 23) and improves the quality of life (4) of patients with chronic neck pain. An HEP reduces healthcare cost (24). Thus, it may benefit more patients who cannot easily attend regular physiotherapy at health care centres and hospitals. Physiotherapy interventions that are cost-effective, time-efficient and appropriate for individuals with neck pain should be identified. Thus, this study aimed to investigate the effects of an HEP on pain, neck mobility, neck muscle strength and endurance and disability among individuals with nonspecific neck pain (NSNP).

MATERIALS AND METHODS

A total of 36 students of a physiotherapy programme aged 18 to 30 years old from a high performance laboratory at the Centre of Physiotherapy, UiTM Selangor, Puncak Alam Campus were recruited. The sample size was determined on the basis of the Krejcie and Morgan Table (25) with 40 known students who were diagnosed with NSNP. This quasi-experimental study was conducted from October 2018 to May 2019. Ethics approval was obtained from UiTM Ethics Committee (600-IRMI/5/1/6/REC/368/18). Participants to the study were invited through a written announcement posted on the notice board of the Physiotherapy Clinic. The participants were diagnosed with NSNP by medical officers. Only those who scored 3 and above in self-rated numeric rating scale were included for the study. Moreover, participants who experienced localised neck pain for over 4 weeks and were motivated to undergo rehabilitation were also enrolled. Participants were excluded if he/she was taking medications for pain management (e.g., pain medications, NSAIDs and steroid drugs); had surgery of the neck region; had neck pain with radiculopathy that radiates to the arm; had shoulder diseases (e.g., tendonitis, bursitis and capsulitis); had inflammatory rheumatic diseases; suffered from frequent migraine; attending training for neck pain or concurrent treatment (e.g., spine manipulation, osteopathy and chiropractice) for the past 3 months; or had inflammatory conditions, cerebral vascular diseases or history of malignancy. The flow of data collection is displayed in Figure 1.

The study procedure was then explained to the participants. Consent was sought from the participants. The participants were randomly assigned into either a home exercise programme (HEP) group (n = 18) or a usual care group (n = 18) by a computerised system with a key in the consecutive number. Sociodemographic data, education level, physical activity, pain level, neck disability and other characteristics were collected. An experienced physiotherapist was assigned to conduct sum of the exercise sessions divided by 18 sessions. Sessions that were not completed by over 70% were considered nonadherent.

The participants in the usual care group received group education and advised to continue their usual activity

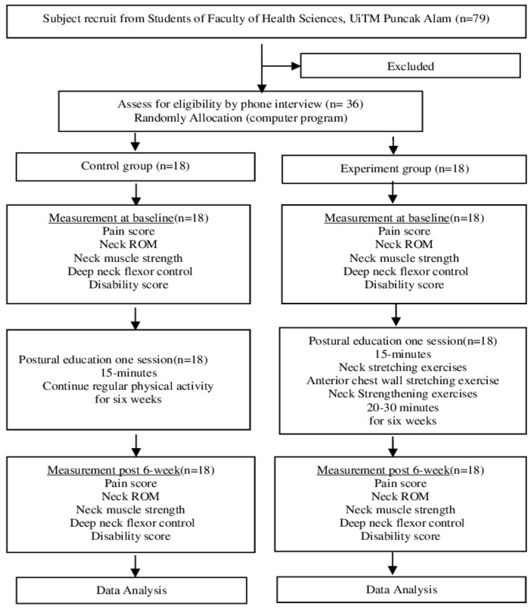

Figure 1: Flow Chart Data Collection

the group education. Both groups received 15 min of physiotherapeutic group educational programme together with correction of posture while sitting and sleeping; doing various activities, such as reading and lifting objects; and performing daily tasks, such as pushing, pulling and other chores.

The HEP group received a trial of prescribed home exercises that were demonstrated by a trained physiotherapist from the Physiotherapy Clinic, UiTM Selangor, Puncak Alam Campus. Home exercises consisted of two stretching exercises (for upper trapezius and levator scapulae), scapular stabilizer exercises, neck flexor endurance (26) and neck extensor muscle strengthening exercises according to the principle of frequency, intensity, time and type (FITT). These exercises were done two to three times per week (e.g., Monday, Wednesday and Thursday). The participants were required to perform all the exercises on the scheduled days. Each exercise was performed with a 5-second hold with 10 repetitions for three sets. Between each exercise, the participants were instructed to take a rest with an interval of 30–60 s. The HEP group was advised to document in a diary the exercises they performed (Figure 2). The exercise diary acted as a motivator for them to adhere to HEP. Every week, the researchers reminded the participants to comply with the programme via the mobile application WhatsApp. All participants were required to return the exercise diary. Adherence to the exercises was calculated as the until the post intervention (after 6 weeks) measurements.

Outcome measure

The outcome measures consisted of pain level; neck disability score; and physical measures, including neck mobility, neck extensor muscle strength and deep neck flexor endurance. Another trained physiotherapist (NA) who was blinded to the patients' group assignment performed the measurement at baseline and 6 weeks after the interventions.

Tick(/) on the date/day you have done your exercise. You are advised to do all exercise prescribed for 3 alternate days (eg.)

2018 NOVEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

2018 DECEMBER

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

2019 JANUARY

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Figure 2: Home Exercise Diary

Pain intensity was measured at rest and during activity by using a numeric rating scale (NRS) at baseline and follow up. A scale of 0 represents 'no pain', whereas a scale of 10 indicates 'worst possible pain' (26). The reliability (ICC = 0.76) of NRS was reportedly high (27).

The cervical range of motion was measured using a bubble inclinometer (Fabrication Enterprises Inc., USA) following standard protocols. This instrument is a reliable and valid tool for measuring the range of neck motion (ICC > 0.7) (28). The sagittal and frontal planes of neck motion, neck flexion, extension and lateral flexion were measured in seated position with the participants' hands on the thigh and the feet on the floor. The axial rotation of neck (rotation to right and left) was measured in supine position with the participant's head and shoulders in neutral position and their hands by the sides.

Neck extensor strength was measured using a manual muscle testing (MMT) in prone lying position with the head hanging outside the plinth. Neck extensor strength was considered as grade 3 when the participants were able to fully extend the neck against gravity. It was scored as grade 4 when the participants could extend the neck against gravity within the full range of motion with minimal resistance at the occiput. It was rated as grade 5 when the participants could fully extend the neck against maximal resistance applied by the assessor (28). The reliability of MMT is high (ICC: 0.82 – 0.98) (29).

The strength of deep cervical flexor muscle was assessed using a pressure biofeedback unit (PBU) (Chattanooga Group Inc., Hixon, TN) following standard protocols. The reliability of PBU ranges from 0.63 to 0.86 (30). The participant was instructed to lie in a hook position with the PBU properly placed at the cervico-occipital junction. The participants were instructed to keep their tongue on the roof of their mouth with their teeth slightly apart during the testing (31). They were then asked to perform nodding movements aimed to elevate the target pressure from 20 mmHg to 22 mmHg. They were asked to hold this pressure for 2 to 3 s, after which they were asked to relax. They were instructed to repeat this action through each increment of 2 mmHg until the maximum pressure of 30 mmHg was reached. The test was repeated three times, and the best performance (i.e., the highest mmHg level) that the participant could hold for 3 s was used for analysis.

Neck disability score was measured using the Northwick Park neck pain questionnaire. It consists of nine sections with five responses for each domain: the score ranges from no difficulty (0) to severe difficulty (3). The total score was calculated by getting the sum of all scores from all domains. The score was presented in percentage (total score/36 Ч 100%). A high percentage indicates a high disability and pain intensity. This questionnaire reportedly has good short-term repeatability (K = 0.62) (32).

Data were analysed using SPSS version 22. The normality of sample distribution was analysed by Shapiro–Wilk test. Differences between groups were analysed using independent t-test and Mann–Whitney test. Nominal data were analysed via Chi-squared test. Paired t-test was used for intragroup comparisons between pre- and post-intervention. The data were analysed via intention-to-treat analysis, wherein the baseline data was used irrespective of the lost to follow up after the intervention period.

RESULTS

The demographic and baseline characteristics of the participants are summarised in Table I. All participants (N = 36) presented with sub-acute neck pain, low score of neck disability, mean pain intensity score (NRS) of 4 and duration of neck pain for 5 weeks. Half of the participants sustained with grade 4 neck extensor strength. Over 10% of the participants had good level of deep neck flexor endurance (26–34 mmHg).

No significant difference was observed at baseline between groups in terms of demographic variables; pain intensity; neck disability score; neck extensor muscle strength; deep neck flexor endurance; and cervical range of motion (ROM) (all p > 0.05) in all directions, except for neck rotation to right (63.97 ± 12.26 vs. 73 ± 9.7, respectively; p = 0.02) and neck rotation to left (64.5 ± 12.33 vs. 75.33 ± 9.00, respectively; p = 0.01).

Table I. Sociodemographic and other characteristics of participants

Variables	Home exercise group (n=18)		Control group (n=18)		*P*
	n (%)	mean (SD)	n (%)	mean (SD)	
Age (years)		22.56 (1.34)		21.89 (1.45)	0.05
Gender					0.54
Male	1(5.6)		2 (11.1)		
Female	17(94.4)		16 (88.9)		
Height (cm)		158.00 (6.69)		158.89 (5.60)	0.29
Weight (kg)		59.89 (13.05)		57.67 (10.35)	0.05
Body Mass Index (kg/m^2)		24.09 (5.07)		22.82 (3.50)	0.18
Academic level					0.06
Degree	17 (94.4)		13 (72.2)		
Diploma	1 (5.6)		5 (27.8)		
Duration of neck pain (weeks)		5.28 (2.27)		5.06 (1.80)	0.36
Pain (NRS, 0-10)		3.39 (1.79)		3.61 (1.54)	0.69
Range of motion (degree)					
Flexion		53.61 (9.19)		54.56 (10.79)	0.78
Extension		54.83 (11.08)		58.67 (13.28)	0.35
Right Side Flexion		30.94 (6.73)		34.61 (6.07)	0.10
Left Side Flexion		33.33 (7.51)		34.06 (8.79)	0.79
Right Rotation		63.67 (12.26)		73.00 (9.70)	0.02*
Left Rotation		64.50 (12.33)		75.33 (9.00)	0.01*
Neck Extensor Strength (MMT)		4.28 (0.57)		4.50 (0.62)	0.27
Deep neck flexors endurance (mmHg)		29.78 (5.36)		29.44 (6.45)	0.87
North wick Park Neck Pain score		6.58 (0.54)		6.67 (0.52)	0.94
Compliance to Exercises					
Noncompliance =1-9 sessions	10 (55.56)				
Compliance:10-18 sessions	8 (44.44)				

NRS: numeric rating scale, MMT: manual muscle testing,
*p < 0.05, ** p < 0.01, ** p < 0.001

After 6 weeks of interventions, the HEP group was better than the control group in most of the variables, namely, pain intensity (p = 0.28), disability (p = 0.96), neck extensor muscle strength (p = 0.73) and all ranges of motion (p = 0.20–0.96) but not with regard to deep neck flexor endurance (p = 0.82). However, the differences between the groups were not statistically significant (all p > 0.05) (Table II).

The pain level, Northwick Park neck pain score (both groups $p < 0.001$) and neck flexion range (both groups, $p < 0.05$) of both groups significantly improved (Table III). With regard to cervical ROM, the HEP group significantly improved in all directions of neck ROM, namely, neck flexion, right side flexion ($p < 0.05$) and frontal plane and axial rotation (both $p < 0.001$). By contrast, the control group improved only in neck flexion ($p < 0.05$)

Table II. Mean (SD) values of Pain (NRS), Range of Motion (degree), Neck Extensor Strength (MMT), Deep neck flexor Endurance (mmHg) and Northwick Park Neck Pain score at 6 week

Variables	Home Exercise group (n=18) mean ± SD	Control group (n=18) mean ± SD	*P*
Pain (NRS, 0-10)	1.44 ± 1.82	2.11 ± 1.81	0.28
Range of motion (degree)			
Flexion	61.33 ± 11.65	59.89 ± 9.05	0.68
Extension	66.00 ± 12.55	61.78 ± 13.48	0.34
Right Side Flexion	36.22 ± 7.80	35.89 ± 4.84	0.88
Left Side Flexion	37.39 ± 7.57	34.00 ± 7.95	0.20
Right Rotation	76.28 ± 8.04	76.11 ± 13.12	0.96
Left Rotation	72.78 ± 9.11	76.72 ± 10.20	0.23
Neck Extensor Strength (MMT)	4.72 ± 0.46	4.67 ± 0.49	0.73
Deep Neck Flexors Endurance (mmHg)	31.50 ± 5.73	32.06 ± 8.82	0.82
Northwick Park Neck Pain score	6.5 ± 0.54	6.67 ± 0.21	0.94

NRS: numeric rating scale, MMT: manual muscle testing,
*$p < 0.05$, ** $p < 0.01$, ** $p < 0.001$

after the 6-week intervention. No statistically significant change in deep neck flexor endurance was observed in both groups (both $p > 0.05$).

DISCUSSION

We aimed to examine and compare the effectiveness of combination of group education and the 6-week HEP described herein with usual care (i.e., group education). Results showed that either the combination of group education and the 6-week HEP or group education significantly improved the pain intensity, neck flexion range, deep neck flexor endurance and neck disability score among individuals with sub-acute NSNP.

The neck extensor muscle strength, cervical right rotation and extension range of the patients in the HEP group significantly improved compared with those in the usual care group (p < 0.001). In the patients with neck pain, the presence of pain may lead to superficial neck muscles spasm and become tight, whereas deep neck muscles are weak (33). The stretching exercises of

Table III. Comparison of Pre- and Post 6-week in Home Exercise Group and Control group

Variables	Home Exercise group		Control group	
	Baseline	6 Weeks	Baseline	6 Weeks
	mean (SD)	mean (SD)	mean (SD)	mean (SD)
Pain (NRS, 0-10)	3.39 (1.79)	1.44 (1.82)***	3.61 (1.54)	2.11 (1.81)***
Range of Motion (degree)				
Flexion	53.61 (9.19)	61.33 (11.65)*	54.56 (10.79)	59.89 (9.05)*
Extension	54.83 (11.08)	66.00 (12.55)***	58.67 (13.28)	61.78 (13.48)
Right Side Flexion	30.94 (6.73)	36.22 (7.80)*	34.61 (6.07)	35.89 (4.84)
Left Side Flexion	33.33 (7.51)	37.39 (7.57)***	34.06 (8.79)	34.00 (7.95)
Right Rotation	63.67 (12.26)	76.28 (8.04)***	73.00 (9.70)	76.11 (13.12)
Left Rotation	64.50 (12.33)	72.78 (9.11)***	75.33 (9.00)	76.72 (10.20)
Neck Extensor Strength (MMT)	4.28 (0.57)	4.72 (0.46)***	4.50 (0.62)	4.67 (0.49)
Deep Neck Flexor Endurance (mmHg)	29.78 (5.36)	31.50 (5.73)	29.44 (6.45)	32.06 (8.82)
Northwick Park Neck Pain Score	11.78 (10.61)	6.5 (8.54)***	13.56 (6.99)	6.67 (5.21)***

NRS: numeric rating scale, MMT: manual muscle testing
*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

HEP focus on the specific anatomical functions of the levator scapulae assist in neck mobility in extension, lateral flexion and rotation (34), and the upper trapezius in neck extension (35) which the neck extensor strength of the participants in the HEP group increased because of the specific neck extensor muscle and deep neck flexor endurance exercises, demonstrating the effectiveness of the 6-week HEP in the management of neck pain. A previous study reported that deep neck flexor training improves neck mobility, reduces dizziness and pain and improves the activities of patient with chronic neck pain related to prolonged immobilisation (36).

The 6-week HEP described herein was based on the principles of frequency, intensity, time, and type (conducted three times per week). This programme achieved an effect similar to that obtained by an 8-week active exercise programme designed by Noormohammadpour et al. (37). In the latter, pain intensity improved by 62% by the end of the programme. This programme involved chin tuck and stretching exercises held for 20 s and performed for five repetitions three times a day. Another study devised a 4-week programme involving neck and shoulder stretching exercises performed five days per week. This programme reduced pain by 27% (38) and improved pain by 58% was observed in the current study. The 6-week HEP involved neck stretching sustained for 5 s for 10 repetitions, three times a day. Moreover, this programme included specific strengthening exercises and endurance training. We argue that pain reduction is improved not only by the duration of exercise but also by the mode and type of exercise.

Results showed that mean neck flexion range and deep neck flexor endurance improved by 14% and 6%, respectively. A randomised controlled trial (RCT) involving 567 office workers designed a 12-week programme of endurance exercises performed twice a week both at the workplace and at their homes (12). This programme improved neck flexion range and deep neck flexor endurance by 7% and 5%, respectively. The substantial improvement in neck mobility and neck muscle endurance observed in the present study was attributed to the fact that the individuals enrolled herein were younger and thus had wider neck range and higher deep neck flexor endurance. By contrast, the aforementioned RCT was conducted among women aged ≥30 years with chronic pain. The present study suggested that a group education and 6-week HEP or group education may similarly improve neck flexion ROM and deep neck flexor endurance as a 12-week HEP programme (12). The positive effects of both HEP and posture education were most likely due to the fact that the participants were aware of posture and chronic neck problems because they had a background in healthcare programme (39).

This study also monitored the participants' compliance to the programme. The participants were instructed to record their compliance in a diary. Moreover, they were reminded via phone calls. However, less than 50% of the participants in the exercise group completed 10 out of the 18 sessions. The participants' compliance was higher at the beginning of the programme but decreased over time. The risk of withdrawal/dropout is slightly higher in the exercise group (40). Furthermore, the participants in this study were solely university students who were busy at the time with preparations for the final examinations. They also had difficulty incorporating the HEP into their daily routine (41). This noncompliance could be due to the lack of commitment to the programme or merely due to poor time management. By contrast, previous studies achieved high compliance (80%) (41, 42). Moreover, they reported remarkable improvement in pain and disability scores as measured by NDI after follow up for 12 months but not for 6 months (43). The present study obtained a low mean pain intensity of 3.39–3.6 out of 10 at baseline compared with that of a previous study (56–58 out of 100), which also reported that pain intensity was reduced to 2, similar to the findings of the present study. Jordan et al. (44) highlighted that the manner of delivery of exercises, whether they are supervised or not, has an effect on adherence. Supervised exercises allow monitoring and immediate feedback that may help to increase exercise adherence (45) or overcome some of the barriers to adherence, especially among those who lack motivation (46).

A group education and a 6-week home-based exercise programme that consists of specific neck muscle stretching, neck extensor muscle strengthening, and endurance exercises thrice per day for three days per week may be superior to group education in terms of improving neck rotation range and neck extensor muscle strength in adults with subacute NSNP.

This study has several limitations. First, this study was not randomised and only observed short-term effects. The effectiveness may be influenced by exercise adherence and exercise habit, however, may not be able to sustain for long without supervision. Moreover, this study was conducted in a single group programme who had prior knowledge of neck pain and management. Furthermore, the use of manual muscle testing (MMT) in grading the neck extensor muscle was probably not sensitive enough. Hence, it was not able to measure small interval changes compared with when units of force were used. Therefore, the findings may not be generalised to other groups of participants. Additionally, the participants reported low adherence to the programme in their diary. This situation might have affected our analysis of the participants' compliance as they might have overstated their adherence. A follow up study should involve participants suffering from high pain intensity and with different chronicity. It should also examine the long-term effects of supervised or individual exercise programmes to increase adherence. Furthermore, the factors that affect adherence should be identified to achieve a better outcome.

CONCLUSION

A 6-week HEP including group education neck muscle stretching and endurance exercises, may effectively improve neck mobility, neck extensor muscle strength and neck endurance, hence reduce neck disability among individuals with NSNP.

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