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Original Article

Effects of self-posture correction exercise in forward head posture of smartphone users

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Abstract

The majority of smartphone users tend to tilt heads forward to focus on screens which involves a combination of muscles tension and weakening leading to muscle performance reduction. This study aimed to compare the effects of self-exercise three times-per-week for six weeks combined with received knowledge in experiment and control received knowledge only were assessed craniovertical angle-CVA, head-tilt angle-HTA and shoulder angle-SHA by kinovea program, neck strength with hand-held dynamometer, neck endurance by holding time, flexibility by pectoralis-minor and lattisimus-dorsi length and neck pain with NDI. Forty-six participants that had CVA less than 45° and pectoralis-minor length greater than 6 cm. then random assignment to each group (n=23). All outcomes analyzed by independent t-test (parametric) and Mann-Whitney u-test (non-parametric). CVA, neck flexion-extension strength and neck flexion endurance of experiment increased and left-pectoralis-minor length reduced more than control with statistically significant differences. Self-exercise improved CVA, neck flexion-extension strength, flexion endurance, and flexibility.

Keywords: forward head posture, self-posture correction, muscle performance, neck pain, smartphone users

1. Introduction

Nowadays, smartphones play an important role in the daily lives of a large number of individuals. Since the device is used as a source of knowledge and entertainment as well as communication, a survey on the use of information technology and communication among Thai family members aged six years and older. The survey included about 63.3 million people. The survey found 56.7 million (89.6%) smartphone users. From a comparative analysis of smartphone usage trends among people aged 6 years and older during five-year period from 2014 to 2018, it was found that smartphone usage had increased from 77.2% (48.1 million users) to 89.6% (56.7 million users)(Technology, 2018) An examination of internet use among the age groups revealed that the 15-24 age group had the highest use of the internet (76.8%) followed by the 25–34 age group (60.1%) (Patricia, Larson, Mueller-Klaus, & Oatls, 1992; Technology, 2018; Young, Trudeau, Odell, Marinelli, & Dennerlein, 2012). A previous study found that smartphone use had exceeded two hours per day. Such a usage level could result in musculoskeletal injuries (Berolo, Wells, & Amick 2011). Symptoms of musculoskeletal injury in smartphone users are especially prominent in the muscles of the neck and shoulder and are thus known as "*text-neck*" which results in pain in the neck area (Zhi *et al.*, 2013). Smartphone usage posture often includes an increase in head-tilt angle and neck flexion for periods that impose stress upon the atlanto-occipital joint and an increase in torque applied to the extensor musculature to maintain static equilibrium (Fernandez-de-Las-Penas, Alonso-Blanco, Cuadrado, & Pareja, 2006). From the foregoing, it was found that the majority of smartphone users attempt to

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incline their heads and necks downward and frontally to concentrate their attention onto the smartphone screens while holding the smartphone at a lowered position. In so doing, they assume a forward-head posture (FHP) that causes the muscles in some parts to become strained and weakened which makes it easier for problematic injuries to develop when performing activities requiring extensive use of the upper limbs muscles (Aitken, 2008; Wikipedia, 2013). Moreover, there were many research studies which improved forward head posture in smartphone users with many exercises. The study was conducted by Al-Harbi *et al.* (2017) which compared a deep-neck flexor-strengthening exercise with electrotherapy modalities in smartphone users with forward-head posture. Their study divided their volunteer participants into three groups: G1 (control group, n=10), which used a pressure biofeedback unit (PBU); G2 (n=10), a group which underwent deep-neck flexor-strengthening exercise; and G3 (n=10), which received treatment in the form of electrotherapy modalities with ultrasound and interferential therapy. All three groups received specifically defined treatment care administered in five sets-per-day, three times-per-week, for four weeks. Following treatment, it was found that the experimental group had a cervical range of motion (CROM) and NDI that had increased and improved the most. Also, prior to being treated for pain-pressure threshold in the three groups, no differences were observed in the NDI and forward-head posture. However, after the groups received treatment for pain-pressure threshold, the NDI and forward-head posture were statistically significant difference ($P<0.05$). The deep cervical flexor exercise combined with a PBU is a useful method for the treatment of neck motion and neck muscle endurance in those with forward-head posture (Al-Harbi & Hussain, 2017). A study conducted by Kage *et al.* (2016) compared the results of deep-neck flexor-strengthening exercise with the results of using the McKenzie neck exercise in 30 individuals with forward-head posture who were randomly divided into two groups. Group A (n=15) received care by means of the McKenzie neck exercise and stretching the pectoralis-minor. Group B (n=15) received treatment through a deep-neck flexor-strengthening exercise and stretching the pectoralis-minor once a day in a total of six sessions. Results of this study revealed that forward-head posture, elasticity of the pectoralis-minor muscles, and the CROM value differed with statistical significance between the two groups. The deep-neck flexor-strengthening exercise combined with stretching of the pectoralis-minor muscles and the McKenzie neck exercise combined with stretching of the pectoralis-minor muscles are capable of improving the CROM, forward neck posture, and elasticity of the pectoralis-minor (Kage , Patel, & Pai, 2016). In 2017, Cho *et al.* conducted a study that compared the effectiveness of upper cervical spine mobilization and a stabilization exercise with upper thoracic spine mobilization and mobility exercise. Thirty-two participants with forward-head posture were divided into the cervical group (n=16) and the thoracic group (n=16). They received treatment for a period of four weeks with a follow-up assessment two weeks later at the sixth week. Indications of improvement in the CVA, cervical extension, numeric pain rating scale (NPRS), and NDI were found in the thoracic group with a statistical significance of $P<0.05$ in the sixth week of monitoring the results compared with the cervical group. Moreover, 11 out of 15 (68.8%) of research participants in the thoracic group compared with 8 out of 16 (50%) of research participants in the cervical group exhibited a global rating of change score (GRC) greater than +4 in week 4 of monitoring. Integrated treatment using the upper thoracic spine mobilization and mobility exercise demonstrated that cervical spine mobilization and stabilization exercise can produce better overall short-term outcomes in CVA (sitting position), cervical extension, NPRS, NDI, and GRC (Cho, Lee, & Lee, 2017). From the foregoing, forward-head posture in smartphone users had increased and affected to personality and musculoskeletal disorder which reduced muscle performance and increased neck pain. Moreover, FHP improvement had several exercises which used intricate equipment and must suggested or treated by professors.

The objective in this study was to compare the effects of self-posture correction exercise combined with obtained text-neck knowledge of experiment group and control group which obtained text-neck knowledge only in forward head posture of smartphone users.

2. Materials and Methods

FHP-Participants were recruited from the students of Thammasat University, Rangsit campus. The participants had age range between 18 to 25 years. Participants had been using their smartphones for more than or equal to a year and were using the phones for greater than or equal to 2.5 hours/day (Berolo *et al.*, 2011). The features of these students included forward inclination of their heads at the CVA less than 45° (Weon *et al.*, 2010), pectoralis-minor muscles length greater than 6 cm. (Jeramy & Rachel, 2007) as inclusion criteria. Participants who had neck pain symptom, musculoskeletal disease, surgery history, car driving (Health, 2000), backpacking (Chansirinukor , Dianne , Karen , & Brenton, 2001) and sleeping on high pillow (Health, 2000) were excluded. Sample size was calculated from formula of compare mean independent-two groups by used result from collateral research (Lau *et al.*, 2010). The acquired sample size was eleven (n/group) and in case dropout of participants, n/group was twenty-three. Therefore, total of sample size was forty-six and were randomly assigned into two equal groups (n=23). The experiment group who received care in the form of text-neck knowledge combined with a self-posture correction exercise through video instruction three times-per-week for six weeks (Falla , Jull, Russell , Bill , & Paul, 2007; Park & Kim, 2015). Researchers trained all exercises on the first time, and after that the participants of the experiment group followed all exercises as video instruction and exercise plan which researchers called to follow up exercising in each participants. The control group received care only in the form of text-neck knowledge derived from printed document which researchers followed up reading of document in control group. Upon completion of the six weeks, both groups were assessed post-test to measure the CVA, HTA, SHA (Figure 2), muscle performance in terms of strength (Figure 3 and 4), endurance (Figure 5), muscle tightness (Figure 6), and neck pain (NDI). All participants were informed about procedure of the study and signed an informed consent form prior to participation in procedure study. Participants and assessors were double blinded experiment which blinded group of each participant.

Contents of text-neck knowledge in printed document consisted of text-neck characteristic from

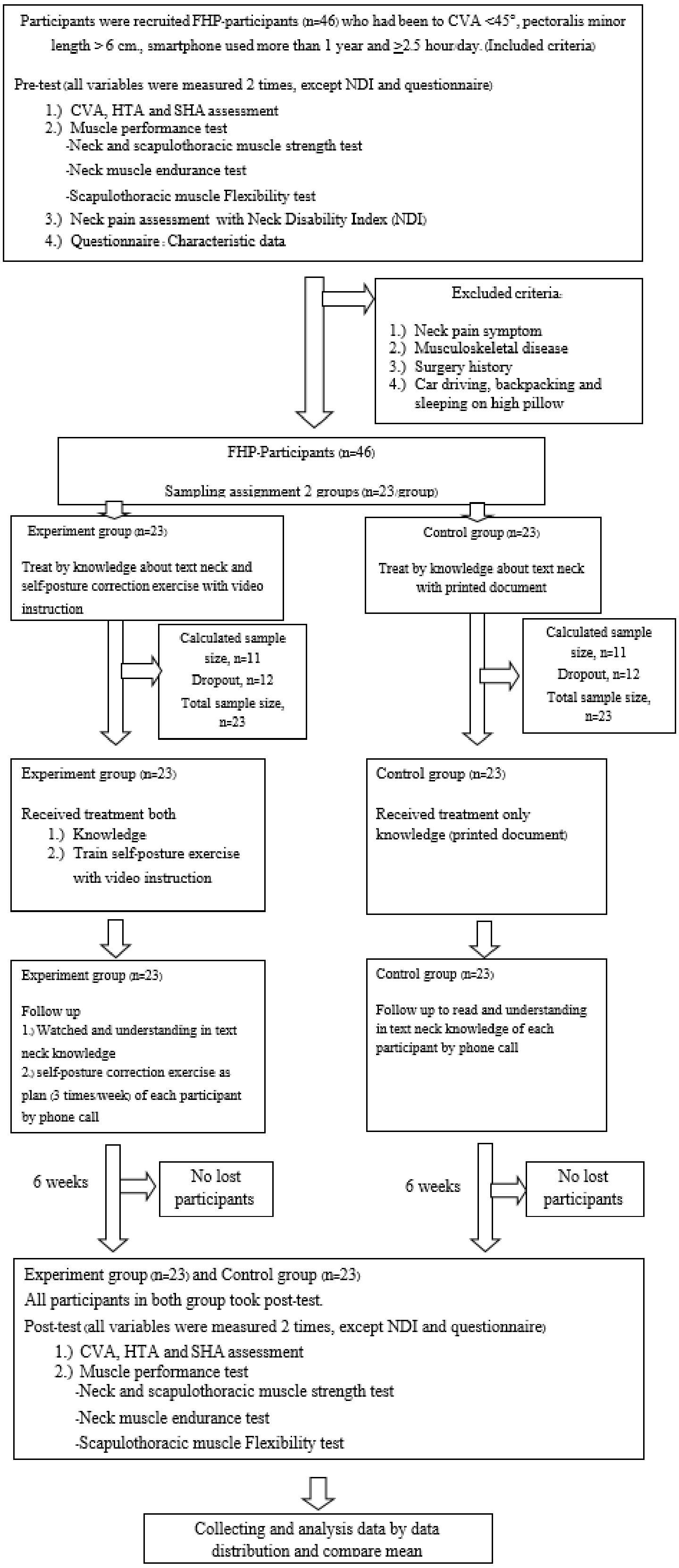


Figure 1. RCT diagram of effects of self-posture correction exercise with video instruction in FHP-smartphone users

Figure 2. CVA, HTA and SHA assessment

a.) Cervical flexion b.) Cervical extension c.) Cervical side bending

Figure 3. Neck muscle strength assessment by hand held dynamometer

a.) Middle trapezius b.) Rhomboid c.) Lower Trapezius

Figure 4. Scapulothoracic muscle strength assessment by hand held dynamometer

a.) Cervical flexion b.) Cervical extension

Figure 5. Neck muscle endurance assessment

a.) Latissimus Dorsi length b.) Pectoralis minor length

Figure 6. Latissimus dorsi and Pectoralis minor muscle flexibility assessment

smartphone used, prevalence, physical and mental symptom, posture correcting of text-neck and caution of smartphone used. For video instruction presented to text-neck knowledge and ten self-posture correction exercises (Figure 7) (Patcharapa , Maythawee , & Ananta, 2015) as following:

1. Deep-cervical flexor muscle (longus capitis, longus coli and scaleni) strengthening exercise was keeping chin closed your neck and held contract 10 sec /time, 10 times/set, 3 sets as Figure 7a).

2. Cervical flexor muscle strengthening exercise was keeping chin closed your neck and exert resistance of both hands on forehead, 15 times/ set, 3 sets as Figure 7b).

3. Scapulothoracic (middle and lower trapezius) strengthening exercise was attaching your arms to the body with elbows flexing, convergence to contract of both shoulders, 10 times/set, 3 sets as Figure 7c).

4. Scapulothoracic (rhomboid, middle and lower trapezius) strengthening exercise was attaching your arms to the body with elbows flexing, convergence to contract of both shoulders and held both shoulders as W shape and stretched your both arms as V shape, 10 times/set, 3 sets as Figure 7d).

5. Scapulothoracic (middle and lower trapezius) strengthening and stretching of pectoralis-minor and back extension exercise were attaching your arms to the body, flexed elbows to 90 degrees with the body, convergence to contract of both shoulders and pulled out the elastic band, 10 times/set, 3 sets as Figure 7e).

6. Scapulothoracic (middle and lower trapezius) strengthening exercise and stretching of pectoralis-minor and rotator-cuff were stretching your arms, flexed elbows to 90 degrees on plane with raised dumbbells to 90 degrees and convergence to contract of both shoulders, 10 times/set, 3 sets as Figure 7f).

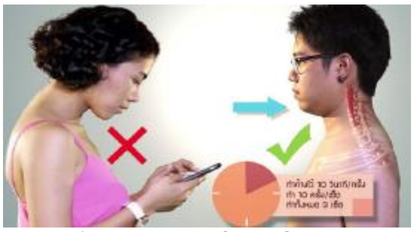
7.Left- and right-neck muscle stretching by neck to tilt on your left which felt to right-neck muscle strained, your right-hand held with chair and your left-hand pressed on your head, 10 times/set, 3 sets as Figure 7g). For the right side did on the contrary.

8. Neck exercise was stretching posterior neck muscle both left and right by tilted-head on left side which felt to posterior-neck muscle strained, your right-hand held with chair and your left-hand pressed on your head about 20 sec./time, 10 times/set, 3 sets as Figure 7h). For the right side did on the contrary.

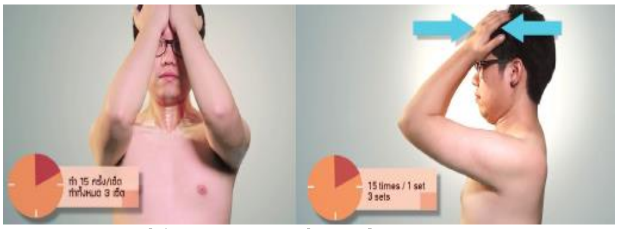
9. Scapulothoracic (pectoralis-minor) muscle stretching by facing on wall, stretched shoulder height then reaching forward, felt to strained on your chest and held about 20 sec./time, 10 times/set, 3 sets as Figure 7i).

10. Scapulothoracic (pectoralis-minor) muscle stretching by sitting on the chair, back attached to the backrest, hands clasped at the back of the neck, stretched elbows and reclined backward about 20 sec./time, 10 times/set, 3 sets as Figure 7j).

Video instruction and printed document were proved for validity with six concerned professionals (Patcharapa *et al.*, 2015). The measurement of assessors were trained by special professor and were assessed by intra-rater reliability of all measurements as ICC=0.647-0.950, moderate to high measurements. Assessors assessed the assessments of forward-head posture (CVA, HTA, and SHA) were carried out by lateral-photography for angular measurements using the Kinovea program. The participants who were in sitting

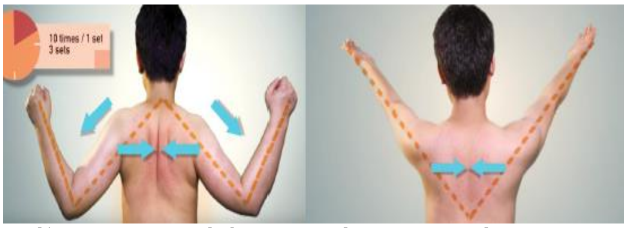


a.) Exercise 1 Neck muscle exercise



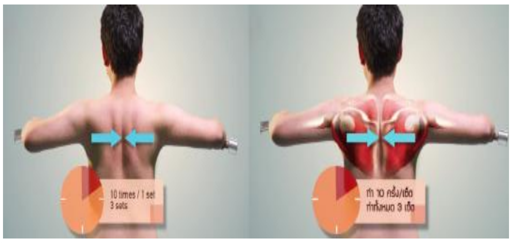
b.) Exercise 2 Neck muscle exercise

c.) Exercise 3 Scapulothoracic



d.) Exercise 4 Scapulothoracic muscle exercise muscle exercise

e.) Exercise 5 Scapulothoracic



f.) Exercise 6 Scapulothoracic muscle exercise muscle exercise

g.) Exercise 7 Neck muscle exercise

h.) Exercise 8 Neck muscle exercise

i.) Exercise 9 Scapulothoracic

j.) Exercise 10 Scapulothoracic muscle exercise muscle exercise

Figure 7. Exercises in video instruction (10 self-posture correction exercises)

posture were marked on the spinous process of C7, the canthus of eye, and the tragus of ear (Ruivo, Pezarat-Correia, & Carita, 2015). Assessments of neck flexion-extension strength were carried out using a digital hand-held dynamometer which measured the force in Newton (N) (Bahar, Johnson, Curran-Everett, & Maluf, 2012). Neck flexion endurance was assessed by the hold time of the flexed neck when the neck is bent by viewing the movement of the marked neck folds (Bahar *et al.*, 2012; Harris *et al.*, 2005). Neck extension endurance was assessed by the hold time of the extended neck by viewing a scale movement of more than five degrees on an inclinometer measured in seconds (Bahar *et al.*, 2012). While the participant was lying on the test table, the muscular flexibility or length of the left- and right-pectoralis-minor was assessed by the distance from the posterior aspect of acromion to the test table using a straight-edge marked in centimeters. Another muscular flexibility, left- and right-latissimus-dorsi length were assessed by the distance from the lateral epicondyle to the test table measured in centimeters (Bahar *et al.,* 2012). Neck pain assessment was carried out using the NDI questionnaire of 10 items (Uthaikhup, Paungmali, & Pirunsan, 2011). Each item had 0–5 points for a maximum score of 50 points. A high score indicates a severe disability. Researcher collected and analyzed data by SPSS program, Version 22. Data distribution was confirmed using the Shapiro-Wilk test. If the data had a normal (parametric) distribution, an independent sample *t*-test was used. If the data had an abnormal (non-parametric) distribution, the Mann-Whitney U-test was used. The reported data were then compared using mean and median values, standard deviation (SD), P-values. Differences within the groups were analyzed using pre- and post-treatment tests with the paired *t*-test for parametric data or the Wilcoxon signed-rank test for non-parametric data. The confidence level was set at P<0.05. The present study was granted approval for the conduct of research on human participants by the Human Research Ethics Committee (Panel 3) at the Faculty of Nursing Science of Thammasat University (approval number 93/2559).

3. Results and Discussion

This study had not dropout during experiment period. The participants of this study had an average age of experiment group 21.61±1.56 years, control group 20.91±1.16 years. The percentages of females and males in experiment group were 56.5% and 43.5%, respectively. For control group were 87% of females and 13% of males. Their average weight, height and BMI of experiment group were in order to 67.04±16.21 kg, 165.74±8.58 cm, and 24.22±4.43 kg/m^2. And control group were 65.70±16.98 kg, 161.30±7.30 cm, and 25.00±4.98 kg/m^2, respectively. Congenital diseases were reported in allergy 13.04% of experiment group, 4.35% of control group, thyroid 4.35% of both and anemia 4.35% of control group (Table 1). All congenital diseases were not musculoskeletal disorder which did not effect in this study. An inter-group comparison showed no statistically significant differences between the experimental group and control group prior to receiving treatment by statistical analysis, mean comparison of independent sample *t*-test and the Mann-Whitney U-test. However, differences were found between the experimental and control groups in their CVA, neck flexion strengths, neck extension strengths, neck extension endurances, and lengths of the left-pectoralis-minor muscle with a statistical significance following treatment (P<0.05). Effect size of inter-group comparison found that after treated by self-posture correction exercises combined with obtained text neck knowledge had the small effect with three outcomes, moderate effect with seven outcomes and large effected with two outcomes more than obtained text-neck knowledge only. Statistically significant differences of CVA, neck flexion-extension strength, neck flexion endurance, left-pectoralis-minor length had the moderate to large effect size as Table 2. Specifically, the experimental group had a mean CVA of 47.33±5.78 degrees and a mean SHA of 64.98±9.19 degrees which were improved forward-head posture and an increase in neck muscle performance. The mean values of neck flexion strength, neck extension strength, neck flexion endurance, and neck extension endurance were 17.62±3.32 N, 23.61±3.06 N, 40.72±22.89 sec and 128.62±50.25 sec, respectively, in experiment group. There were also reductions in muscle strain, or reductions in the mean lengths of both the left-pectoralis-minor muscles was 5.42±1.15 cm and right-pectoralis-minor muscles was 6.02±1.33 cm, including reductions in neck pain with NDI values of 1.87±2.77. These values differed with a statistical significance of P<0.05. The control group experienced improvements in the mean values of CVA, neck flexion strength, neck extension strength, and NDI which were 43.85±5.14 degrees, 14.71±1.62 N, 31.13±13.64 N, and 2.00±1.98, respectively. This group differed, however, with a statistical significance (P<0.05). Effect size of within group comparison, experiment group had the small to large effect size of all outcomes then statistically significant differences of CVA, SHA, neck flexion-extension strength, neck flexion-extension endurance, left- and right-pectoralis-minor length and NDI had the moderate to large effect size, showed that self-posture correction exercise combined with obtained text-neck knowledge had affected to nine outcomes compared with pre-treat. Control group had the small to large effect size of all outcomes, statistically significant differences of CVA, neck flexion strength, neck extension strength, and NDI had the moderate to large effect size, Text-neck knowledge obtaining had affected to improve four outcomes compared with before obtained text-neck knowledge (Table 3).

The results of this study demonstrated that self-posture correction exercise combined with text-neck knowledge obtaining affected either the angle of the bend of the neck or caused an increase in the neck angle (CVA), increased the upper limbs muscle performance (neck flexion-

Table 1. Characteristics of the participants

Characteristic		Experiment group		Control group	
		Mean±SD	n (%)	Mean±SD	n (%)
Age (y)		21.61±1.56	-	20.91±1.16	
Male		-	10 (43.50)		3 (13.00)
Female		-	13 (56.50)		20 (87.00)
Weight (kg)		67.04±16.21	-	65.70±16.98	
Height (cm)		165.74±8.58	-	161.30±7.30	
Body mass index (kg/m^2)		24.22±4.43	-	25.00±4.98	
Congenital disease					
Yes	Allergy	-	3(13.04)	-	1 (4.35)
	Thyroid	-	1(4.35)	-	1 (4.35)
	Anemia	-	-	-	1 (4.35)
No		-	19 (82.60)	-	20 (87.00)

Table 2. Effects of the self-posture correction exercise between groups in FHP-smartphone users

Variable	FHP-Experiment group (N=23)		FHP-Control group (N=23)		P value	Effect size (d)
	Mean±SD	Median	Mean±SD	Median		
Pre-treatment						
1.Forward Head Posture (Angles)						
CVA (°)	40.67±3.83	41.67	39.65±4.71	41.25	0.38[b]	0.26[m]
HTA (°)	22.30±9.47	21.83	20.63±4.53	21.00	0.45[a]	-0.23[m]
SHA (°)	59.85±11.54	59.67	60.33±6.81	58.83	0.87[a]	0.05[s]
2. Muscle performance (strength, endurance and flexibility)						
Neck flexion strength (N)	13.70±1.50	13.40	13.62±1.49	13.65	0.65[b]	0.13[s]
Neck extension strength (N)	17.89±3.25	17.70	18.88±2.24	19.10	0.24[a]	0.36[m]
Neck flexion endurance (sec)	32.82±15.83	29.67	32.88±12.63	31.05	0.99[a]	0.00[s]
Neck extension endurance (sec)	108.00±68.18	92.58	118.00±55.19	1.11E2	0.27[b]	0.33[m]
Lt. Pectoralis minor length (cm)	6.54±1.56	6.30	6.30±1.38	5.80	0.55[b]	0.18[s]
Rt. Pectoralis minor length (cm)	6.76±1.45	6.53	7.21±1.30	7.10	0.27[a]	0.33[m]
Lt. Latissimus dorsi length (cm)	5.67±2.17	5.60	5.98±1.47	6.30	0.28[b]	0.32[m]
Rt. Latissimus dorsi length (cm)	5.58±1.52	5.68	6.15±1.22	5.67	0.17[a]	0.41[m]
3. Neck pain (NDI)						
Neck Disability Index (NDI)	3.96±3.46	3.20	3.57±2.71	3.75	0.89[b]	0.04[s]
Post-treatment						
1.Forward Head Posture (Angles)						
CVA (°)	47.33±5.78	47.50	43.85±5.14	43.67	0.04[a]*	-0.64[m]
HTA (°)	21.57±5.36	20.50	19.30±4.66	18.30	0.11[b]	0.49[m]
SHA (°)	64.98±9.19	64.17	62.17±7.33	61.83	0.26[a]	-0.34[m]
2. Muscle performance (strength, endurance and flexibility)						
Neck flexion strength (N)	17.62±3.32	17.25	14.71±1.62	14.78	0.00[b]*	1.27[l]
Neck extension strength (N)	23.6±3.06	23.15	21.16±2.72	21.65	0.01[b]*	0.82[l]
Neck flexion endurance (sec)	40.72±22.89	35.69	31.13±13.64	28.53	0.04[b]*	0.63[m]
Neck extension endurance (sec)	128.62±50.25	128.64	118.77±54.62	113.29	0.53[a]	-0.19[s]
Lt. Pectoralis minor length (cm)	5.42±1.15	5.35	6.21±1.41	6.25	0.04[a]*	0.61[m]
Rt. Pectoralis minor length (cm)	6.02±1.33	5.80	6.77±1.52	7.05	0.09[a]	0.53[m]
Lt. Latissimus dorsi length (cm)	5.55±2.11	5.05	5.73±1.62	5.30	0.75[b]	0.09[s]
Rt. Latissimus dorsi length (cm)	5.67±1.23	5.70	5.99±1.02	5.95	0.35[a]	0.28[m]
3. Neck pain (NDI)						
NDI	1.87±2.77	1.10	2.00±1.98	1.71	0.49[b]	0.20[s]

Analysis by *t*-test, [b] Analysis by Mann-Whitney U test. Effect size (d). ≤ 0.2 small effect size, defined by [s], 0.5 moderate effect size, defined by [m], ≥ 0.8 large effect size, defined by [l], FHP=forward head posture, SD=standard deviation, CVA=craniovertebral angle, HTA=head tilt angle, SHA=shoulder angle, N=Newton, NDI=neck disability index (maximum 50 points)

Table 3. Effects of the self-posture correction exercise within the groups in FHP-smartphone users in pre- and post-treatment

Variable	FHP-Experiment group (N=23)		P value	Effect size (d)	FHP-Control group (N=23)		P value	Effect size (d)
	Pre-treatment Mean±SD	Post-treatment Mean±SD			Pre-treatment Mean±SD	Post-treatment Mean±SD		
1.Forward Head Posture (angles)								
CVA (°)	40.67±3.83	47.33±5.78	0.00[b]*	0.832[l]	39.65±4.71	43.85±5.14	0.00[b]*	0.727[m]
HTA (°)	22.30±9.47	21.57±5.36	0.68[a]	-0.095[s]	20.63±4.53	19.30±4.66	0.18[b]	0.581[m]
SHA (°)	59.85±11.54	64.98±9.19	0.03[a]*	0.492[m]	60.33±6.81	62.17±7.33	0.21[a]	0.260[m]
2.Muscle performance (strength, endurance and flexibility)								
Neck flexion strength (N)	13.70±1.50	17.62±3.32	0.00[b]*	0.859[l]	13.62±1.49	14.71±1.62	0.01[a]*	0.700[m]
Neck extension strength (N)	17.89±3.25	23.61±3.06	0.00[b]*	0.9[l]	18.88±2.24	21.16±2.72	0.00[a]*	0.915[l]
Neck flexion endurance (sec)	32.82±15.83	40.72±22.89	0.02[b]*	0.612[m]	32.88±12.63	31.13±13.64	0.33[a]	-0.133[s]
Neck extension endurance (sec)	108.0±68.18	128.62±50.25	0.02[b]*	0.596[m]	118.0±55.19	118.77±54.62	0.97[a]	0.014[s]
Lt. Pectoralis minor length (cm)	6.54±1.56	5.42±1.15	0.00[a]*	-0.817[l]	6.30±1.38	6.21±1.41	0.64[b]	0.518[m]
Rt. Pectoralis minor length (cm)	6.76±1.45	6.02±1.33	0.02[a]*	-0.532[m]	7.21±1.30	6.77±1.52	0.13[a]	-0.311[m]
Lt. Latissimus dorsi length (cm)	5.67±2.17	5.55±2.11	0.33[b]	0.516[m]	5.98±1.47	5.73±1.62	0.23[a]	-0.162[s]
Rt. Latissimus dorsi length (cm)	5.58±1.52	5.67±1.23	0.72[a]	0.065[s]	6.15±1.22	5.99±1.02	0.37[a]	-0.142[s]
3. Neck pain (NDI)								
NDI	3.96±3.46	1.87±2.77	0.00[b]*	0.681[m]	3.57±2.71	2.00±1.98	0.00[b]*	0.68[m]

[a] Analysis by paired *t*-test, [b] Analysis by Wilcoxon signed rank test; Effect size (d); ≤ 0.2 small effect size defined by [s], 0.5 moderate effect size defined by [m], ≥ 0.8 large effect size defined by [l], FHP=forward head posture, SD=standard deviation, CVA=craniovertebral angle, HTA=head tilt angle, SHA=shoulder angle, N=Newton, NDI=neck disability index (maximum 50 points)

extension strength, neck flexion endurance and left-pectoralis-minor muscle flexibility) and reduced the symptoms of neck pain.

Smartphone users are prone to incline their heads to focus onto the monitor screens for periods. Subsequently, they suffer from poor posture, or forward-head posture, round shoulder, and slouched posture. A poor posture, by its nature, induces changes in the angle of the neck, reduces muscle performance and increases symptoms of neck pain. Exercising the upper limbs will help to improve, and also prevent, a poor posture. Cervico-scapulothoracic strengthening and stretching exercises can improve cervical and scapulothoracic alignment properly and can also correct and prevent poor posture. The results of good cervico-scapulothoracic alignment will help to increase muscle performance and reduce symptoms of neck, shoulder, and back pain (Kage *et al.*, 2016; Silriluck & Santhanee, 2016; Yoo, 2013a, 2013b). A stretching exercise can increase muscle length or muscle flexibility (ROM), CVA., muscle strength, and reduce pain symptoms (Yoo, 2013b). Most exercises of other studies used complicated equipment and some exercise must be treated by expert, but this study was self-exercising through video instruction.

CVA and NDI of within group comparison were statistically significant differences. For study of inter-group comparison, CVA showed statistically significant differences but NDI was not statistically significant different as the sample size (n) might be not enough. This research calculated sample size from CVA result of other inter-group comparison study which sample size calculation should be referring on each outcome and study. Therefore, each outcome might use different sample sizes and repeated measurements of each outcome may have an effect also on the outcomes. Some outcomes in this study were not conformed to hypothesis, due to sample size which may be calculated to follow each study outcome and design and repeated measurement increasing.

The limitations in this research include the rather short time in which to conduct a comparative case study which self-exercising may be use long time to improve forward-head posture. While monitoring the results of exercise as well as the lack of detailed information on the activities of the volunteers in the two groups during the six-week period of this research study. Some of their actions may have impacted the research study. For example, computer using affected to forward-head posture.(Falla *et al.*, 2007; Waersted, Hanvold, & Veiersted, 2010). The participants were students and have to use computer in their education. Even though, some activities such as car driving, backpacking and sleeping on high pillow were excluded on recruitment. On this research had similar population from included and excluded recruitment and followed up self-exercising and text-neck knowledge reading of both groups. Future research studies involving comparative studies and monitoring the results should include an upward-adjustment of the monitoring time, as well as a follow-up on the activities being carried out by the volunteers during the monitoring period for the purpose of obtaining reliable research data. Providing information on smartphone use and prevention paired with self-posture correction exercise will increase muscle performance in the form of neck flexion strength, neck extension strength and endurance, and will lower left-pectoralis-minor muscle tension.

4. Conclusions

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