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Analysis of the relationship between smartphone users and neck disability treatment programs: A quasi-experimental study

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Abstract
Background and objective: The continuous of using a smartphone for a long time can cause various musculoskeletal problems. It abets incorrect postures such as a hunched or neck bending postures which strains the neck. In Malaysia, the Malaysia Communications and Multimedia reported that smartphone users were dominated by young adults, from the age group of 20 – 24 with 18.8%. Meanwhile, grouped into broad generational age bands, it can be seen that adults account for 73.1% of all users followed by pre-teens and teens by 12.5% and seniors with 14.4%. Therefore, college student at age of 20 – 24 years old have been found to have the risk of neck pain resulting from the addiction of using smartphone. The objective of this study was to analyze the effectiveness of basic neck disability treatment programs (stretching and postural modification against stretching alone) in smartphone users among students of Asia Metropolitan University (AMU) in Malaysia.
Materials and Methods: The study design was a quasi – experimental study. Minimum of 30 participants were selected for those who met the inclusion criteria. Participants were allocated to Group 1 (Stretching and Postural Modification) and Group 2 (Stretching), 15 participants for each group. Pain intensity and cervical range of motion were evaluated before interventions and after 4 weeks of interventions.
Result: The results in this study indicated that both stretching and postural modification versus stretching alone were equally effective in reducing neck pain and improving cervical range of motion of smartphone users, however there was no significant difference found between the groups. Thus, null hypothesis was accepted and rejecting the alternate hypothesis.
Conclusion: After 4 weeks of intervention, participants in Group 1 were significantly improved than participants in Group 2.

Keywords: Smartphone, neck pain, cervical ROM, stretching, postural modification

Introduction
A smartphone is a mobile hand-held device with advanced computing capabilities, such as internet communication, information retrieval, entertainment (music, videos, and games), e – commerce, and other capabilities. Because of its portability, the smartphone has had a large impact on modern life [1]. Smartphone has become a necessity for most people. Smartphones are used for both communication and entertainment purposes, such as message, music, media, internet access, photos, and games [2].
According to Gartner Inc., the worldwide sales of smartphone to end users totaled 349 units in the first quarter of 2016, which is a 3.9% increase over the same period in 2015. Smartphone sales represented 78% of total mobile sales in the first quarter of 2016m [3]. According to reports done by Amanda Lenhart (2012), about one in four teens in America reported owning a smartphone which mean that smartphones are increasing among teenage users [4].
In Malaysia, the smartphone user base is expected to reach 11 million in 2016 and observe an upward trend to 10% CAGR (compound annual growth rate) from 2013 to 2017, according to a new study by mobile marketing and commerce company Vserv [5]. For 2017, the number of smartphone users in Malaysia is estimated to reach 17.8 million [6]. Smartphone users were dominated by young adults, from the age group of 20 – 24 with 18.8% users. The second largest group was 25 – 29 which accounted for 16.3%. Group into broad generational age bands, it can be seen that adults account for 73.1% of all users followed by pre – teens by

12.5% and seniors with 14.4% [7].

As mentioned earlier, smartphone is a mobile hand – held device with advanced computing capability, such as internet communication which also known as social networking. Over years, social networking among teenagers (middle and high school students) and college students has become more and more popular. It is a way for the new generation to make connections, not only in school or campus, but with friends outside of school. According to English Oxford Dictionaries, social network is defined as a dedicated website or other application which enables users to communicate with each other by posting information, comments, messages, images [8], such as the use of Facebook, Instagram, YouTube, blogs, Twitter, or MySpace. Social networking is a way that helps many people feels as they are belong to a community. Even so, as the smartphone users are spending more time on their phone, it may result in smartphone addiction.

Based on the study done by Hyo – Jeong Kim *et al.* (2015), the average daily use of smartphone among university students in Korea showed 42.1% used smartphoone for more than 4 hours, and 21.6% used them between 3 to 4 hours. In short, 80% of the students used smartphones for more than 2 hours every day [9].

Social networking in general is particularly popular in Malaysia, with nearly half of the population maintaining a Facebook account. Malaysia's netizens appear to prefer the internet to TV, spending most twice as much time online as they do watching television. 21% of Malaysian internet users access the web via mobile devices or smartphones and spend 19.8 average hours on the internet via smartphones each week [10].

The continuous of using smartphone for a long time can cause various musculoskeletal problems [11]. In particular, it can abet incorrect postures such as hunched or neck bending postures [12]. Neck flexion is expected to increase due to the frequent use of relatively small screen of a smartphone, the smaller the screen of the smartphone, the greater the neck flexed [14]. Furthermore, according to study done by Sang – Yong – Lee *et al.* (2016), as smartphone usage time became longer, the neck flexion angle increased which strains the neck [14]. Furthermore, Kim *et al.* (2015) reported that a longer duration of smartphone usage caused a higher degree of neck pain [15]. This may lead to high incidence and prevalence of neck pain among those with prolonged static neck flexion.

The use of smartphones may result in smartphone addiction, which is the combination of internet and mobile phone addiction problems which then into smartphone addiction [16]. The continuous use of a smartphone for a long time can cause various musculoskeletal problems [17]. When using a smartphone, people usually will flex their neck downwards to stare at the lowered object and maintain the head in forward position for long periods of time [18]. Maintenance of a non- neutral neck posture, such as a flexed posture, is a well-known cause of neck pain [19]. Berolo, Wells, and Amick surveyed a Canadian university population and reported that the duration and frequency of use of mobile phones were related to the prevalence of neck pain [20].

Additionally, the maintenance of a head-forward posture decreases cervical lordosis of the lower cervical vertebrae and creates a posterior curve in the upper thoracic vertebrae to maintain balance; this is known as the forward head posture (FHP; turtle neck posture) [21]. A previous study stated that FHP causes shortening of the muscular fibers around the articulation points of the atlantoocipitalis and overstretching of muscles around joints, possibly producing chronic neck pain [22]. Other studies have found that smartphone use could be related to musculoskeletal symptoms, including muscular fatigue and tenderness, as well as a decreased cervical range of motion [23]. Bad posture can lead to early wear and tear on the spine and possible future surgeries, according to research done by Kenneth Hansraj, chief of spine surgery at New York Spine Surgery and Rehabilitation Medicine. His study found that looking at a phone at 60-degree angle is about the same as applying 60 extra pounds of force on the spine. That is about the weight of an 8-year-old child [24].

Although there are lot of studies have done to investigate the impact of smartphone on musculoskeletal disability, but there is a few study (stretching and postural modification) in the treatment of musculoskeletal disability related to smartphone use. Hence, this study was conducted to analyze the effectiveness of basic neck disability treatment program (stretching and postural modification versus stretching) in smartphone users among students of Asia Metropolitan University (AMU) in Malaysia.

Materials and Methods

Study Design, Setting and Population

The study design was a quasi – experimental study. A total of 30 participants from Asia Metropolitan University were selected for the study by purposive sampling method on basis of those who met the inclusion criteria. This study was approved by the university research ethical committee.

Inclusion criteria

This study included the individuals between age group of 20 – 30 years old, both male and female students, all races, using smartphones for more than 4 hours each day followed by onset of symptoms and voluntarily participate.

Exclusion criteria

This study excluded the individuals who have neurological disorder, recent neck, shoulder, arm and hand injury, cervical disc prolapsed, spinal or cervical trauma and cervical radiculopathy.

Method and Procedure

Participants were allocated to Group 1 and Group 2 (Figure 1). Participants in Group 1 were taught to perform neck stretching exercises, 5 times a week for 4 weeks followed by postural modification. Participants in Group 2 were taught to perform neck stretching exercises only, 5 times a week for 4 weeks. Pamphlets of neck stretching exercises and postural modification were given to participants in Group 1 and pamphlets of neck stretching alone were given to participants in Group 2 as their guidelines to perform the activities at home (Figure 2 and Figure 3) [25, 24] Dosage for stretching: 5 – 10 repetitions, held for 10 - 30 seconds [26].

Outcome Measures

The outcome measures, pain intensity and neck range of motion were evaluated before interventions and after 4 weeks of interventions.

Pain intensity was evaluated by using Visual Analogue Scale (VAS) ranging from 0 to 10.

Neck/Cervical Range of Motion (ROM) was measured using a goniometer and conducted in the order of flexion,

extension, lateral flexion, and rotation, with the participant sitting, with head and trunk held erect (Figure 4) [27]. The universal goniometer is a frequently used tool to quantify limitations in ROM. Physical therapists use this instrument to quantify limitations of ROM at the beginning of treatment and to quantify the effectiveness of interventions after treatment [28].

Data Analysis

The GraphPad software was used to analyze the data. The paired t – test was used to analyze the difference score within each group while the unpaired t – test was used to analyze the groups. Data was entered into Microsoft Excel 2010 for calculation and tabulation. Probability values of less than 0.05 were considered statistically significant, while the values of more than 0.05 were considered as non – significant difference. Value of confidence interval was set at 95%.

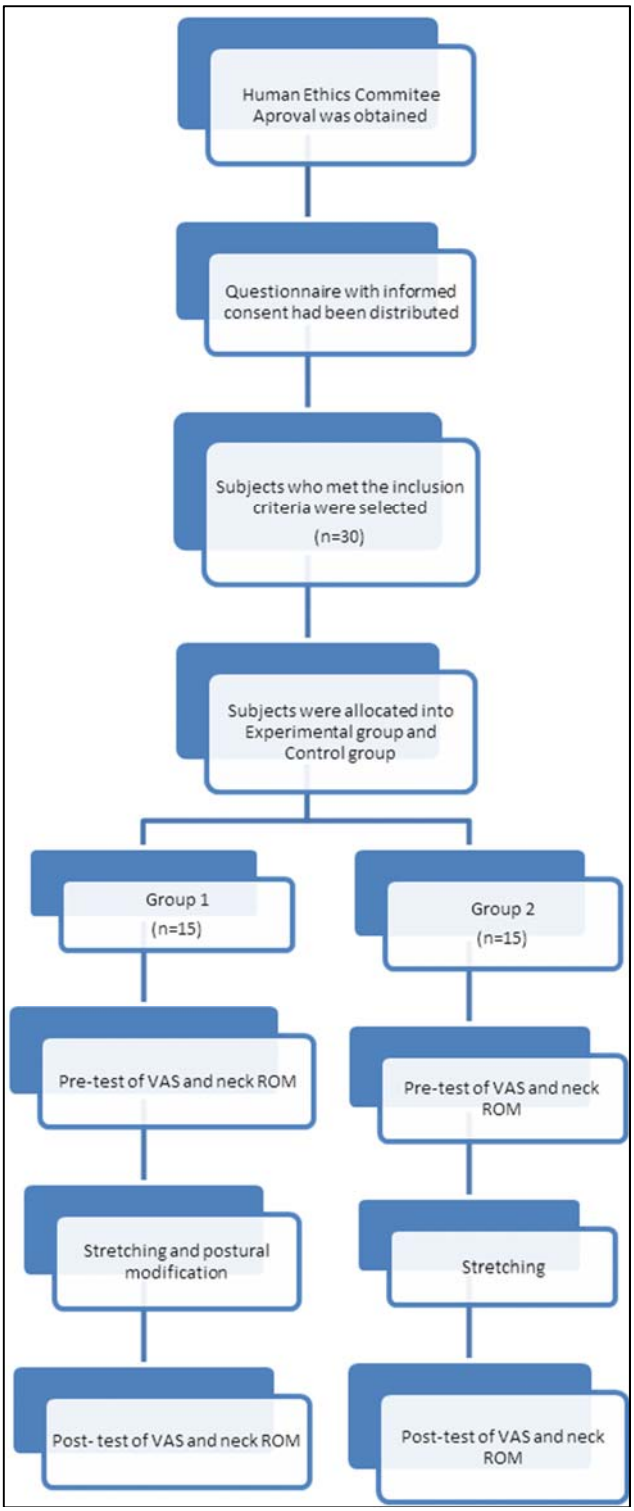


Fig 1: Participant flowchart

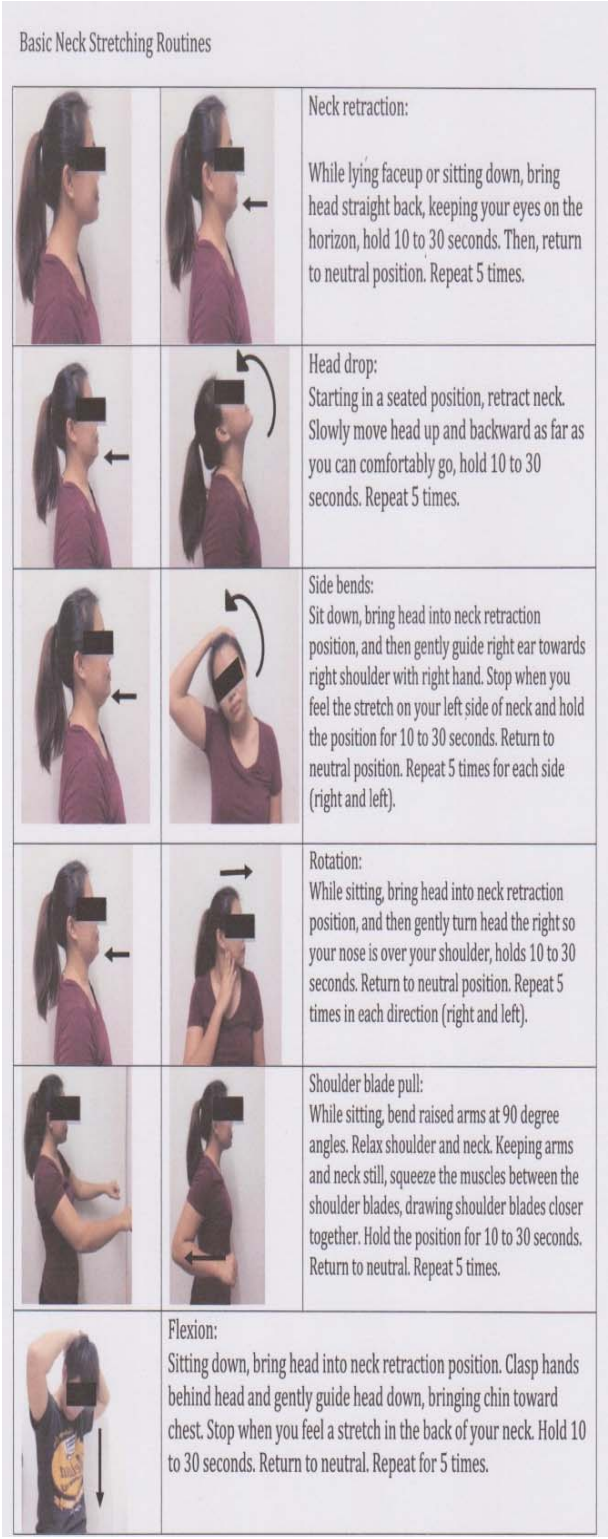


Fig 2: Basic Neck Stretching Routines Pamphlets

Fig 3: Postural Modification for Smartphone Users Pamphlets

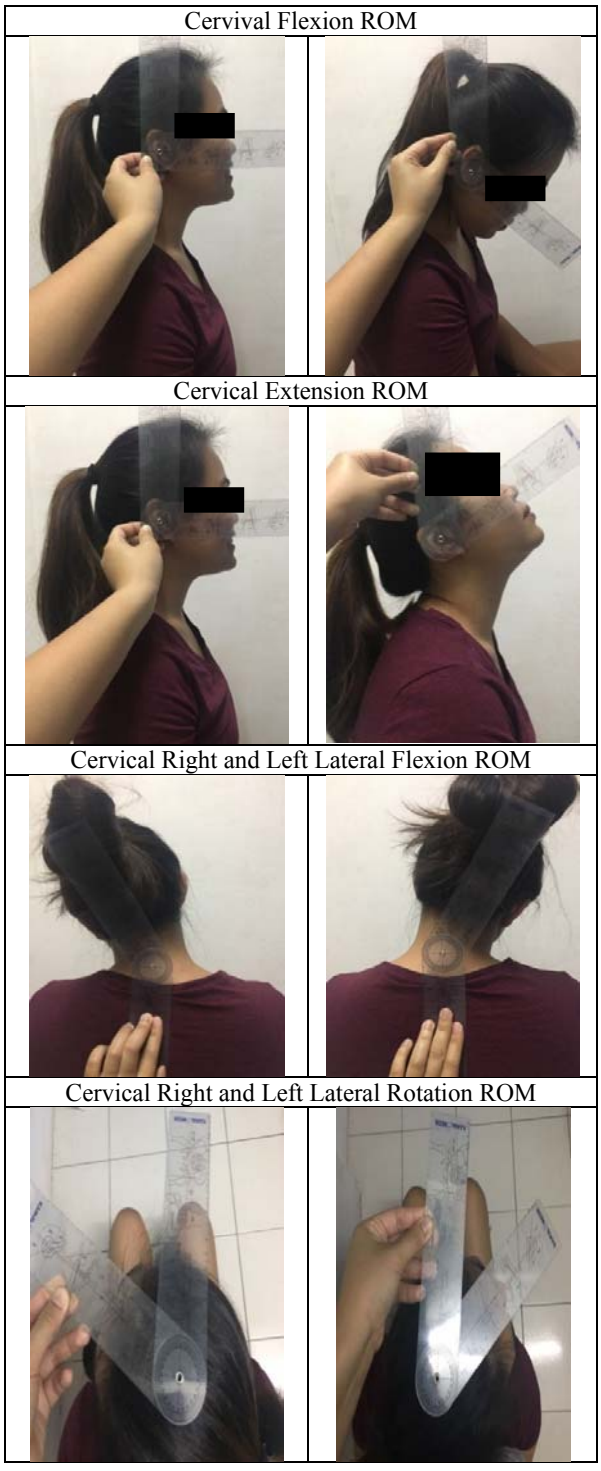


Fig 4: Cervical ROM Measuring Techniques

Results

All the subjects in Group 1 were given stretching and postural modification techniques to follow by using pamphlets and all the subjects in Group 2 were given stretching routines only and they were required to follow the guidelines and perform the stretching routines as shown in the pamphlets for 5 times a week over 4 weeks period as planned. The comparisons of the pre and post test scores of pain intensity (VAS) and Cervical Range of Motion (CROM) for both groups are shown in Table 1, Graph 1 and Graph 3. Meanwhile, comparisons of posttest of VAS scores and CROM are shown in Table 2, Graph 2 and Graph 4.

Change in Cervical Flexion ROM

The mean value (SD) for cervical flexion ROM were 40(4.63) and 37.27(7.24) at baseline in Group 1 and Group 2 respectively and increased by 3.53 (95%CI 1.90-5.17) and 1.87 (95%CI 1.03-2.7) respectively after 4 weeks. There was a significant difference between groups with p value ≤0.05 (p= 0.0366).

Change in Cervical Extension ROM

The mean value (SD) for cervical extension ROM were 35(8.86) and 38.33(7.72) at baseline in Group 1 and Group 2 respectively and increased by 5.13 (95%CI 3.69-6.58) and 1.67 (95%CI 0.76-2.57) respectively after 4 weeks. However, there was no significant difference between the groups with p value ≥0.05 (p = 0.9132).

Change in Cervical Right Lateral Flexion ROM

The mean values for pretest and posttest measurement of Group 1 for the degree of cervical right lateral flexion were 28.00(SD=5.92) and 35.67 (SD=4.17) respectively. Meanwhile, for Group 2, the mean values for pretest and post-test were 32(SD=6.49) and 34.27(SD=6.40) respectively. The differences within groups were significant. However, the differences between the two groups was statistically not significant with p value ≥0.05 (p = 0.4835).

Change in Cervical Left Lateral Flexion ROM

There was a significant increase in cervical left lateral flexion ROM in both groups after 4 weeks, (from 4.12-7.08, p=0.0001 in Group 1 and from 1.11-3.16.p=0.0005 in Group 2). However, no significant difference was found between groups with p value ≥0.05 (p=0.3197).

Change in Cervical Right Lateral Rotation ROM

Significant improvement in right lateral rotation of both groups after 4 weeks (0.97-7.70, p=0.0135 in Group 1 and 0.13-2.40, p=0.0314 in Group 2). However, the difference between the two groups was statistically not significant with p value ≥0.05 (p=0.2668).

Change in Cervical Left Lateral Rotation ROM

After 4 weeks there was increased in degree of cervical left lateral rotation ROM of Group 1 and Group 2 from 0.32 to 3.02, p=0.0192 and from 0.15 to 2.25, p= 0.0281, respectively. However, no significant difference was found between both groups with p value ≥ 0.05 (p=0.1331).

Change in VAS of Neck Pain

The average score of VAS reduced by 2.67 (95%CI, 2.32-3.01, p=0.0001) in Group 1 and 0.80 (95%CI, 0.57-1.03, p=0.0001) in Group 2 after 4 weeks. However, there was no significant difference between groups with p value ≥0.05 (p=0.0663).

Table 1: Pain scores (VAS) and Cervical Range of Motion (CROM) mean values of both groups at pre- and post - treatment evaluations

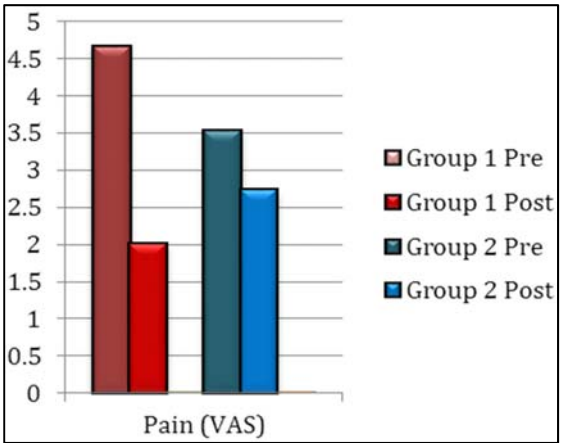
	Group 1 (n=15)			Group 2 (n=15)		
	Pre	**Post**	**p -value**	**Pre**	**Post**	**p - value**
Pain (VAS)	4.67	2	≤0.0001**	3.53	2.73	≤0.0001**
ROM (°)						
Flexion	40	43.53	0.0004*	37.27	39.13	0.0003*
Extension	35	40.13	≤0.0001**	38.33	40	0.0014*
Right Lateral Flexion	28	35.67	≤0.0001**	32	34.27	0.0003*
Left Lateral Flexion	30.13	35.73	≤0.0001**	35.33	37.47	0.0005*
Right Lateral Rotation	54.33	58.67	0.0135*	55	56.27	0.0314*
Left Lateral Rotation	59.33	61	0.0192*	55.13	56.33	0.0281*

*-statistically significant,
**-statistically highly significant

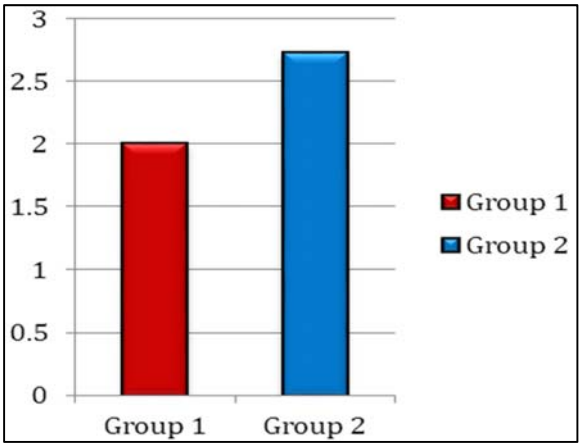
Table 2: Intergroup Post-Treatment Values

	Group 1	Group 2	p - value
	Post-treatment	**Post-treatment**	
Pain (VAS)	2	2.73	0.0663
ROM (°)			
Flexion	43.53	39.13	0.0366*
Extension	40.13	40	0.9132
Right Lateral Flexion	35.67	34.27	0.4835
Left Lateral Flexion	35.73	37.47	0.3197
Right Lateral Rotation	58.67	56.27	0.2668
Left Lateral Rotation	61	56.33	0.1331

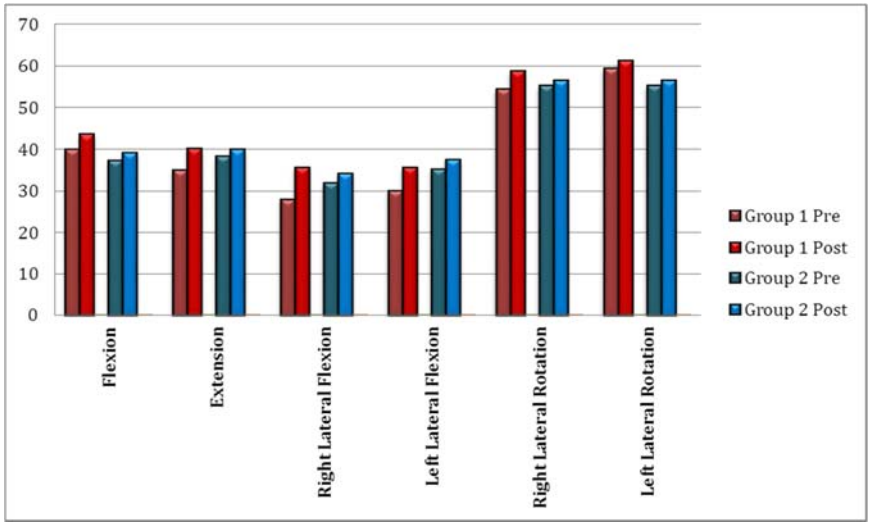
*-statistically significant



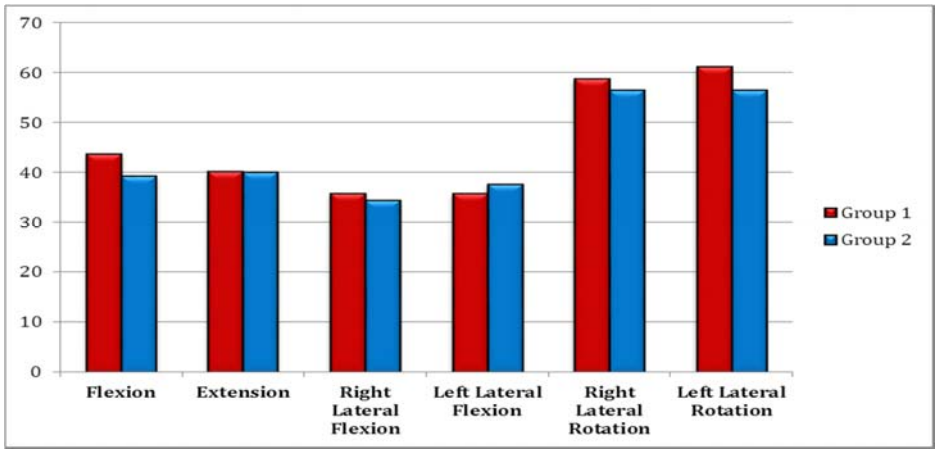
Graph 1: Comparison of pre and post-treatment pain scores on VAS between groups



Graph 2: Comparison of post-treatment pain scores on VAS between groups



Graph 3: Comparison of pre and post - treatment values of Cervical ROM between groups



Graph 4: Comparison of post - treatment Cervical ROM between groups

Discussion

The aim of this study was to analyze the effectiveness of stretching and postural modification versus stretching alone in neck disability among smartphone users by comparing the neck range of motion and pain scale after 4 weeks home-based treatment program.

This study was done among university students with age groups ranging from 20 to 30 years who used smartphone more than 4 hours each day followed by the onset of symptoms such as neck pain or neck muscle fatigue. When I found out the study done by Arja Ha¨ kkinen *et al.* (2008) which was to compare the effectiveness of a 12-month home-based combined strength training and stretching program against stretching alone in the treatment of chronic neck pain, the study was done among 25 to 53 years patients with non – specific neck pain and the duration of non – specific neck pain was more than 6 months [29].

The result of this study indicated that both stretching and postural modification versus stretching alone were equally effective in reducing neck pain and improving cervical range of motion of smartphone users, but no significant difference found between the groups. The result obtained were in consensus with the previous study done by Ana Cláudia Violino Cunha *et al.* (2008) in which the pain intensity reduced and ROM improved following muscle chain stretching, proposed by global posture reeducation method and conventional static stretching over neck region [30].

Both groups exhibited improvement in the mean cervical ROM but there was greater improvement in Group 1 (Stretching and Postural Modification), which the ROM mean increased by approximately up to 8° compared to Group 2 (Stretching alone), which is increased only around 3°.

In this study, the pain intensity scores was measured by using VAS was also reduced in both groups after 4 weeks of treatment program, on average 5 times weekly. However, the decrease of the neck pain was greater in the present stretching and postural modification group than that of the stretching alone group. The average score of VAS were reduced by 2.67 in Group 1 and 0.80 in Group 2 after 4 weeks. According to study done by Ylinen *et al.* (2007) found that at a 12 months follow – up, a significant reduction in neck pain as a result of stretching exercise performed at average of twice weekly [31].

Participants in this study were students from Asia Metropolitan University, therefore, sex, age, and how they did their treatment program without any supervision may affect the outcome. Individually adjusted stretching treatment could also make some difference. Thus, the results of this study may not be generalized to the whole population.

According to Ylinen *et al.* (2007), the advice about stretching exercises and manual therapy are among the most commonly used treatments for chronic neck pain. However, their effectiveness has not been compared in randomized studies [31]. Furthermore, regular self – administered stretching was as effective in abolishing pain and thus may be considered as a first choice of treatment since it is easy to perform and inexpensive to be introduced in practice.

Limitations of the study

The limitations of this study were limited sample size, short – term result, non – supervised exercise training and the participants had low levels of pain intensity.

Recommendations for future research

It is recommended that future studies should be done with greater sample size, done by targeting or choosing a specific Cervical ROM (flexion or extension or lateral flexion or lateral rotation), specific VAS value (range: mild(1-3) or moderate(4-7)or severe (8-10)) and specific duration of neck pain (acute or chronic). It is also recommended that future study should be carry out for long-term period of treatment with follow up to find out the effectiveness of the treatment and supervising each participant in both groups during treatment program instead of letting them to do by themselves at home.

Conclusion

After 4 weeks of treatment program, participants in Group 1 were significantly better than those in Group 2. However, the difference in the effectiveness between both groups was minor. Therefore, both of the treatments considerably increase cervical ROM and reduce neck pain among smartphone users. These reasonable treatment programs (Stretching and Postural Modification) can be recommended for the first instance as an applicable therapy intervention to prevent neck stiffness and to relieve neck pain at least in short – term.

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