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IMPACT OF SMARTPHONE USAGE ON EFFICACY OF PHYSIOTHERAPY EXERCISES AND INTERVENTION MEASURES FOR MECHANICAL NECK PAIN: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Excessive smartphone usage and the resulting postural choices have led to a rise in musculo-skeletal disorders, especially in the neck region. The purpose of the present research was to understand the success of the intervention on the cervical range and pain among smartphone users with mechanical neck pain and to elucidate the effect of hours of smartphone usage as an interacting variable in the effectiveness of the treatment provided. In this quasi-experimental study, 45 male participants, aged 18 to 29 years, with mechanical neck pain and who used smartphones were divided into three equal groups that underwent physiotherapy intervention programmes that included manipulation, passive stretching, and interferential therapy. The outcome measures were pain, cervical range of motion, pain pressure threshold, and handgrip strength. The pain scores for the passive stretching group improved more, with a mean value of 3.6 points for the immediate treatment result and 1.4 points after ten treatment sessions compared with the mean values of the manipulation group (3.3 and 2.0 points, respectively). Users of their phones for three or more hours daily had a significant decrease in cervical range of motion compared to the immediate change seen after the intervention.

***Keywords*:** Functional health; Musculo-skeletal disorders; Neck pain Physical therapy; Smartphone.

INTRODUCTION

Mechanical neck pain is multifactorial in origin. Its causes include poor posture, repetitive movements, and holding the head or arms in the same position for long periods of time, such as during occupational activities (Constand & MacDermid, 2013). Neck problems arise among smartphone users since there is a constant change to normal curve of their cervical spine, thus increasing the stress load on the cervical spine (Hansraj, 2014), triggering pain and spasm of the musculoskeletal structures and ligaments of the cervical region.

Importantly, mechanical neck pain associated with the excessive use of smartphones is on the rise, due to the static muscular load placed on the neck and shoulders and is considered to be associated with musculoskeletal disorders (Gustafsson *et al*., 2017). Too many hours of smartphone use, with the head and neck turned/tilted towards the smartphone itself or toward the screen of the smartphone, can pose a high risk for triggering chronic neck pain (Park *et al*., 2015).

Research on the effects of smartphone usage hours on the musculoskeletal system is available (Widhiyanto *et al.,* 2017; Al-Hadidi *et al.,* 2019). Still, these studies have not determined the exact role that the hours of usage play as an interacting variable on treatment modalities. Previous studies have pointed out significant relationships between hours of smartphone usage and neck pain. For example, in a very recent study it was concluded that students used smartphones for more than five hours a day and also found a positive correlation between the duration of usage and duration of pain (Al-Hadidi *et al.,* 2019).

In a recent study in Saudi Arabia, 71% of youngsters complained of cervical pain (AlZarea & Patil, 2015). Furthermore, in a cross-sectional questionnaire study on a population of university students, an association was found between using a smartphone device and the existence of pain in the base of the right thumb, right shoulder and neck (Berolo *et al.*, 2011).

Neck pain affects the quality of life by increasing the level of morbidity and decreasing work-related activities and leisure activities (Hagberg & Wegman, 1987; Westgaard *et al.,* 1993; Daffner *et al.,* 2003). However, even though the issue of neck pain is becoming increasingly common and thus important, research into its optimal treatment is still sparse (Kim *et al.*, 2015) and therefore fails to provide sufficient high-quality evidence to effectively guide conservative treatment approaches (El-Sodany *et al.*, 2014). This could be due to the poorly understood clinical nature of neck pain in concurrence with inconclusive results about the efficacy of commonly used treatment interventions (Heintz & Hegedus, 2008).

Manual therapy is the most preferred physical therapy approach to insidious neck pain and mechanical neck pain (Masaracchio *et al.,* 2019). A study in 2005 found an immediate reduction in perceived neck pain after cervical spine manipulation (Cleland *et al.,* 2005). However, there is limited quality evidence to support that manipulation produces positive effects in neck pain reduction, patient satisfaction and functional improvement (Casanova-Méndez *et al.*, 2014, Young *et al.*, 2014). Instead, the literature suggests that stretching can significantly improve pain and the range of motion (ROM) of the neck, especially in the cervical region, which can lead to benefits for patients with mechanical neck disorders (Akhter *et al.*, 2014).

In recent studies of neck pain, stretching exercises for the neck and upper limbs, strengthening exercises, and static and dynamic stabilisation exercises were recommended as being highly effective in combating pain (Akhter *et al.*, 2014; O'Riordan *et al.*, 2014; Kay *et al.*, 2015). Nevertheless, there remains inconclusive results regarding the efficacy of manual therapy and stretching, which could be due to insufficient sample size and poor methodological quality of the studies conducted (Häkkinen *et al*., 2007; Farooq *et al*., 2018). Patients are often found to be apprehensive of neck manipulation techniques, and such concerns are also voiced in specific research papers (Ernst, 2007). This subjective difference (in the opinion of the researchers) aside, however, the literature available on comparisons of effectiveness between manipulation and stretching is still sparse.

PURPOSE OF RESEARCH

This study was conducted to understand which intervention technique, namely stretching or manipulation, should be provided for specific functional loss and pain in the neck of smartphone users. It was designed to investigate the confounding effects of hours of smartphone usage for any treatment to be successful. Therefore, the objective of the present research was to determine the difference in the effect of manipulation and stretching on the cervical range of motion and pain among smartphone users with mechanical neck pain, and to elucidate the impact of hours of smartphone usage as an interacting variable in the effectiveness of the treatment provided.

METHODOLOGY

Ethical clearance

The present study was begun after obtaining approval from the university's Human Research Ethics Committee for the trial (approval no. REC#2018-01-45).

Participants

Forty-five participants were assessed for eligibility (Figure 1). Participants recruited for inclusion were aged 18 to 29 years, with mechanical neck pain and right hand dominance. They were screened using the Neck Disability Index (NDI) (Vernon & Mior, 1991; Cleland *et al.*, 2008) scoring scheme. Those with a score of eight points and less were recruited for the study. Participants were excluded if they had neck pain not due to mechanical causes, or neck pain that did not originate from the lower cervical spine. Furthermore, participants were excluded if they had a history of recent surgery or neck trauma, facial paresthesia, visual disturbances, dizziness and vertigo. They were also excluded if they had received cervical spine manipulation or any manipulation within the preceding month.

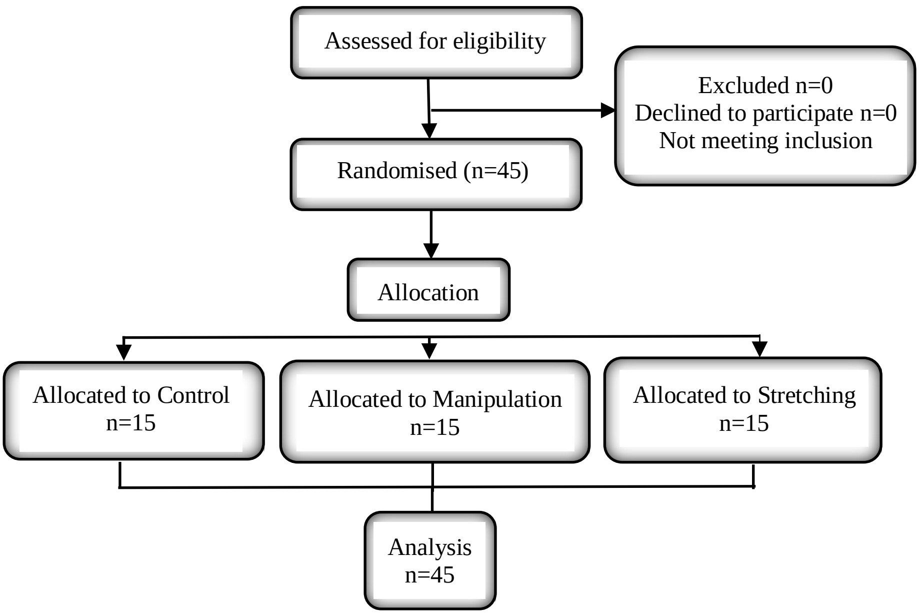


Figure 1. **ENROLMENT FOR STUDY**

Participants who met the inclusion criteria were then provided with written consent forms to sign and participate in the study. The 45 participants were non-randomly allocated to three groups of 15 people each. Allocation bias was reduced because all the study participants were recruited based on their NDI score, and were equally divided into the groups. The participants were also asked to provide information about their daily hours of smartphone usage by rating it as less than three hours or more than three hours per day.

Measures

The outcome measures were pain, cervical range of motion (CROM), pain pressure point threshold (PPT) and handgrip strength (HGS). Subjective pain levels were measured using a visual analogue scale (VAS) (Delgado *et al.*, 2018). Participants were asked to mark the neck pain perceived by them on a 10-cm line drawn in the assessment sheet ranging from no pain on the extreme left to maximum pain on the extreme right, followed by cervical range of motion (CROM), handgrip strength (HGS) and pain pressure threshold (PPT). This order was selected to minimise the effects of one measurement on the other.

CROM was measured using a DUALER IQ PRO digital inclinometer (JTECH Medical, Midvale, UT, USA) (Prushansky *et al*., 2010). Measurements were recorded with the participant seated with the inclinometer fixed using straps on the side of their head. The participant moved their neck from neutral until the end-range of flexion to measure flexion ROM and then repeated this motion from the neutral position until the end-range of extension to measure extension ROM, as shown in Figure 2. For recording the left and right lateral neck flexion, the digital inclinometer was placed on top of the head in the sitting position and recorded from the neutral position to lateral flexion in both right and left directions. For cervical rotation, the participant was positioned in the supine. The inclinometer was placed on their forehead; with the rotation degrees measured from neutral to the end-range the participant could do actively (Hoving *et al*., 2005). The average of three measurements recorded was taken as the final measurement for all movements.

Figure 2.
DIGITAL INCLINOMETER MEASURING CERVICAL EXTENSION

Figure 3.
HAND GRIP-STRENGTH MEASURED USING JAMAR DYNAMOMETER

HGS was measured using a Jamar dynamometer (Performance Health, Akron, OH, USA), as shown in Figure 3. The second handle position (Trampisch *et al.,* 2012) with the shoulder at neutral, elbow flexed to 90 degrees, and wrist slightly extended as per norms of the American Association of the Hand, was used. Maximum isometric grip contractions each of five seconds were performed three times for each hand, alternating between sides and with adequate rest of two minutes. The intervals were designed to minimise performance fatigue (Trossman & Li, 1989). The average of the three measurements per hand was recorded as the final grip-strength score for each. HGS was assessed to check if there is any relationship between neck pain and the handgrip strength pre- and post-intervention (Fayez, 2014)

PPT was measured using a pain pressure algometer (Reeves *et al.*, 1986; Ylinen *et al.*, 2007). A baseline force gauge algometer (White plains, New York 10602 USA) device was used for the study. The algometer was placed over the spinous process of the involved segment using a 0.5-cm^2-tip probe. The participants were instructed to notify the examiner the moment the sensation of pressure changed to discomfort or pain. At this point, the test was stopped and the results were recorded. This procedure was performed three times with a ten-second rest between trials, with the recorded score being the average of the three scores. All outcome measurements were taken at pre-test, immediately post-intervention, and after ten sessions at the end of two weeks.

Research design

After the pre-test, the experimental group, Group I received Maitland manipulation, Group II received passive stretching and the control group (Group III) received Interferential therapy (IFT) and self-stretching. All three groups were taught to perform regular home-based self-stretching exercises involving flexion, extension, bilateral lateral flexion and rotation of the cervical spine until the end-range, with each position maintained for 30 seconds and repeated on alternate days for two weeks. All three groups were given IFT (Electro-Stimulator; Enraf Nonius BV, Rotterdam, the Netherlands). Treatment was conducted using procedures that has been previously outlined (De Domenico, 1982; Ma *et al.*, 2011; Fuentes, 2020). A pre-set mode was selected for pain relief, a crossfire method was employed, four electrodes were placed on the back of the neck and the treatment duration was 20 minutes. The same procedures were followed for all 10 sessions.

A single assessor certified in manual therapy did the manipulation based on the participant's condition. The choice of level of the cervical spine to manipulate was left to the discretion of the assessor. The participant was positioned in the supine position. After static palpation for painful sites, the active movement test was done to rule out where the manipulation would be applied. Additionally, the quality of motion was examined. The manipulation was administered six times on alternate days for two weeks using the same technique, a lateral glide manipulation, as shown in Figure 4.

***Figure 4*. NECK LATERAL GLIDE MANIPULATION**

Group II received passive stretching involving flexion, extension, lateral flexion and rotation of the cervical spine until the end-range. Each position was maintained for 30 seconds, and repeated three times in a single session for all 10 treatment sessions.

All the interventions were performed in the outpatient department for approximately 60 minutes per participant, five times per week, for two weeks under the guidance of a physiotherapist.

Analysis of data

The calculation of the minimum sample size was undertaken using the G*power version 3.0.10 software programme. A repeated-measures ANOVA was used to measure the effect of each intervention on the outcome variables. It was further used to reveal the interaction effect of daily smartphone usage hours on the effects of intervention and outcome variables. This analysis was done using the SPSS version 22 software programme (IBM Corp., Armonk, NY, USA).

RESULTS

Table 1 provides a detailed description of the descriptive statistics and significant differences between group variances of the 45 participants allotted to three different groups. Participants did not differ significantly regarding age, NDI, VAS, right and left handgrip strength, hours of smartphone usage, or PPT scores at baseline.

***Table 1*. PARTICIPANT CHARACTERISTICS AND COMPARISONS BETWEEN GROUPS**

Variables	**Manipulation Group** (n=15)	**Stretching Group** (n=15)	**Control Group (CG)** (n=15)	**p-value**
Age (years)	22.40±2.79	22.46±0.83	22.00±1.19	0.751
VAS (cm)	5.6±1.4	5.4±1.6	4.9±1.3	0.405
NDI score	5.80±2.67	5.73±1.6	5.86±1.56	0.984
HGS right (kg)	34.6±8.7	42.8±7.6	36.4±6.7	0.016
HGS left (kg)	33.6±7.1	40.8±7.2	36.4±7.5	0.034
PPT (kg)	1.6±0.4	1.8±0.3	1.5±0.3	0.069
Smartphone usage less than 3 hours/day	1.9±0.9	2.3±0.6	2.3±0.6	0.975
Smartphone usage more than 3 hours/day	5.1±0.7	5.3±0.8	5.1±0.8	0.879

VAS=Visual Analogue Scale NDI=Neck Disability Index HGS=Hand Grip Strength
PPT=Pain Pressure Threshold ∗Significant $p \leq 0.01$

When interpreting these statistical data, the interaction effect on the outcome-measurements of the intervention group's statistical significance was indicated at ($p \leq 0.05$), and the confidence interval was set at 95%. Time×group interaction and time interaction effect were significantly higher in the experimental groups (manipulation and stretching) when compared to the control group for VAS and CROM in all directions ($p \leq 0.05$). Group effect was only significant for

VAS, CROM flexion, CROM right rotation, handgrip strength right and pain pressure threshold ($p \leq 0.05$) as presented in Table 2.

Table 2. **REPEATED MEASURES ANOVA, POOLED MEANS AND STANDARD DEVIATIONS FOR ALL OUTCOME MEASURES**

Variables	Group	Mean ±Standard Deviation Baseline	Immediate	Post	Repeated measures ANOVA Interaction effect η_p^2 (p value)	Group effect η_p^2 (p value)	Time effect η_p^2 (p value)
Pain VAS (cm)	M	5.6±1.4	3.3±1.1	2±1	**0.657 (0.00)***	**0.244 (0.004)***	**0.563 (0.00)***
	S	5.4±1.6	3.6±1.7	1.4±1.1			
	CG	4.9±1.3	4.8±1.4	6±1.5			
CROM-FL (degrees)	M	63.3±10.8	71.7±9.3	67.0±8.8	**0.405 (0.00)***	**0.279 (0.002)***	**0.493 (0.00)***
	S	77.2±9.1	85.2±9.9	73.1±7.6			
	CG	73.7±7.1	73.7±7.2	72.8±7.2			
CROM-E (degrees)	M	66.1±8.2	76.2±7.1	70.8±8.8	**0.193 (0.00)***	0.087 (0.169)#	**0.310 (0.00)***
	S	72.1±8.8	79.4±7.9	70.7±7.5			
	CG	76.1±8.1	76.3±7.8	76.0±8.2			
CROM-LFR (degrees)	M	54.3±6.6	61.0±5.9	58.5±8.3	**0.197 (0.00)***	0.105 (0.114)#	**0.219 (0.00)***
	S	59.8±6.2	70.4±9.2	60.1±10.0			
	CG	61.6±5.8	60.8±5.7	60.5±5.8			
CROM-LFL (degrees)	M	50.3±8.3	61.2±7.8	57.7±7.8	**0.379 (0.00)***	0.058 (0.31)#	**0.469 (0.00)***
	S	57.3±8.0	66.4±11.1	58.1±7.6			
	CG	60.7±6.3	60.6±6.4	60.7±5.7			
CROM-RR-(degrees)	M	75.5±6.5	84.4±6.8	81.6±10.1	**0.333 (0.00)***	**0.289 (0.001)***	**0.450 (0.00)***
	S	83.0±9.3	91.4±8.3	82.2±7.5			
	CG	75.1±5.2	75.1±5.1	74.6±4.8			
CROM-RL (degrees)	M	76.1±7.8	86.8±5.9	82.4±9.5	**0.277 (0.00)***	0.137 (0.056)#	**0.327 (0.00)***
	S	79.6±8.8	86.7±8.3	80.8±8.3			
	CG	76.4±5.2	75.9±5.1	75.2±5.8			
HGSR (kg)	M	34.6±8.7	35.6±7.1	37.8±7.4	0.048 (0.417) #	**0.159 (0.034)***	0.062 (0.087)#
	S	42.8±7.6	43.0±6.4	44.0±7.3			
	CG	36.4±6.7	36.6±6.1	36.6±6.1			
HGSL (kg)	M	33.6±7.1	34.6±8.6	35.8±9.0	0.037 (0.362) #	0.095 (0.143)#	0.053 (0.227)#
	S	40.8±7.2	41.0±6.4	41.6±7.8			
	CG	36.4±7.5	36.5±7.4	36.8±7.4			
PPT (kg)	M	1.6±0.4	1.7±0.3	1.7±0.2	0.067 (0.24)#	**0.227 (0.007)***	0.00 (0.827)#
	S	1.8±0.3	1.8±0.1	1.8±0.2			
	CG	1.5±0.3	1.3±0.4	1.5±0.2			

VAS=Visual Analogue Scale; CROM=Cervical Range of Motion; FL=Flexion; E=Extension; LFR=Lateral Flexion Right; LFL=Lateral Flexion Left; RR=Rotation Right; RL=Rotation Left; HGSR=Hand Grip Strength Right; HGSL=Hand Grip Strength Left; PPT=Pain Pressure Threshold; M=Manipulation Group; S=Stretching Group; CG=Control Group ∗Significant effect ($p \leq 0.05$) #Non-significant

The control group did not show any significant change in time, group or time×group interaction effect for the variables.

There was a significant difference in the VAS score between the experimental groups immediately and in the post-test results. Stretching was found to be more effective with a mean value of 3.6 points immediately after intervention and 1.4 points after ten treatment sessions when compared with manipulation (3.3 and 2.0 points, respectively), based on pain reported by the participants as shown in Table 2. Passive stretching +IFT+ self-stretching was found to be effective for treating participants with neck pain and who were using smartphones for more than three hours daily.

In contrast, participants who were having neck pain and who were using smartphones for less than three hours per day responded positively to manipulation +IFT+ self-stretching. The differences between more and less than three hours of smartphone usage between the three groups are presented in Figure 5a.

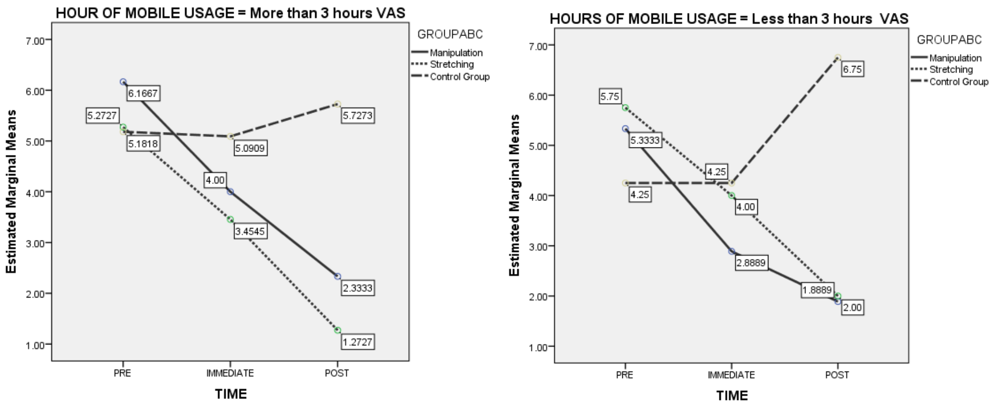
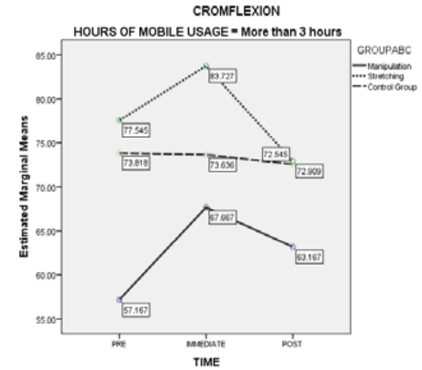
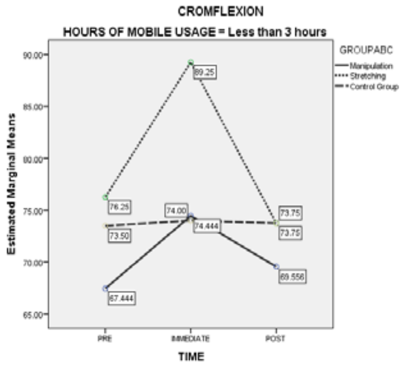


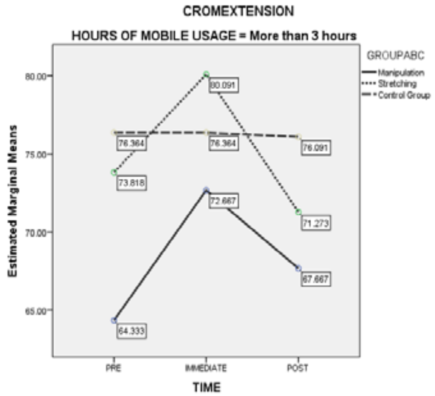
Figure 5a. **INTERACTION EFFECTS FOR PAIN: SMARTPHONE USAGE FOR LESS THAN AND MORE THAN 3 HOURS/DAY (Visual Analogue Scale [VAS])**

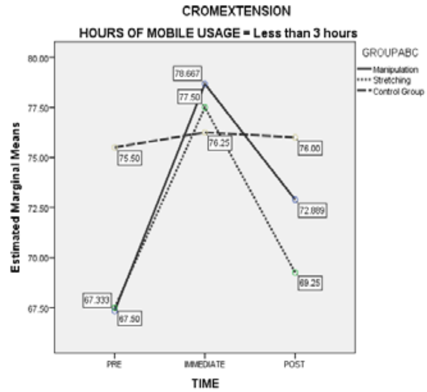
The post-test result differences of CROM extension among the manipulation and stretching groups had mean values of 70.8 and 70.7 degrees, respectively. CROM flexion also showed a significant difference between the groups, with an increase in flexion observed among the manipulation intervention patients (mean value of 67.00 degrees), compared to a decrease in the stretching group. There was a significant change seen among the intervention groups for right CROM lateral flexion (mean value of 58.5 degrees) and left CROM lateral flexion (mean value of 57.7 degrees) for the manipulation technique. The mean differences indicate that there was no statistically significant difference between cervical spine manipulation and stretching.

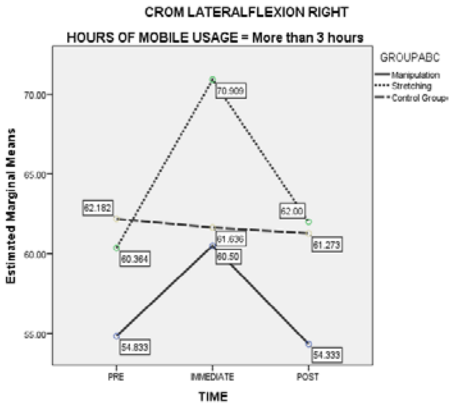
Notably, the right CROM rotation did not present any significant differences among the intervention groups. Left CROM rotation was significantly different between all groups and had a better mean score difference for the experimental groups than for the control group. The mean difference between manipulation and stretching did not show any significant difference. Still, the results are inconclusive for demonstrating that one is more effective than the other, as shown in Table 2. However, the interaction effect between the groups based on duration of smartphone usage suggests that manipulation +IFT+ self-stretching is effective in improving CROM functions overall in all the directions, and the differences between less than three hours and more than three hours of smartphone usage are represented in Figure 5b. There was a change reported in right-sided HGS between groups, but there was no difference in left-sided HGS between groups among the treatment groups, as shown in Table 2. The results suggest that manipulation +IFT+ self-stretching yields a better treatment effect than passive stretching. Less than three hours and more than three hours of smartphone usage are represented in Figure 5c. There were no significant differences in PPT observed for all three groups.

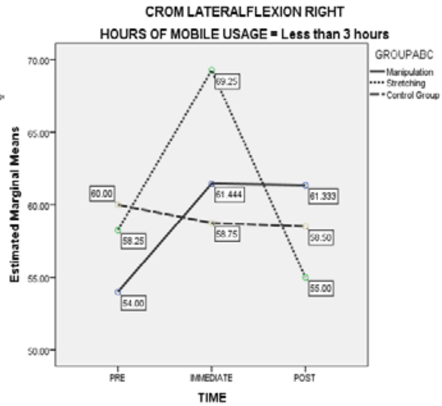












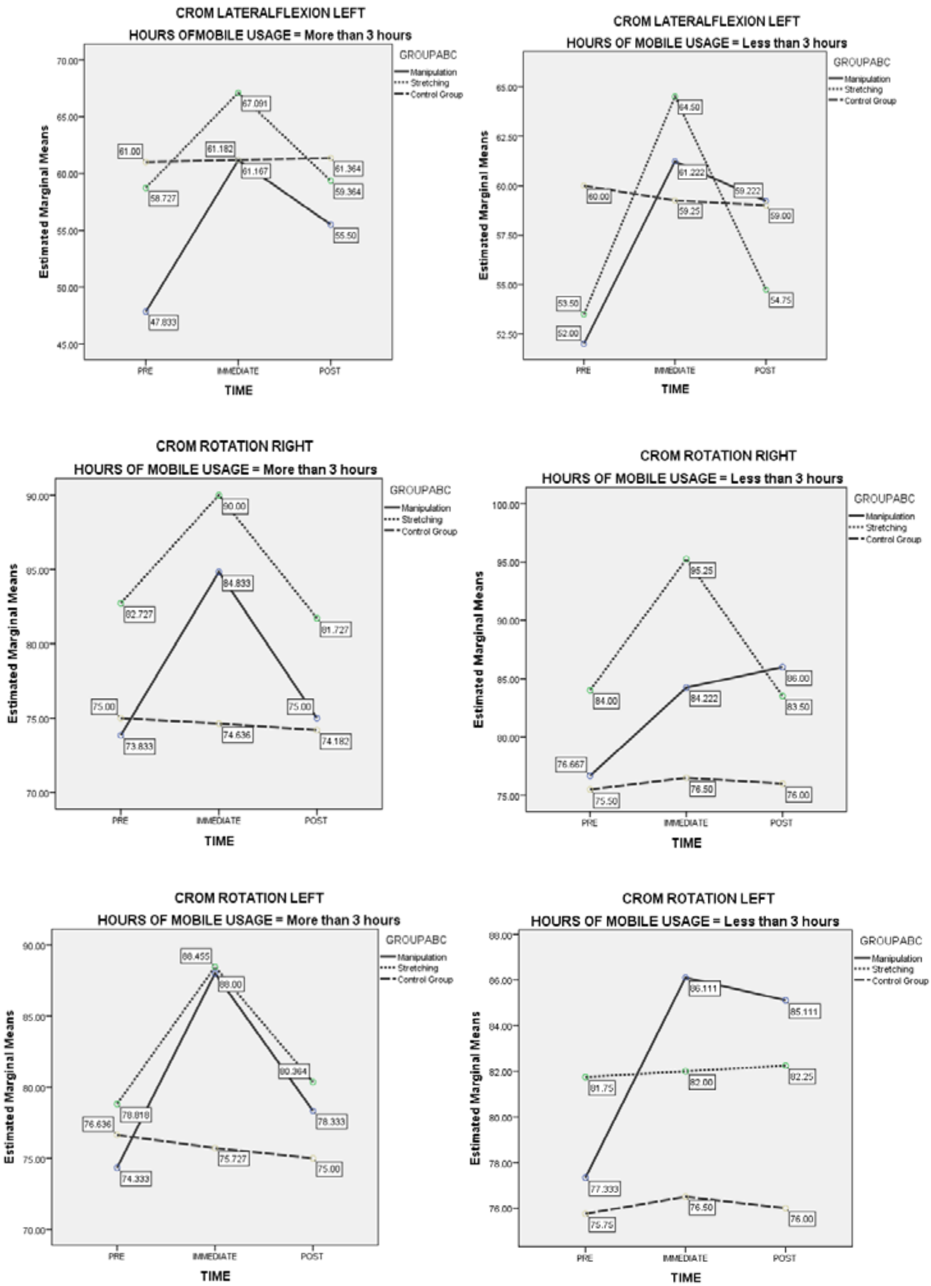


Figure 5b. **INTERACTION EFFECTS FOR CERVICAL RANGE OF MOTION (CROM): SMARTPHONE USAGE FOR MORE AND LESS THAN 3 HOURS/DAY**

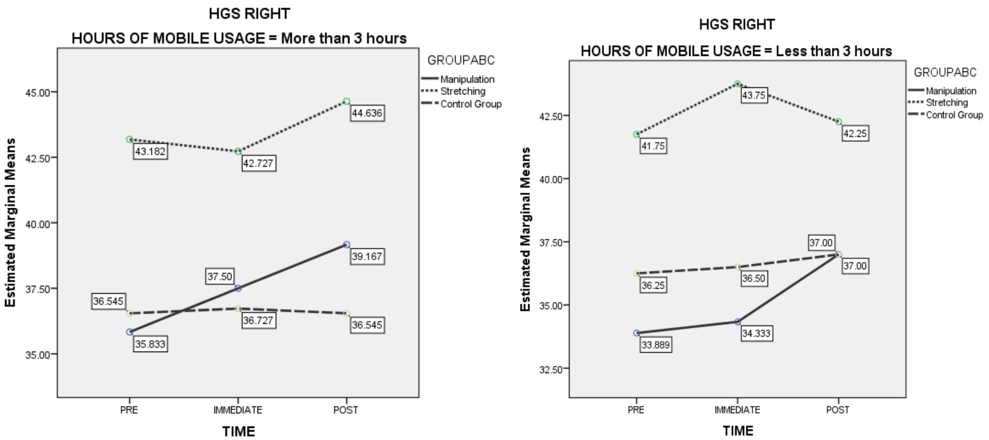


Figure 5c. INTERACTION EFFECT OF SMARTPHONE USAGE FOR MORE AND LESS THAN 3 HOURS/DAY FOR RIGHT-HAND GRIP STRENGTH (HGS)

DISCUSSION

The present study evaluated the effects of manipulation and stretching to improve pain and functional disability in participants with mechanical neck pain and to determine whether the use of smartphones can have an impact on treatment effectiveness. In this study, the control group did not present any difference in their outcome measures, whereas the treatment groups showed significant differences and improvements after receiving their respective treatments.

The interesting observation here is that stretching was recorded as an effective treatment according to the VAS scale, and manipulation was recorded as an effective treatment according to CROM, HGS, and PPT. Stretching was found to reduce pain perception, possibly by increasing stretch tolerance, as was also observed in an earlier study using static stretching and muscle energy techniques (Phadke *et al*., 2016). Static stretching may reduce pain by inhibiting the effects of Golgi tendon organs, thereby reducing neuronal motor discharges, which in turn relaxes the musculotendinous unit by resetting the resting length and promoting Pacinian corpuscle modification. This allows for relaxation in the musculotendinous unit tension, thereby affecting the pain perceptions individuals (Frontera, 2003).

Notably, prior studies have shown that CROM may benefit from manipulation in all planes, especially for patients with neck pain of mechanical origin (Hurwitz *et al*., 2009; Miller *et al*., 2010; Mayana *et al*., 2017). CROM flexion was significantly changed for the manipulation group, whereas rotation, extension and lateral flexion were not found to be significantly different between the two experimental groups. Prior research on CROM took it as one entity without being broken down into different planes (Mayana *et al*., 2017). There are reports about the role of stretching in reducing pain and increasing ROM (Cunha *et al.*, 2008), which may have led to a perceived sense of well-being and the report of improved quality of life.

A significant improvement in deep cervical flexor motor performance was reported after cervical manipulation in prior studies (Dunning *et al*., 2012). This could be why flexion alone was found to be improved following manipulation. In yet another study, the stretching exercise groups showed a significant difference in the left rotation, left lateral bending and right lateral bending results (Oh & Yoo, 2016), which could be the reason why there are no significant differences to highlight between the effectiveness of manipulation and stretching.

An increase in HGS in response to cervical manipulation was demonstrated by earlier researchers (Botelho & Andrade, 2012; Humphries *et al.*, 2013) as well as in the present study. Other authors have also reported an immediate increase in HGS in both affected sides following cervical manipulation (Gorrell *et al.*, 2016). Since the participants in the current study were all right hand-dominant, this could explain why there was no significant difference in the intervention methods for the left side HGS.

Studies investigating the effects of cervical manipulation on lateral epicondylalgia have also described both sensory and motor changes including increased HGS following manipulation (Fernández-Carnero *et al.*, 2011). While others have found no significant change in HGS in response to isometric exercises and manipulation (Humphries *et al.*, 2013). The PPT did not show a significant difference among the intervention groups, which supports the results of prior studies that reported no change in PPT following cervical manipulation (Martínez-Segura *et al.*, 2012).

Other research previously suggested that there could be an interaction between the effects of treatment of a conventional treatment programme and passive stretching, and that such interactions should be researched further (Phadke *et al.*, 2016). Therefore, the second objective of this study was to detect the impact of smartphone usage on treatment outcomes by determining the interaction effects of usage hours.

Pain perception was recorded as higher for participants using smartphones for more than three hours in the mobilisation group, and responded favourably after stretching. This might be because, after stretching there is a reduction in the perceived feeling of "bothersome soreness", as well as "feelings of soreness" (Jamtved *et al.*, 2010). This indicates that people who used smartphones for more than three hours daily felt more pain and, therefore, had a higher perceived recovery. An interaction effect was visible between manipulation and stretching groups, meaning that people who used their smartphones for more than three hours had a significantly higher level of pain perception. Some researchers studied pain severity according to smartphone use duration, and reported significant differences in headaches (Lee & Song, 2014) and muscle fatigue (Kim *et al*., 2013).

Also, a significant interaction effect between manipulation and stretching group CROM was observed. Participants who used smartphones for more than three hours presented a decrease in CROM function after cervical spinal manipulation. Prior studies concluded that dynamic joint contributions could be expressed in degrees or in percentages of total CROM (Wu *et al*., 2007; Anderst *et al.*, 2015; Wang *et al*., 2018).

HGS of the dominant hand was found to have a significant interaction effect on smartphone usage among the three groups. HGS of those participants who used smartphones for more than three hours was found to be higher than that of those who used smartphones for less than three hours. The interaction effect of smartphone usage hours on HGS was significant, meaning that the effectiveness of the treatment was substantial irrespective of the hours of smartphone usage.

A study in 2015 determined that, among university students who were divided into high smartphone users and low smartphone users using the smartphone addiction scale (SAS) (Demirci *et al.*, 2014), pain and decreased hand function, like pinch grip strength, were significantly more expressed in the high smartphone user group when compared with the low user group (İNal *et al*., 2015). The HGS of the study participants were less than the normative values of a similar age group reported by earlier studies (Mathiowetz *et al*, 1985; Abdelhameed

& Abdel-aziem, 2016), which also could be an indicator for HGS changes among smartphone users.

The current study has certain limitations; including notably that the sample size was small and randomisation was not done for the group division. It is also important to note that the long-term effects of the treatment were not studied. Further research could be undertaken to study the psychological effects of physiotherapy treatments, as well as perceived psychological recovery from pain.

PRACTICAL APPLICATION

The physical therapy management of mechanical neck pain is more effective when using manual therapy techniques. Rehabilitation practitioners should be concerned with how patients react to treatment both in the short-term and long-term. Asking patients to abstain from using portable gadgets during the interventional period could help speed up the recovery phase and allow them to reap full benefits of the treatment.

CONCLUSION

It can be concluded in the present study that both cervical spine manipulation and stretching exercises effectively relieved pain and reduced disability in patients with mechanical neck pain due to smartphone use. This study attempted to bridge the gap between understanding the effectiveness of stretching versus manipulation and confounding the effects of hours of smartphone usage on treatment outcome. Therapists should screen patients based on their smartphone usage hours, and the type of pain, movement restriction and functional loss they experience, to determine the most effective therapy (be it stretching or manipulation) to combat pain and restore functional status.

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