POSTURAL RETRAINING EXERCISES PROTOCOL- EFFECTIVENESS ON POSTURE, NECK PAIN AND DISABILITY IN TEXT NECK SYNDROME IN COLLEGE STUDENTS: A RANDOMIZED EXPERIMENTAL TRIAL

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Abstract

Background: Text Neck Syndrome (TNS) is characterized by neck pain and muscle damage as a result of a stress injury or overuse syndrome caused by prolonged and repeated staring down at mobile phones in poor posture. Text neck syndrome is physiotherapeutically treated with electrotherapy, manual therapy, isometrics to the cervical muscles, and active range of motion exercises. Postural correction and retraining exercises have been identified as the most effective methods for correcting changes in posture abnormalities and restoring function. Due to the lack of existing evidence on postural retraining methods for neck syndrome, it is mandatory to frame an absolute protocol. Aim: To determine the effects of postural retraining exercise protocol on posture, neck pain, and disability in college students with Text Neck Syndrome (TNS). Methodology: It's an experimental study involving 40 college students suffering from text neck syndrome. Convenience sampling method was used to collect a data. They were divided into two groups- Postural Retaining Exercise Protocol (PREP) Group and the Conventional Exercise Protocol (CEP) Group. Outcome measures: Visual Analogue Scale (VAS), Neck Disability Index (NDI), Spondylometric measurement. Stastical analysis& Results: The collected data was recorded and tabulated. The statistical package for social science (SPSS) version 21.7 was used to analysis the dataThe statistical tool Chi-squared test was used for determining the homogeneity of sample in demographic variables of the two groups. Paired 't' test was used to analyze the pre and post-test value of each group, unpaired 't' test was used to compare pre-test values and post- test values between the two groups. Conclusion: Results of this study showed that Postural Retraining Exercise Protocol (PREP) & Conventional Exercise Protocol (CEP) group had a statistically significant difference between pre-test & post-test values of pain, disability & cervical angle.
Keyword: Neck Pain, Text Neck Syndrome, Postural Retraining Exercises, Neck Disability index, Spondylometric Measurements.

INTRODUCTION

Neck pain, a prevalent global public health issue, affects 16.7% to 75.1% of the population, with diverse etiological factors such as ergonomic, individual, behavioral, and psychosocial aspects[1]

The escalating use of handheld mobile devices (HHMD) contributes to musculoskeletal complaints, with neck pain being predominant, often attributed to the emerging phenomenon of "text neck[2,3]Text neck results from sustained poor posture while using mobile devices, causing acute to chronic pain in the neck and upper back[4,5]. Studies indicate a 35% prevalence of text neck syndrome among smartphone users, particularly affecting the 15-18 age group[6].

Text neck posture mirrors forward head posture, leading to muscle imbalances and contributing to various issues, including postural abnormalities, thoracic kyphosis, shoulder pain, headaches, and radiating pain[7,8.] The prolonged use of modern-era gadgets is considered a significant factor in this syndrome, influencing anxiety and stress levels[9,10]. With the increased reliance on electronic devices for education during the COVID-19 pandemic, the prevalence of text neck syndrome has risen.

Physiotherapeutic interventions for text neck syndrome encompass electrotherapy, manual therapy, isometrics, and active range of motion exercises. Evidence supports the effectiveness of post-isometric relaxation, dynamic neck strengthening exercises, progressive resisted exercise, shoulder and neck resistance training, and McKenzie exercises in alleviating pain and disability associated with text neck syndrome[11].

In conclusion, text neck syndrome, labeled the "Pain of the Modern Era," stems from the extensive use of handheld mobile devices. Addressing it involves a multifaceted approach, including postural retraining exercises, which have shown efficacy in reducing pain, disability, and correcting postural abnormalities in college students. Future research should focus on establishing a standardized protocol for postural retraining in text neck syndrome.

METHODOLOGY
This is the experimental study design, Pre- test and Post-test type study. Convenient Sampling method was used to collect a data .This study was conducted on Smart Phone users among college students at various department of Mahatma Gandhi Medical College & Research Institute, Sri Balaji Vidyapeeth, Puducherry. The inclusion criteria was collegiate in age between 17- 25, both male and females & those who were using mobile phones more than 3 hours per day only added in this study. The exclusion criteria was traumatic injury of the cervical spine, any neurological or cardiovascular problems, a history of surgery and fracture in the upper limb and the spine during the past year, mass lesion in spinal column & inflammatory disease and cervical instability & spinal cord compression. Before starting the study the ethical approval was obtained from the institutional ethical committee. 40 participants were selected based upon the inclusion and exclusion criteria and they were allocated into two groups by convenience sampling method. Before the commencement of the study aim and procedure were explained and informed consent was obtained. The participants were then randomly allocated to two groups, i.e., The Postural Retraining Exercise Protocol (PREP) group and The Conventional Exercise Protocol (CEP) group.

OUTCOME MEASURES
Visual Analogue Scale (VAS):
Visual analogue scale (VAS) is a validated, psychometric response scale used to measure subjective characteristics of pain. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed along the length of a 10-cm line that represents a continuum between the two ends of the scale - no pain (0 cm) on the left end of the scale and worst pain (10 cm) on the right end of the scale. Measurements taken from left end of the scale to patient marking point are measured in centimeters. The VAS for pain in the cervical spine has a test-retest reliability of 0.95 to 0.97. It's a reliable tool for musculoskeletal conditions (ICC- 0.97).[12]

Neck Disability Index (NDI):
Neck disability index (NDI) is a standard, self - reported, condition specific functional status questionnaire for neck pain. NDI have 10 items including pain, personal care, lifting, reading, headaches, concentration, work, driving, sleeping and recreation. Maximum score of the instrument is 50; each item is rated from 0 to 5, in which 0 means no pain or disability 5 means worst pain or complete disability. NDI exhibited excellent reliability (ICC = 0.88) in the patient with mechanical neck pain.[13]

Spondylometer:
Spondylometer is a low-cost non-invasive instrument used for measuring spinal curvature in the sagittal plane. It is an apparatus made up of an aluminum vertical rod and 39 horizontally shaped and deformable horizontal rods with cross section. These rods are pointed at the back and the contours of the vertebral curvatures are drawn on the paper attached to the back of the instrument. Spondylometer allows quantitative evaluation of the lumbar curvature with excellent levels of intra- and inter-examiner reliability. In this study, a spondylometer is used to assess the cervical lordotic angle. The spinous process of the cervical vertebra is palpated. The participant is positioned on the spondylometer with bare feet and arms at the side of the body. When the participant is in an upright position (most erect position), the therapist adjusts the horizontal rods in the cervical region. After that, the least prominent point is marked on the paper, and the cervical angle being measured.[14]

INTERVENTION
The participants were then randomly allocated to two groups, i.e., The Postural Retraining Exercise Protocol (PREP) group and The Conventional Exercise Protocol (CEP) group. Postural Retraining Exercise Protocol (PREP) group as Experimental group and Conventional Exercise Protocol (CEP) group as Control group consists of 20 participants in each group. A cervical assessment proforma along with, the neck posture angle, intensity of pain, and neck disability were measured by VAS, Spondylometer and NDI. After the pre-test measurement PREP group received cervical isometric exercises, postural education and postural retraining protocol, while the CEP group received cervical isometric exercises and postural education. The participants received treatment for duration of 40 minutes, three days per week for 4 weeks duration that implies, 40 minutes of treatment on alternate days for a total of 4 weeks period.

Postural retraining exercise protocol
PREP group received cervical isometric exercises, postural education along with postural retraining. Cervical isometric exercise was performed in sitting position with elastic resistance band (neck flexion, extension, side flexion and rotation) for 6 sec hold, 5-10 repetitions for each session.[15] Postural education was provided by proper education of upright posture while using hand-held mobile devices, which includes holding the device close to eye level, using the device while standing or sitting and holding the device with a line of sight perpendicular to the surface of the device, & using a large screen.[3] Postural retraining includes self-stretching exercises, deep neck flexor activation and strengthening exercises. In self-stretching exercises, levator scapula stretching, upper trapezius stretching, sternocleidomastoid stretching and pectoralis stretching were given for duration of 30 sec. hold for initial sessions and added five more sec every two weeks. Deep neck flexor activation started with supine lying progressed with sitting position for duration of two seconds hold, six repetitions and progressed to ten repetitions of 10 seconds hold. Strengthening exercises includes side lying shoulder forward flexion, prone shoulder abduction, prone shoulder external rotation, side lying shoulder external rotation, push up, shoulder abduction- external rotation in sitting back to wall, flexion sitting back to wall, prone lying 'V','T' and 'W' exercises.[11]

Conventional exercise protocol
CEP group received cervical isometric exercises performed in sitting position with elastic resistance band (neck flexion, extension, side flexion and rotation) for 6 seconds hold, 5-10 repetitions for each session.[15] Postural education was provided by proper education of upright posture while using hand-held mobile devices, which includes holding the device close to eye level, using the device while standing or sitting and holding the

device with a line of sight perpendicular to the surface of the device, & using a large screen.[3]

STATISTICAL ANALYSIS AND INTERPRETATION

The statistical package for social science (SPSS) version 21.7 was used to analysis the data. Statistical analysis was done for all participants (n=40) in 2 groups that is PREP (Postural Retraining Exercise Protocol) group and CEP (Conventional Exercise Protocol) group. The statistical tool Chi-squared test was used for determining the homogeneity of sample in demographic variables of the two groups. Paired 't' test was used to analyze the pre and post-test value of each group, unpaired 't' test was used to compare pre-test values and post- test values between the two groups.

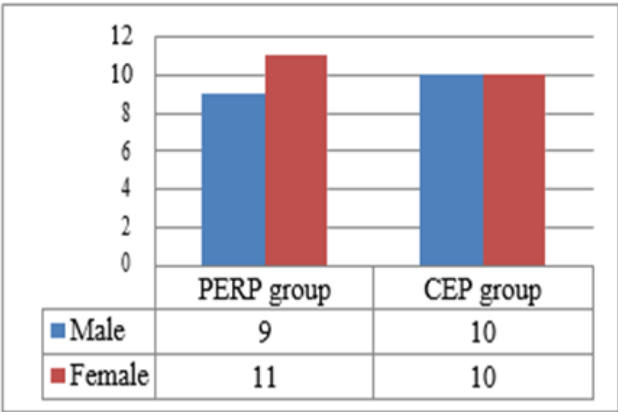**Table 1. Stastical analysis for Descriptive variables.**

Variables					PREP Group	CEP Group	'p'-Value
Age	Age Group	PREP Group(n)	CEP Group(n)	Mean	20.3	20.6	0.714
	18	1	1				
	19	6	5				
	20	7	4				
	21	1	4	S.D	1.52	1.53	
	22	2	3				
	23	3	3				
Gender	Male				9	10	0.752
	Female				11	10	
Hours of mobile usage/ day	Hours	PREP Group(n)	CEP Group(n)	Mean	5.6	5.4	0.911
	4	4	4				
	5	5	7	S.D	1.09	1.05	
	6	6	5				
	7	5	4				

Table 4.1., shows the descriptive variables of age, gender, & total hours of mobile usage of PREP group & CEP group. It was statistically analyzed by using Chi-squared test. Pertaining to the Age, the mean age of PREP group was 20.3 with S.D of ± 1.52 and CEP group was 20.6 with S.D of ±1.53, at 'p'-value of 0.714, which was found to be non-significant at ⬜=0.05. The result of the test indicates that there is no significant difference pertaining to age between the groups & thereby showing the homogeneity of the samples in terms of age of the participants. Regarding the gender distribution between the groups, the total number of participants were 40, in which PREP group had 9 male and 11 female participants, CEP group had 10 male and 10 female participants at 'p'=0.752, which was found to be non-significant at ⬜=0.05. The result of the Chi-squared test indicates that there is no significant difference between the groups pertaining to gender. Concerning hours of mobile usage, the mean value for hours of mobile usage in PREP group was 5.6 with S.D of ±1.09 and CEP group is 5.4 with S.D of ± 1.05 .The 'p' value of Chi-squared test was 0.911, which was found to be non- significant at ⬜=0.05. The result of the test indicates that there is no significant difference between the groups pertaining to the hours of mobile usage, thereby showing the homogeneity of the groups.

Graph 1. Age distribution between the Groups.

	18	19	20	21	22	23
PREP Group(n)	1	6	7	1	2	3
CEP Group(n)	1	5	3	3	4	4
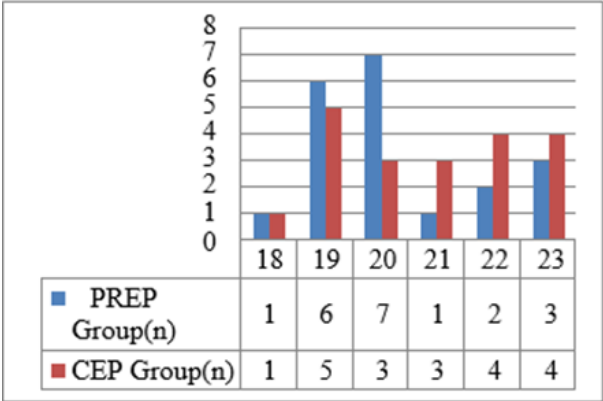
Graph 2. Gender distribution between the groups.

	PERP group	CEP group
Male	9	10
Female	11	10

Graph 1, shows the age group distribution of PREP group & CEP group. According to the age group distribution, at the age of 18, 2 participants (1 in PREP & 1 in CEP), at the age of 19, 11 participants (6 in PREP & 5 in CEP), at the age of 20, 10 participants (7 in PREP & 3 in CEP), at the age of 21, 4 participants (1 in PREP & 3 in CEP), at the age of 22, 6 participants (2 in PREP & 4 in CEP) and, at the age of 23, 7 participants (3 in PREP & 4 in CEP group).

Graph 2. Shows the gender of participants in PREP group and CEP group, with 20 participants in each group, out of which PREP group has 9 male and 11 female participants and CEP group has 10 male and 10 female participants.

Graph. 3. Hours of mobile usage between the groups.

|	4 Hrs	5 Hrs	6 Hrs	7 Hrs
PREP Group	4	5	6	5
CEP Group	4	7	5	4
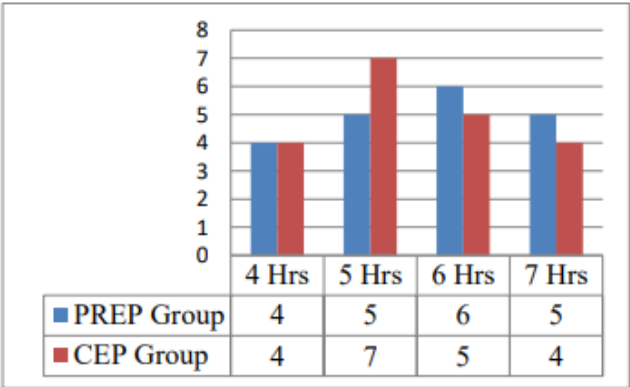
Graph 3., shows that 8 participants (4 in each group) with 4 hours of average mobile usage, 12 participants (5 in PREP & 7 in CEP group) with 5 hours of average mobile usage, 11 participants (6 in PREP & 5 in CEP group) with 6 hours of

average usage and 9 participants (5 in PREP & 4 in CEP group) with 7 hours of average use of mobiles per day.

Table 2. Comparison of Pre-test and Post- test values of PREP Group.

Variables		N	Mean	SD	Mean Difference	$'t'$ Value	'p' Value
VAS	Pre- test	20	5.95	±0.88	2.77	16.90	<0.001
	Post-test	20	3.17	±0.51			
NDI	Pre- test	20	58.40	±3.97	28.10	32.06	<0.001
	Post-test	20	30.30	±3.06			
SPONDYLOMETRIC MEASUREMENT	Pre- test	20	43.20	±1.23	4.50	26.44	<0.001
	Post-test	20	38.70	±0.86			

Table 2. Shows that pre- test and post-test values of VAS, NDI & Spondylometric measurements of PREP group. The mean value of VAS in pre-test was 5.95 with S.D of ±0.88 and post-test was 3.17 with S.D of ±0.51. The mean difference between the pre and post-test score was found to be 2.77 with 'p'-value of <0.001. The mean value of NDI in pre-test was 58.40 with S.D of ±3.97 and post-test was 30.30 with S.D of ±3.06. The mean difference between the pre and post-test score was found to be 28.10 with 'p'-value of <0.001,. The mean value of spondylometric measurement in pre-test was 43.20 with S.D of ±1.23 and post-test was 38.70 with S.D of ±0.86. The mean difference between the pre and post-test score was found to be 4.50 with 'p'-value of <0.001. The result of this paired student's $'t'$-test reported that there was significant difference in Pain level, Neck Disability Index & Spomdylometric measurements between the pre-test and post-test scores of PREP group.
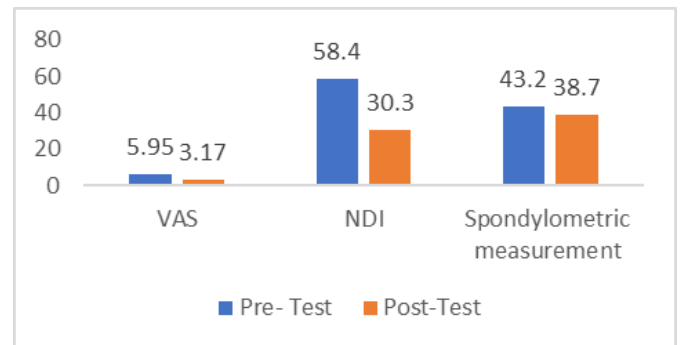
Graph.4 shows that there was a reduction in pain intensity, disability level, in Spondylometric measurement in the post test, it was compared with the Pre-test of PREP group.
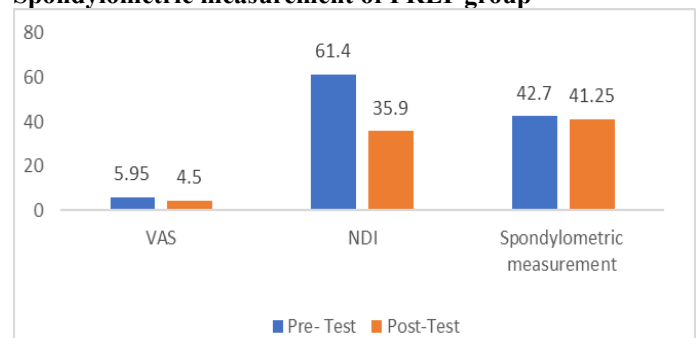
Graph. 4. Pre-test and Post-test values of VAS, NDI & Spondylometric measurement of PREP group.

Table 3. Comparison of Pre-test and Post- test values of CEP Group.

Variables		N	Mean	SD	Mean Difference	$'t'$ Value	'p' Value
VAS	Pre- test	20	5.95	±0.80	1.45	15.21	<0.001
	Post-test	20	4.50	±0.79			
NDI	Pre- test	20	61.40	±5.27	25.50	27.01	<0.001
	Post-test	20	35.90	±4.74			
SPONDYLOMETRIC MEASUREMENT	Pre- test	20	42.70	±1.03	1.45	12.70	<0.001
	Post-test	20	41.25	±1.25			

Table 3. Shows that pre- test and post-test values of VAS, NDI & Spondylometric measurements of CEP group. The mean value of VAS in pre-test was 5.95 with S.D of ±0.88 and post-test was 4.50 with S.D of ± 0.79. The mean difference between the pre and post-test score was found to be 1.45with 'p'-value of <0.001. The mean value of NDI in pre-test was 61.40 with S.D of ± 5.27 and post-test was 35.90 with S.D of ±4.74. The mean difference between the pre and post-test score was found to be 25.50 with 'p'-value of <0.001,. The mean value of spondylometric measurement in pre-test was 42.70 with S.D of ±1.03 and post-test was 41.25 with S.D of ± 1.25. The mean difference between the pre and post-test score was found to be 1.45 with 'p'-value of <0.001. The result of this paired student's $'t'$-test reported that there was significant difference in Pain level, Neck Disability Index & Spomdylometric measurements between the pre-test and post-test scores of CEP group.

**Graph. 5. Pre-test and Post-test values of VAS, NDI & Spondylometric measurement of PREP group**

Graph.5 shows that there was a reduction in pain intensity, disability level, in Spondylometric measurement in the post test; it was compared with the Pre-test of CEP group.

Table 4. Comparison of Post- test values of PREP Group & CEP Group.

Variables	Post –test	N	Mean	SD	Mean Difference	't' Value	'p' Value
VAS	PREP Group	20	3.17	±0.51	1.32	6.23	<0.001
	CEP Group	20	4.50	±0.79			
NDI	PREP Group	20	30.30	±3.06	5.60	4.43	<0.001
	CEP Group	20	35.90	±4.74			
SPONDYLOMETRIC MEASUREMENT	PREP Group	20	38.70	±0.86	2.55	7.49	<0.001
	CEP Group	20	41.25	±1.25			

Table 3. Shows that Post - test of VAS, NDI & Spondylometric measurements of PREP Group & CEP group. The Post- test mean value of VAS in PREP Group was 3.17 with S.D of ±0.51 and post-test mean value of VAS in CEP Group was 4.50 with S.D of ± 0.79. The mean difference between the post-test score PREP and CEP Group was found to be 1.32 with 'p'-value of <0.001. The Post- test mean value of NDI in PREP Group was 30.30 with S.D of ±3.06 and post-test mean value of NDI in CEP Group was 35.90 with S.D of ± 4.74. The mean difference between the post-test score PREP and CEP Group was found to be 5.60 with 'p'-value of <0.001. The Post- test mean value spondylometric measurement in PREP Group was 38.70 with S.D of ±0.86 and post-test mean value of spondylometric measurement in CEP Group was 41.25 with S.D of ± 1.25. The mean difference between the post-test score PREP and CEP Group was found to be 7.49 with 'p'-value of <0.001. The result of this unpaired student's 't'-test reported that there was significant difference in Pain level, Neck Disability Index & Spomdylometric measurements of post-test value of PREP Group & CEP group, but compared with the CEP group the PREP Group shows more significate results.

Graph 6. Comparison of Post- test values of PREP Group & CEP Group.
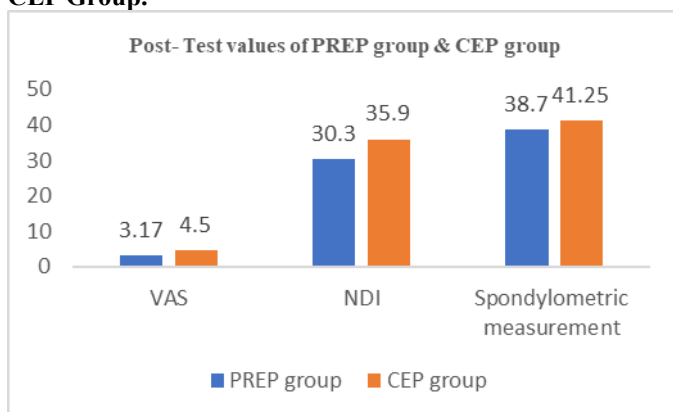
Graph.6 shows the comparison of post- test values of PREP group & CEP group. It shows the PREP group shows the more significant reduction of pain intensity, disability level and spondylometric measurement when it was compared with the CEP group.

DISCUSSION

The data analysis pre & post- test values of the participants within group and between the group, & correlation were done using Chi-squared test, Student 't' test and Pearson product moment correlation coefficient test.Studies showed that the prevalence of Neck pain, between 19-29 years of age, both males & females was increased along with smartphone addiction.[16]It's considered as the estimation and prevention of Text Neck Syndrome (TNS) among smartphone users reports to be 90% of people affected by neck related musculoskeletal problem by using mobile phones in non-ergonomic way.[17]

Results of this study showed that measured pain, disability and spondylometric measurement, in Postural Retraining Exercise Protocol (PREP) & Conventional Exercise Protocol (CEP) group had a statistically significant difference between pre-test & post- test values, it implies that though CEP showed improvement in pain, disability & cervical angle, the PREP group showed relatively larger ranges of improvements in pain, disability & cervical angle, thereby depicting that the Postural Retraining Exercise Protocol adopted to be beneficial than the Conventional Exercise Protocol.

The results demonstrated that the PREP can improve the movement patterns and the alignment of the head, shoulder & thoracic spine in people with TNS. It seems that improvement in scapular kinesis & alignment would be followed by improvement in neuromuscular force created by cognition and conscious control of the musculature after PREP. Cools, et al., 2007, noted that the improvements of corrective alignment of the head & spine during rehabilitation exercises, stating that this strategy of simultaneous correction of the posture should be noted in all of the phases of rehabilitation programme.

The efficacy of postural retraining exercise protocol used in this study had a significant effect on pain, disability and cervical angle among participants with Text Neck Syndrome. As it has been evident that maintaining the incorrect sitting posture for a longer time could causes the appearance & persistence of musculoskeletal disorder to the head, neck, shoulder & dorso-lumbo-sacral spine. During the Covid-19 pandemic, there was a shift from non-digital working to digital working. It became a usual routine for students to spend most of the time (nearly 8-12 hrs./day) attending online lectures, webinars, and meetings, in front of the computer or mobile screens. Because of our adjustment to a new normal life due to COVID-19 pandemic, continuous smartphone use lead to increased load on the cervical muscles and it was a major cause of Text Neck Syndrome. In the era of new normal, text neck syndrome is emerging as a public health threat globally. To combat the effects of smartphone overuse, during and post lockdown period, a structured exercise program is necessary. Smartphone use results in more head and neck flexion due to its relatively small size The postural deviations cause alterations in muscle activities and an increase in cervical load. There occurs increased activity of neck extensor

muscles and upper trapezius. Continuous use of a smartphone, when arms are unsupported, puts excess strain on the upper trapezius, reducing its pressure pain threshold. Besides, there occurs reduced activity in thoracic extensors and lower trapezius muscles.[18] Hence, these structured postural retraining exercise protocol have proved to be efficient as it is a mandatory need of the current time.

The ability or not of the neck muscles to sustain a contraction at low load (low percentage of an individual's maximal voluntary contraction), which is consistent with the daily postural demands of the muscles, has been of particular interest recently. Clinical research has demonstrated a significantly inferior performance of the cranio- cervical flexor muscles in maintaining sustained low loads in patients with Text Neck Syndrome.[19]Several authors have identified the important function of the deep neck flexor and extensor muscles of postural and segmental control.[20, 21] The Postural Retraining Exercise Protocol (PREP) thereby proves to be effective than the CEP protocol due to its muscle action and retraining strategies adapted.

This trial was conducted only on the college students for a, 4-week duration, and it shows that the intervention had a significant effect. Future studies are needed to find out the effectiveness of postural retraining exercises across various age groups. Further studies are recommended to determine the effectiveness of this postural retraining exercise programme on any other postural-related neck-specific conditions. This study mainly focused on exercise therapy program, while therapeutic modalities & other treatment techniques were not included in this study, so future studies along with any other treatment methods can be complementary.

CONCLUSION

Results of this study showed that Postural Retraining Exercise Protocol (PREP) & Conventional Exercise Protocol (CEP) group had a statistically significant difference between pre-test & post-test values of pain, disability & cervical angle. Compared with the CEP group, the PREP group showed relatively larger ranges of improvements in pain, disability & cervical angle, thereby depicting that the Postural Retraining Exercise Protocol adopted to be beneficial than the Conventional Exercise Protocol.

References

1. *Safiri, S., et al. (2020). Global, regional, and national burden of neck pain in the general population, 1990-2017: systematic analysis of the Global Burden of Disease Study 2017. BMJ, 368.*

2. *Genebra, C. V. D. S., Maciel, N. M., Bento, T. P. F., Simeão, S. F. A. P., & Vitta, A. D. (2017). Prevalence and factors associated with neck pain: a population-based study. Brazilian Journal of Physical Therapy, 21(4), 274-280. https://doi.org/10.1016/j.bjpt.2017.05.005.*

3. *Fiebert, I., Kistner, F., Gissendanner, C., & DaSilva, C. (2021). Text neck: An adverse postural phenomenon. Work (Reading, Mass.), 69(4), 1261-1270. https://doi.org/10.3233/WOR-213547.*

4. *Jain. D., Jawade, S., & Chitale, N. (2021). Effectiveness of Progressive Resisted Exercise along with Conventional Exercise and Conventional Exercise Program alone in Subjects with Text Neck Syndrome. Journal of Pharmaceutical Research International, 536-542. https://doi.org/10.9734/jpri/2021/v33i59b34412*

5. *Kumari, S., Kumar, R., & Sharma, D. (2021). Text Neck Syndrome: The Pain of Modern Era. International Journal of Health Sciences and Research, 11(11). https://doi.org/10.52403/ijhsr.20211121.*

6. *Ahmed, S., Akter, R., Pokhrel, N., & Samuel, A. J. (2019). Prevalence of text neck syndrome and SMS thumb among smartphone users in college-going students: a cross-sectional survey study. Journal of Public Health, 29(2), 411-416. https://doi.org/10.1007/s10389-019-01139-4.*

7. *Bae, W. S., Lee, H. O., Shin, J. W., & Lee, K. C. (2016). The effect of middle and lower trapezius strength exercises and levator scapulae and upper trapezius stretching exercises in upper crossed syndrome. Journal of Physical Therapy Science, 28(5), 1636-1639. https://doi.org/10.1589/jpts.28.1636*

8. *Bhavna, A., & Sharma, P. (2020). Association of hand performance with neck disability in text neck syndrome among college students. Indian journal of physiotherapy and occupational therapy, 14(4), 13-19.*

9. *Vijayakumar, M, Joshi, R., Chavan, R. M., & Shinde, S. A. (2018). Prevalence of Text Neck Syndrome in college students in Pune.Int J Bas Applied Res. 8(8), 1227.*

10. *Gracias, A. L. (2019). Prevalence of Neck Disability due to Text Neck in the population of Goa and its assessment using goniometer: A Cross sectional study among college students. Ind J Res. 8(3):57-9.*

11. *Arshadi. R., Ghasemi, G. A., & Samadi, H. (2019). Effects of an 8-week selective corrective exercises program on electromyography activity of scapular and neck muscles in persons with upper crossed syndrome: Randomized controlled trial. Physical Therapy in Sport, 37, 113-119. https://doi.org/10.1016/j.ptsp.2019.03.008*

12. *Bijur, P. E., Silver, W., & Gallagher, E. J. (2001). Reliability of the visual analog scale for measurement of acute pain. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine, 8(12), 1153–1157. https://doi.org/10.1111/j.1553-2712.2001.tb01132.*

13. *Young, I. A., Dunning, J., Butts, R., Mourad, F., & Cleland, J. A. (2018). Reliability, construct validity, and responsiveness of the neck disability index and numeric pain rating scale in patients with mechanical neck pain without upper extremity symptoms. Physiotherapy Theory and Practice, 35(12), 1328-1335. https://doi.org/10.1080/09593985.2018.1471763.*

14. *Twomey, L., & Taylor, J. (1979). A description of two new instruments for measuring the ranges of sagittal and horizontal plane motions in the lumbar region. The Australian journal of physiotherapy, 25(5),201-203. https://doi.org/10.1016/S0004-9514(14)61042-4.*

15. *Alpayci, M., & İlter, S. (2017). Isometric Exercise for the Cervical Extensors Can Help Restore Physiological Lordosis and Reduce Neck Pain. American Journal of Physical Medicine & Rehabilitation, 96(9), 621-626. https://doi.org/10.1097/phm.0000000000000698*

16. *Rashid, M. K., Ali Jadoo, S. A., Al- Hussainy, A. D., & Latif, I. B. (2022). Prevalence of text neck syndrome among Iraqi medical students: a cross-sectional study. Journal of Ideas in Health. 5 (1), 693-699.*

17. *Kamalakannan, M., Rakshana, R., & Padma priya, R. (2020). Estimation and prevention of text neck syndrome among smart phone users. Biomedicine, 40(3), 372-376. https://doi.org/10.51248/.v40i3.30.*

18. *Binoy Mathew, & Mary Elizabeth Tidiya Walarine. (2020). Neck pain among smartphone users: an imminent public health issue during the pandemic time -Journal of Ideas in Health , 3(Special 1), 201-204.*

19. *Juil, G., Barrett, C., Magee, R., & Ho, P. (1999). Further clinical clarification of the muscle dysfunction in cervical headache. Cephalalgia: an international journal of headache, 19(3), 179-185. https://doi.org/10.1046/j.1468-2982.1999.1903179.*

20. *Mayoux-Benhamou, M. A., Revel, M., Vallee, C., Roudier, R., Barbet, J. P., & Bargy, F. (1994). Longus colli has a postural function on cervical curvature. Surgical and radiologic anatomy: SRA, 16(4), 367-371. https://doi.org/10.1007/BF01627655.*

21. *Vitti, M., Fujiwara, M., Basmanjian, J. M., & Iida, M. (1973). The integrated roles of longus colli and sternocleidomastoid muscles: an electromyographic study. The Anatomical record, 177(4), 471-484. https://doi.org/10.1002/ar.1091770402.*