LGJDX
ISSN No: 1008-0562
Journal Of Liaoning Technical University
Natural Science Edition

EFFECT OF PAIN NEUROSCIENCE EDUCATION WITH CONSERVATIVE TREATMENT IN FEMALE STUDENTS WITH FORWARD HEAD POSTURE

Saba Noreen
The University of Faisalabad
Orcid id: 0009-0002-8224-2611

Dr. Marium Zafar
The University of Faisalabad
Orcid id: 0000-0003-4235-9858

Ruhma Tariq
The University of Faisalabad
Orcid id: 0009-0000-9515-4384

Hira Razaqat
University of Faisalabad

Dr Maria Sajid
STMU PRC ISD
Orcid id: 0009-0003-9050-5319

Dr. Hifza Riaz
Riphah International University
Orcid id : 0009-0004-6409-9780

Ahsan Taqweem
Riphah International University, Lahore Campus

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

ABSTRACT

Background : Pain neuroscience education is an educational approach aimed at helping individuals better understand the complex nature of pain. A frequent postural distortion known as "forward head posture," or FHP, occurs when the head is positioned forward relative to the spine and shoulders .Effect of PNE to FHP, individuals may develop a more accurate understanding of the pain associated with forward head posture.

Objective : To determine the effect of pain neuroscience education with conservative treatment in female students with forward head posture

Method :A randomized clinical trial was conducted from the university of Faisalabad allied health sciences campus. Participants was randomly allocated by probability simple sampling techniques in two groups. Group A was the study group. Patient in this group was received conservative treatment of forward head posture with pain neuroscience education. As baseline treatment was applied TENS, isometrics, self-stretching, hot packs.Group B was the control group and receive only baseline treatment. For six weeks, both groups acquired the intervention twice a week. Version 25 of SPSS was employed for statistical analysis.

Results :Craniovertebral angle in pretreatment with mean ±SD of group A (44.100±3.805), group B (41.771±5.2809). Following therapy, there were notable differences (p=0.009) between the groups, with group A's mean ±SD being 51.092 ±4.992 and group B's being 45.542 ±5.444.Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001).Showed significant improvement in cervical flexion ,extension lateral bending right and left rotation with significant p value (<.001) both groups.

Conclusion : Study's findings suggest that pain neuroscience education, in conjunction with conservative therapy, produces positive results for female students who exhibit forward head posture.

Keywords: Conservative treatment, forward head posture, Pain neuroscience education

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

INTRODUCTION

PNE, or pain neuroscience education, aims to inform patients about the physiological and biochemical causes of pain. Subsequently, "Even with the discomfort, goal-setting, pacing, and gradually increasing movement exposure will boost the patient's engagement and help them regain function and a better quality of life." PNE has been referred to by a number of titles, such is instruction on pain biology, pain neurophysiology, and neuroscience (1).

The debate over whether PNE should be applied in a "hands-on" or "hands-off" manner is the last topic pertaining to its application. Regretfully, a lot of therapists with only a passing familiarity with PNE perceive it exclusively in sharp contrast to movement techniques like exercise and manual therapy, which maintain that a patient in pain has to get either manual treatment or exercise, as an educational and cognitive enforcement, or a cognitive intervention like PNE (2). When paired with other therapeutic modalities PNE has been demonstrated to be helpful in the treatment of pain. It should thus be included in the pain treatment regimens that physiotherapists use. Furthermore, the demand for its application in routine clinical practice is growing as a result of the advancements achieved in our understanding of pain neurobiology (3). PNE is utilized in combination with manual therapy, neural mobilization, and exercise treatments.Right now, there are differing views on the precise quantity, frequency, and nature of a PNE intervention (4). In the scientific literature, pain neuroscience education, or PNE, is gaining popularity. the understanding that long-term MSK pain is not only a temporal continuation of acute pain, but rather a self-sustaining maladaptive neuronal response has provided the basis for this educational paradigm from a strictly biopsychosocial perspective.(5, 6).

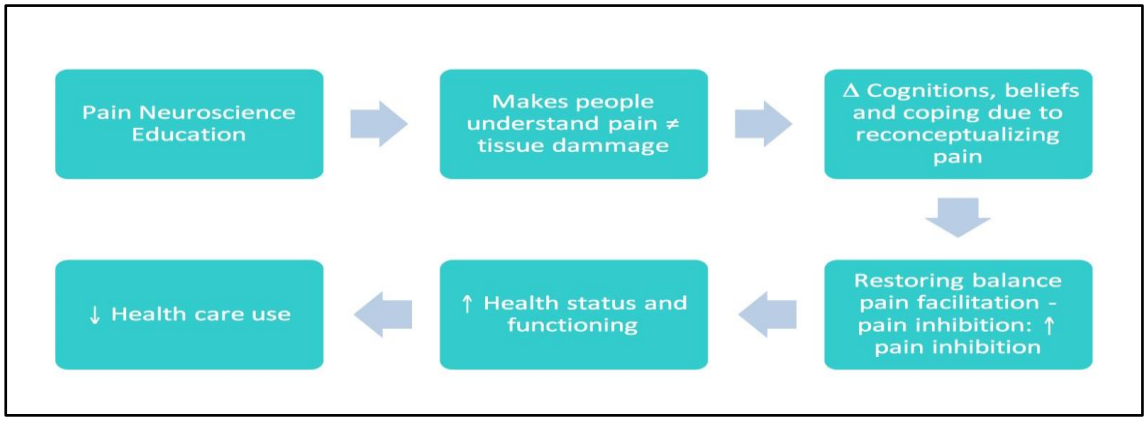

Figure 1 Pain Neuroscience Education

The biopsychosocial approach is becoming more and more important in pain neuroscience teaching. Seeks to educate patients on the molecular and physiological aspects of their pain experience. Louis Gifford, a former biologist who became a physical therapist, is credited for using PNE as a pain reliever for the first time in history at the 1999 International Association on the Study of Pain meeting in Austria. (7).

Conversely, forward head posture (FHP) is regarded as by an elevated cervical spine tilt and an excessive anterior head position in relation to a vertical reference line.

Defying optimum head posture most often is "forward head posture," which is defined as the head pushing forward into the sagittal plane such that it is in front of the trunk. (8).Head movement too far forward in respect to the body's vertical axis can lead to a frequent postural aberration called forward head posture (FHP), which accentuates the lordosis of the cervical spine. (9) It was discovered that 63.96% of people both male and female, had a forward head position.(10, 11) The forward-leaning head position not only causes in painful necks and unbalanced muscles, in addition involving signs and symptoms including numbness, tingling in the hands and arms, muscular spasms, teeth clenching, pinched nerves, exhaustion, limited range of motion, temporomandibular joint dysfunction, headaches, migraines, and myofascial pain syndrome living with these symptoms makes it challenging to carry out regular tasks.(12)

For example, a survey of university students in Pakistan revealed that 63.96% of them had FHP, whereas a study of dental professionals indicated that 85.5% of them reported having FHP. In a different research, Sixty-six percent of individuals in good health, aged 20 to 60, reported having forward head posture. According to several studies carried out in various nations, prevalence rates in the general population might range from 30% to 70%, depending on variables including age, employment, and lifestyle choices. Students exhibited a 73% frequency of forward head position.(13) Women are more likely than males to have forward head position (24.1%) compared to 9.1%.(14)

Research indicates that PNE, which dispels myths and teaches people about pain processes, may have positive impacts on FHP. According to one study, teenagers with neck discomfort who had PNE had noticeably lower FHP than those who didn't.(15) More investigation needs to be conducted to validate PNE's long-term usefulness and determine the best implementation tactics, even if these studies indicate a good effect on FHP.(16) There are a number of plausible paths that have been suggested based on current research, however the precise processes through which Pain Neuroscience Education (PNE) could affect Forward Head Posture (FHP) are not clear yet. (17) People may be more likely to adjust their head posture and lower their FHP if knowledge and comprehension of ideal posture and movement patterns are promoted. (17)

LGJDX
ISSN No: 1008-0562
Journal Of Liaoning Technical University
Natural Science Edition

MATERIALS AND METHODS

A randomized clinical trial was conducted by forming two comparable groups from the selected sample naming Group A and Group B. Group A received pain neuroscience education and group B was control group.The study was carried out at the Faisalabad University.Study ran march 2024 to july 2024 . A sample size of 28 taken from the university of faisalabad calculated through Epitool

Sample Size For Comparing Two Means

Input Data

Confidence Interval (2-sided)	95%
Power	80%
Ratio of sample size (Group 2/Group 1)	1

	Group 1	Group 2	Difference*
Mean	68	76	-8
Standard deviation	5.01	9.35	
Variance	25.1001	87.4225	

Sample size of Group 1	14
Sample size of Group 2	14
Total sample size	28

Figure 2 :Sample Size Calculation through Open-EPI

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

non-probability purposive sampling technique used.Age 18 to 25 years female ,craniovertebral angle less than 50 degrees, Pain (mild to moderate) were included .Females with cervical stenosis ,History of shoulder and spine surgery ,Respiratory disease and joint disease ,Cervical redculopathy and Females with spinal deferomities were excluded. Cervical pain assessment through Numeric pain rating scale.Forward head posture through Craniovertebral angle Cervical Range of motion measure using goniometer.2 intervention were made Group A :Patient in this group received conservative treatment with pain neuroscience education.As baseline treatment was applied, isometrics, self streatching, hot packs.Group B was the control group TENS, isometrics, self streatching, hot packs. and receive only baseline treatment.Both groups was receive d intervention 2 times per week for 6 weeks. Pre readings was taken before the starting of intervention. Post treatment reading was taken between 5 to 6th weeks. Data was analyzed through SPSS 27.The rules and the regulations set by the ethical committee of The University of Faisalabad were followed

RESULTS

Table 1: Mean ±SD of Age of the Students

	Treatment Groups				Total	
	Group A		Group B			
	N	Mean ±SD	N	Mean ±SD	N	Mean ±SD
Age of Patient	14	21.785±1.050	14	20.928±1.384	28	21.357±1.282

Table show mean and SD of age of students in group A (21.785±1.050) and in group B (20.928±1.384).

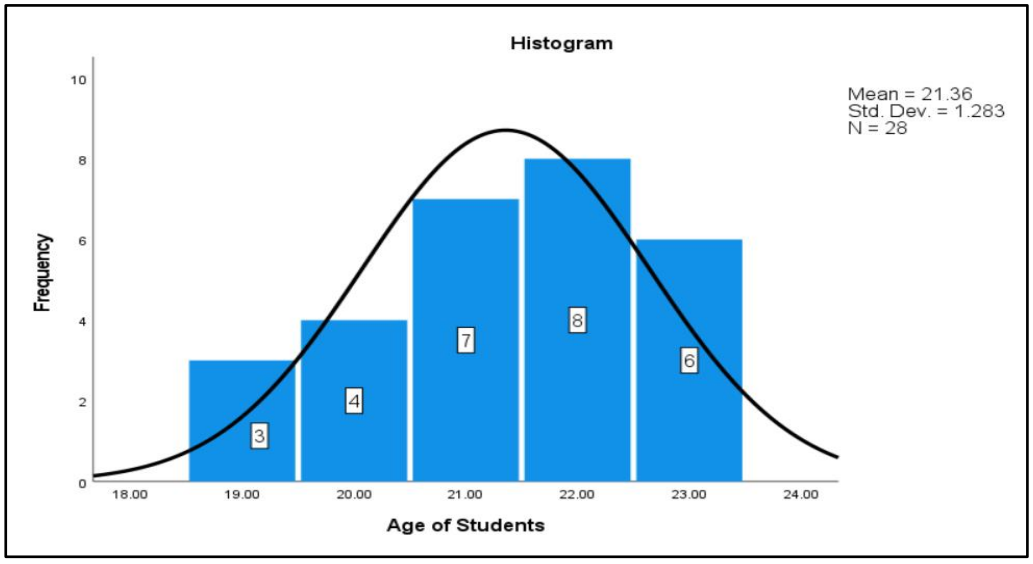

Figure 3: Histogram of the age of the students

Histogram of age of the students show N=28 with mean 21.36 and SD 1.283.

Independent sample t test was applied for between groups comparison. There were non-significant differences (p=0.094) between groups in revised neurophysiology pain questionnaire in pretreatment with mean ±SD of group A (7.500±1.400), group B (6.428±1.827). There were significant differences (p=0.014) between groups in post treatment with mean ±SD of group A (10.142 ±1.511), group B (8.500±1.786) .There were non-significant differences (p=0.272) between groups in cervical flexion in pretreatment with mean ±SD of group A (46.428±8.016), group B (49.714±7.477). There were significant differences (p=0.017) between groups in post treatment with mean ±SD of group A (75.357 ±9.499), group B (65.928±10.125). There were non-significant differences (p=0.293) between groups in cervical extension in pretreatment with mean ±SD of group A (38.500±8.131), group B (41.714±7.720). There were significant differences (p=0.005) between groups in post treatment with mean ±SD of group A (65.071 ±5.889), group B (56.785±8.229). There were non-significant differences (p=0.781) between groups in Cervical right rotation in pretreatment with mean ±SD of group A (49.642±6.923), group B (48.857±7.862). There were significant differences (p=0.006) between groups in post treatment with mean ±SD of group A (62.142 ±6.712), group B (53.928±7.640). There were non-significant differences (p=0.211) between groups in cervical left rotation in pretreatment with mean ±SD of group A (49.642±6.923), group B (44.500±13.171). There were significant differences (p=0.002) between groups in post treatment with mean ±SD of group A (72.571±9.378), group B (58.571±11.998). There were non-significant differences (p=0.240) between groups in cervical right lateral bending in pretreatment with mean ±SD of group A (6.2428±2.344), group B (7.857±3.779). There were significant differences (p=0.009) between groups in post treatment with mean ±SD of group A (31.428 ±3.056), group B (25.357±7.458). There were non-significant differences (p=0.177) between groups in cervical left lateral bending in pretreatment with mean ±SD of group A (6.428±2.344), group B (8.214±4.209). There were significant differences (p=0.004) between groups in post treatment with mean ±SD of group A (30.000±6.793), group B (21.428±7.449).Paired sample t test was applied for within group difference. Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001).

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

Table 2: Independent sample t test Between groups comparison of NPRS , Craniovertebral Angle and RNPQ at Pre and Post treatment

		Treatment Groups			Independent Sample T-test	
			Group A	Group B		
Outcome Measure	**Assessment**	**N**	**Mean ±SD**	**Mean ±SD**	**Mean Difference**	**P value**
NPRS	Pre Treatment	14	5.285±1.138	5.142±1.406	.142	.770
	Post Treatment	12	2.642±1.215	3.785±1.251	-1.142	.021
Craniovertebral Angle	Pre Treatment	14	44.100±3.805	41.771±5.280	2.328	.192
	Post Treatment	12	51.092±4.992	45.542±5.444	5.550	.009
RNPQ	Pre Treatment	14	7.500±1.400	6.428±1.827	1.071	.094
	Post Treatment	12	10.142±1.511	8.500±1.786	1.642	.014

Table 3: Independent sample t test Between groups comparison of Cervical ROM at Pre and Post treatment

		Treatment Groups			Independent Sample T-test	
			Group A	Group B		
Outcome Measure	**Assessment**	**N**	**Mean ±SD**	**Mean ±SD**	**Mean Difference**	**P value**
Cervical Flexion	Pre Treatment	14	46.428±8.016	49.714±7.477	-3.28571	.272
	Post Treatment	12	75.357±9.499	65.928±10.125	9.42857	.017
Cervical Extension	Pre Treatment	14	38.500±8.131	41.714±7.720	-3.21429	.293
	Post Treatment	12	65.071±5.889	56.785±8.229	8.28571	.005
Cervical Right Rotation	Pre Treatment	14	49.642±6.923	48.857±7.862	.785	.781
	Post Treatment	12	62.142±6.712	53.928±7.640	8.214	.006
Cervical Left Rotation	Pre Treatment	14	49.642±6.923	44.500±13.171	5.142	.211
	Post Treatment	12	72.571±9.378	58.571±11.998	14.000	.002
Cervical right lateral bending	Pre Treatment	14	6.428±2.344	7.857±3.779	-1.428	.240
	Post Treatment	12	31.428±3.056	25.357±7.458	6.071	.009
Cervical Left lateral bending	Pre Treatment	14	6.428±2.344	8.214±4.209	-1.785	.177
	Post Treatment	12	30.000±6.793	21.428±7.449	8.571	.004

Paired sample t test was applied for within group difference. Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001). Paired sample t test was applied for within group difference. In Group A paired difference of cervical flexion is (28.928) with significant p value (<.001), in Group B (16.214) with significant p value (<.001). In Group A paired difference of cervical extension is (26.571) with significant p value (<.001), in Group B (15.071) with significant p value (<.001). Paired sample t test was applied for within group difference. In Group A paired difference of cervical right rotation is (12.500) with significant p value (<.001), in Group B (5.071) with significant p value (.002). In Group A paired difference of cervical left rotation is (22.928) with significant p value (<.001), in Group B (14.074) with significant p value (<.001). Paired sample t test was applied for within group difference. In Group A paired difference of cervical right lateral bending is (25.000) with significant p value (.001), in Group B (171.500) with significant p value (.001). In Group A paired difference of cervical left lateral bending is (23.571) with significant p value (.001), in Group B (13.214) with significant p value (.001).

Table 4: Paired sample t test Within group comparison of Numeric Pain Rating Scale, Craniovertebral Angle and RNPQ

Outcome	Groups	Assessments						Paired Difference	P value
		Pre Treatment			Post Treatment				
		N	Mean	SD	N	Mean	SD		
NPRS	Group A	14	5.285	1.138	12	2.642	1.215	-2.642	<.001
	Group B	14	5.142	1.406	12	3.785	1.251	-1.357	<.001
Craniovertebral Angle	Group A	14	44.100	3.805	12	51.092	4.992	6.992	<.001
	Group B	14	41.771	5.280	12	45.542	5.444	3.771	<.001
RNPQ	Group A	14	7.500	1.400	10.142	1.511	2.642	7.500	<.001
	Group B	14	6.428	1.827	8.500	1.786	2.071	6.428	<.001

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

Table 5: Paired sample t test Within group comparison of Cervical flexion , Extension, Right Rotation, Cervical Left Rotation, Right lateral bending and Left lateral bending

Outcome	Groups	Assessments				Paired Difference	P value
		Pre Treatment		Post Treatment			
		Mean	SD	Mean	SD		
Cervical Flexion	Group A	46.428	8.016	75.357	9.499	28.928	<.001
	Group B	49.714	7.477	65.928	10.125	16.214	<.001
Cervical Extension	Group A	38.500	8.131	65.071	5.889	26.571	<.001
	Group B	41.714	7.720	56.785	8.229	15.071	<.001
Cervical Right Rotation	Group A	49.642	6.923	62.142	6.712	12.500	<.001
	Group B	48.857	7.862	53.928	7.640	5.071	.002
Cervical Left Rotation	Group A	49.642	6.923	72.571	9.378	22.928	<.001
	Group B	44.500	13.171	58.571	11.998	14.074	<.001
Cervical Right lateral bending	Group A	6.428	2.344	31.428	3.056	25.000	.001
	Group B	7.857	3.779	25.357	7.458	17.500	.001
Cervical Left lateral bending	Group A	6.428	2.344	30.000	6.793	23.571	.001
	Group B	8.214	4.209	21.428	7.449	13.214	.001

LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

DISCUSSION

Current study showed there were non-significant differences (p=0.770) between groups in numeric pain rating scale in pretreatment with mean ±SD of group A (5.285±1.138), group B (5.142±1.406). There were significant differences (p=0.021) between groups in post treatment with mean ±SD of group A (2.642 ±1.215), group B (3.785±1.251). There were non-significant differences (p=0.192) between groups in Craniovertebral angle in pretreatment with mean ±SD of group A (44.100±3.805), group B (41.771±5.2809). There were significant differences (p=0.009) between groups in post treatment with mean ±SD of group A (51.092 ±4.992), group B (45.542±5.444).

Watson JA et al. systematic analysis showed individuals with chronic musculoskeletal illnesses responded better to PNE in conjunction with other therapies when it came to pain intensity, disability, and pain catastrophizing these results were accordance to current results showed PNE with conservative treatments group showed better results as compare group had only conservative treatments There were significant differences (p=0.009) between groups in post treatment with mean ±SD of group A (51.092 ±4.992), group B (45.542±5.444). (18)

A comprehensive evaluation on whether PNE decreased pain intensity was carried out by Lin LH et al. in 2024. Subgroup analysis showed that following PNE, the adult group had a substantial reduction in pain. Additionally, PNE decreased kinesiophobia, as determined p = 0.003 these results were compatible to current research results showed there were non-significant differences (p=0.770) between groups in numeric pain rating scale in pretreatment with mean ±SD of group A (5.285±1.138), group B (5.142±1.406). (19)

Zimney et al.2014 carried out a case study on workplace accidents resulting in acute low back pain (LBP). It has been demonstrated that Therapeutic Neuroscience Education (TNE) is helpful in altering a patient's perception of their pain condition, which may lessen catastrophizing, dread, and anxiety, the Numeric Pain Rating Scale (NRPS), the Oswestry Disability Index (20), the The patient completed all outcome questionnaires with a zero at the time of discharge, indicating that they were pain-free and able to resume full employment these fndngs were compareable to current study results showed. Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001). Paired sample t test was applied for within group difference. Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001). Paired sample t test was applied for within group difference. Group A paired difference of numeric pain rating scale is (-2.642) with significant p value (<.001), in Group B (-1.357) with significant p value (<.001). (21)

Louw A, et al. (2016) did a comprehensive review to find out how effective (PNE) pain neuroscience education is aimed at individuals with prolonged musculoskeletal (MSK) discomfort, function, disability, psychosocial aspects, mobility, and healthcare According to the conclusions, PNE is advised for long-term MSK disorders because of its capacity to alleviate pain and enhance patient awareness of it, enhance function

and diminish disability, minimize psychosocial factors, enhance range of motion, and reduce the need for medical intervention. Current research backs up the aforementioned benefits there were non-significant differences (p=0.770) between groups in numeric pain rating scale in pretreatment with mean ±SD of group A (5.285±1.138), group B (5.142±1.406) and There were non-significant differences (p=0.094) between groups in revised neurophysiology pain questionnaire in pretreatment with mean ±SD of group A (7.500±1.400), group B (6.428±1.827). There were significant differences (p=0.014) between groups in post treatment with mean ±SD of group A (10.142 ±1.511), group B (8.500±1.786) (4).

RCT 2019 by Rufa A, et al. effect of PNE on persistent pain from musculoskeletal issues, which corresponds to a worse life quality and impaired mobility In summary, PNE is a feasible and potentially efficient therapy for persistent pain There were non-significant differences (p=0.094) between groups in revised neurophysiology pain questionnaire in pretreatment with mean ±SD of group A (7.500±1.400), group B (6.428±1.827). There were significant differences (p=0.014) between groups in post treatment with mean ±SD of group A (10.142 ±1.511), group B (8.500±1.786)(22).

An RCT was conducted in 2017 by Rosa Andias et al. To examine the efficacy of neck/shoulder exercises and (PNE) pain neuroscience education with respect to no treatment for teenagers suffering from persistent(CINP) idiopathic neck pain . The results suggest that PNE and exercise may be beneficial for youngsters with CINP There were non-significant differences (p=0.094) between groups in revised neurophysiology pain questionnaire in pretreatment with mean ±SD of group A (7.500±1.400), group B (6.428±1.827). There were significant differences (p=0.014) between groups in post treatment with mean ±SD of group A (10.142 ±1.511), group B (8.500±1.786)(15)

A systematic review done in 2022 by Siddall B et al .both physical activity and pain neuroscience education (PNE) have been investigated as stand-alone therapies for persistent pain in the musculoskeletal system. According to these research, PNE in addition to exercise may offer greater immediate advantages than exercise alone in terms of pain, pain catastrophizing, disability and kinesiophobia There were non-significant differences (p=0.094) between groups in revised neurophysiology pain questionnaire in pretreatment with mean ±SD of group A (7.500±1.400), group B (6.428±1.827). There were significant differences (p=0.014) between groups in post treatment with mean ±SD of group A (10.142 ±1.511), group B (8.500±1.786) . (23)

CONCLUSION

Ultimately, the results of this investigation indicate that pain neuroscience education, in conjunction with conservative therapy, produces positive results for female students who exhibit forward head position. Both posture and pain perception showed substantial improvements when a complete approach integrating conservative therapies with educational components focused on pain neuroscience is used.

REFERENCE

1. King R, Robinson V, Ryan CG, Martin DJ. An exploration of the extent and nature of reconceptualisation of pain following pain neurophysiology education: A qualitative study of experiences of people with chronic musculoskeletal pain. Patient Education and Counseling. 2016;99(8):1389-93.
2. Louw A, Puentedura EJ, Zimney K, Schmidt S. Know pain, know gain? A perspective on pain neuroscience education in physical therapy. journal of orthopaedic & sports physical therapy. 2016;46(3):131-4.
3. Heggannavar A, Deshmukh S. Knowledge, attitude, and practice of pain neuroscience education among physiotherapists: A cross-sectional survey. BLDE University Journal of Health Sciences. 2023;8.
4. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: a systematic review of the literature. Physiotherapy theory and practice. 2016;32(5):332-55.
5. Barbari V, Storari L, Maselli F, Testa M. Applicability of pain neuroscience education: Where are we now? Journal of Back and Musculoskeletal Rehabilitation. 2021;34(4):511-20.
6. Moseley GL, Butler DS. Fifteen years of explaining pain: the past, present, and future. The Journal of Pain. 2015;16(9):807-13.
7. Clarke CL, Ryan CG, Martin DJ. Pain neurophysiology education for the management of individuals with chronic low back pain: A systematic review and meta-analysis. Manual therapy. 2011;16(6):544-9.
8. Silva AG, Johnson MI. Does forward head posture affect postural control in human healthy volunteers? Gait & posture. 2013;38(2):352-3.
9. Harman K, Hubley-Kozey CL, Butler H. Effectiveness of an exercise program to improve forward head posture in normal adults: a randomized, controlled 10-week trial. Journal of Manual & Manipulative Therapy. 2005;13(3):163-76.
10. Naz A, Bashir MS, Noor R. Prevalance of forward head posture among university students. Rawal Med J. 2018;43(2):260-2.
11. Lee J-H. Effects of forward head posture on static and dynamic balance control. Journal of physical therapy science. 2016;28(1):274-7.
12. Lee M-Y, Lee H-Y, Yong M-S. Characteristics of cervical position sense in subjects with forward head posture. Journal of physical therapy science. 2014;26(11):1741-3.
13. Singh S, Kaushal K, Jasrotia S. Prevalence of forward head posture and its impact on the activity of daily living among students of Adesh University–A cross-sectional study. Adesh University Journal of Medical Sciences & Research. 2020;2(2):99-102.
14. Wiguna NP, Wahyuni N, Indrayani AW, Wibawa A, Thanaya SAP. The relationship between smartphone addiction and forward head posture in junior high school students in north Denpasar. Jurnal Epidemiologi Kesehatan Komunitas. 2019;4(2):84-9.
15. Andias R, Neto M, Silva AG. The effects of pain neuroscience education and exercise on pain, muscle endurance, catastrophizing and anxiety in adolescents with chronic idiopathic

neck pain: a school-based pilot, randomized and controlled study. Physiotherapy theory and practice. 2018;34(9):682-91.
16. de Almeida Tolentino G, Lima Florencio L, Ferreira Pinheiro C, Dach F, Fernández-de-Las-Peñas C, Bevilaqua-Grossi D. Effects of combining manual therapy, neck muscle exercises, and therapeutic pain neuroscience education in patients with migraine: a study protocol for a randomized clinical trial. BMC neurology. 2021;21:1-11.
17. Gupta A, Kumar S, Rishi P. Effect of aerobic exercises and therapeutic pain neuroscience education on disability, pain, head posture and QOL in migraine patients. Comparative Exercise Physiology. 2023;19(2):119-26.
18. Watson JA, Ryan CG, Cooper L, Ellington D, Whittle R, Lavender M, et al. Pain neuroscience education for adults with chronic musculoskeletal pain: a mixed-methods systematic review and meta-analysis. The journal of pain. 2019;20(10):1140. e1-. e22.
19. Lin LH, Lin TY, Chang KV, Wu WT, Özçakar L. Pain neuroscience education for reducing pain and kinesiophobia in patients with chronic neck pain: a systematic review and meta-analysis of randomized controlled trials. European Journal of Pain. 2024;28(2):231-43.
20. Dakic JG, Hay-Smith J, Cook J, Lin K-Y, Calo M, Frawley H. Effect of pelvic floor symptoms on women's participation in exercise: a mixed-methods systematic review with meta-analysis. Journal of Orthopaedic & Sports Physical Therapy. 2021;51(7):345-61.
21. Zimney K, Louw A, Puentedura EJ. Use of Therapeutic Neuroscience Education to address psychosocial factors associated with acute low back pain: a case report. Physiotherapy theory and practice. 2014;30(3):202-9.
22. Rufa A, Beissner K, Dolphin M. The use of pain neuroscience education in older adults with chronic back and/or lower extremity pain. Physiotherapy theory and practice. 2019;35(7):603-13.
23. Siddall B, Ram A, Jones MD, Booth J, Perriman D, Summers SJ. Short-term impact of combining pain neuroscience education with exercise for chronic musculoskeletal pain: a systematic review and meta-analysis. Pain. 2022;163(1):e20-e30.