



# Effects of Muscle Energy Technique and Neck Stabilization Exercises on Pain, Psychological Status, and Sleep Disturbance in Patients with Non-Specific Chronic Neck Pain

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## Abstract

**Background:** Neck pain is one of the most common and painful musculoskeletal conditions. It is a problem in societies probably due to the widespread use of electronic gadgets such as computers, mobile phones, and tablets. It causes pain, functional disability, depression, and sleep disturbances. Therapeutic exercises have been known to be one of the major interventions to improve chronic neck pain.

**Objectives:** This randomized controlled study aimed to compare the efficacy of muscle energy technique (MET) and neck stabilization exercise (NSE) on pain, neck disability, depression, anxiety, and sleep disturbance in patients with non-specific chronic neck pain (NSCNP).

**Methods:** Thirty-five participants participated in this study. They were recruited from two hospitals in Lagos state and randomly assigned into 3 groups using computer-generated random number sequence. Group 1 (n = 12) received MET, neck care education (NCE), and infra-red radiation (IR), group 2 (n = 12) received NSE, neck care education (NCE), and IR, and group 3 (n = 11) received NCE and IR. Assessment of pain, neck disability, depression, anxiety, and sleep disturbance were done using numerical pain rating scale (NPRS), neck disability index (NDI), hospital anxiety depression scale (HADS) and Insomnia severity index (ISI) at baseline, end of 4 weeks and 8 weeks post-intervention. This study lasted for a period of 5 months (May - September, 2017).

**Results:** The participants in the 3 groups (MET+NCE+IR, NSE+NCE+IR, NCE+IR) indicated significant improvement in all the outcome parameters; pain (P = 0.001, 0.001, 0.001, respectively), disability (P = 0.002, P = 0.002, P = 0.003, respectively), depression (P = 0.02, 0.002, 0.003, respectively), anxiety (P = 0.01, P = 0.002, P = 0.03, respectively), and sleep disturbance (P = 0.01, P = 0.002, P = 0.01, respectively) post-intervention. Significant differences were observed in all outcome parameters except for depression (P = 0.456) and anxiety (P = 0.179) when across group comparisons were performed.

**Conclusions:** Muscle energy technique and neck stabilization exercises and neck care are all effective in managing pain, neck disability, depression, anxiety, and sleep disturbance in NSCNP patients, but neck stabilization exercises have a better effect than a muscle energy technique.

**Keywords:** Muscle Energy Technique, Exercise, Patients, Chronic Neck Pain

## 1. Background

Neck pain (NP) is a widespread and painful musculoskeletal disorder (1). Chronic neck pain (CNP) represents the bulk of the public health conditions such as poor psychological health, including cognitive distress, anxiety, and depressed mood (2), sleep disturbance (3) resulting in loss of work output at all levels (4). Neck pain is one of the key causes of disability worldwide and it was concluded that stakeholders in a clinical setting, government members, and health researchers need to focus more on the treatment of neck disability (5). Despite the predom-

inance of neck pain, there is a paucity of research on the frequently used therapy (6).

A previous study showed that neck stabilization exercises (NSE) decreased pain and disability in patients with neck pain (7). There is a greater amount of proof on the efficacy of muscle energy technique (MET) in chronic pain condition (8). In spite of the recognition of stabilization exercise in the management of spine and pelvic dysfunction (9), there is a paucity of properly planned intervention studies to determine its effectiveness. The MET is a type of soft-tissue manipulation that uses isometric con-

traction before subsequent stretching or movement of restricted tissues (10). The mode of operation of MET was attributed to either post-isometric relaxation (PIR), which has an effect on the tissues that were isometrically contracted, or reciprocal inhibition (RI), which affects the antagonists to the tissues that have undergone contraction. It was reported that PIR and RI partially explain the benefits of MET (11), which are relatively pain-free joint and soft tissue motion after mild isometric contractions (12). The NSE is a form of a rehabilitation program that was developed for the purpose of relieving pain, improving function, preventing further injury (13) as well as improving the innate mechanisms by which the cervical spine keep up a stable and injury-free state (14).

Presently there are only limited published evidence-based researches to support their usefulness. A reduction in the function of the deep cervical flexor can result in a compensatory rise in activities of the superficial muscles around the neck and shoulder girdle, as well as muscle fatigue under sustained low loads (15). There is a lot of information that poor psychological health, including cognitive distress, anxiety and depression, loss of employment and reduction of income, and increased stress are associated with CNP (2). Artner et al. (3), in a study on the prevalence of sleep deprivation in CNP concluded that sleep disturbance should be assessed when patients with CNP are under treatment. There is also limited studies comparing MET and NSE in NSCNP patients with a wide range of interventions to manage neck pain with lack of effectiveness in some of them.

## 2. Objectives

This study compared the effects of MET and NSE on pain, neck disability, depression, anxiety, and sleep disturbance of patients with NSCNP.

## 3. Methods

This study is a single-blinded randomized controlled trial comprising thirty-five patients with NSCNP. They were recruited from the general out-patient department and physiotherapy department of 2 tertiary hospitals in Lagos state Nigeria. Inclusion criteria were the participants with a recurrent history of NSCNP of more than 3 months without any specific condition detected as the primary reason for the complaint, with pain level greater than or equals to 5/10. The participants with the previous history of spinal surgery, history of trauma to the neck, spinal deformity, and specific neck pain as a result of malignancy, narcotic drugs, and a previous history of physiotherapy intervention were excluded from the study.

### 3.1. Procedure

Participants' physical characteristics, including age, sex, occupation, height, and weight were recorded before commencing the study. Baseline assessment of pain, neck disability, depression, anxiety, and sleep disturbance was done using numerical pain rating scale (NPRS), neck disability index (NDI), hospital anxiety depression scale (HADS), and insomnia severity index (ISI), respectively. Informed written consent was obtained from the participants while ethical approval was obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital, Nigeria with approval number (ADM/DST/HREC/APP/1535).

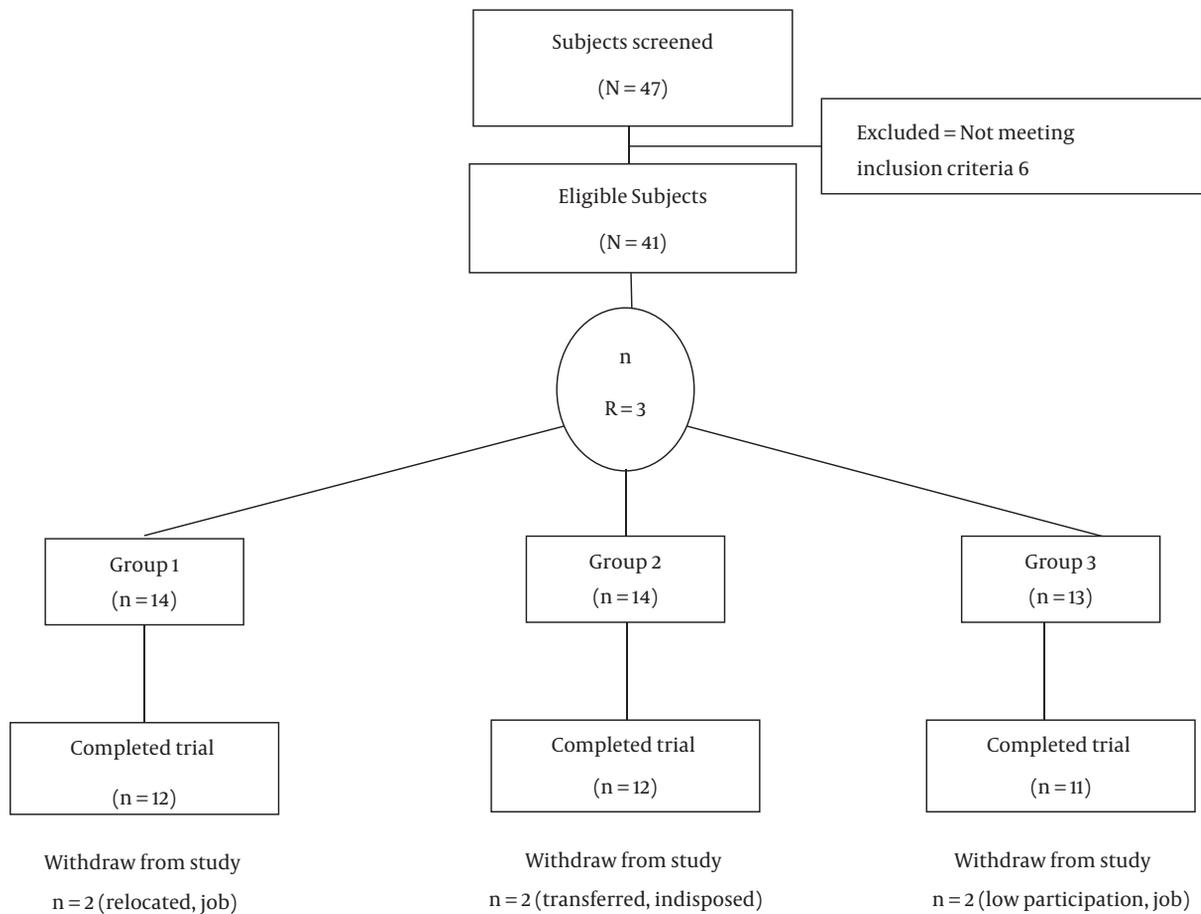
Out of the 47 participants screened for this study, 6 were found ineligible regarding the inclusion criteria and were excluded from the study. The 41 eligible participants were randomly assigned to 3 groups (1, 2, and 3), using the computer-generated random number sequence (Figure 1). The participants in group 1 received MET to the neck for 15 seconds (10), infrared radiation (IRR) and NCE (7). The participants in group 2 received NSE for 30 minutes (16), IRR, and NCE while group 3 received NCE and IRR to the neck. However, only 35 participants completed this study, 6 participants did not complete the study due to different reasons (Figure 1). The participants did this exercise two times a week for 8 weeks. Assessment of pain, neck disability, depression, anxiety, and sleep disturbance was done at baseline, end of 4th and 8th weeks.

### 3.2. Protocol for Neck Stabilization Exercise

Chin tuck, cervical extension, shoulder shrugs, shoulder rolls, scapular retraction 15 repetitions each for 30 minutes (16, 17).

### 3.3. Protocol for Muscle Energy Technique

The participant was in the supine lying position. The therapist was at the end of the bed near the participant's head. The therapist assessed the movements of the cervical spine that were restricted. The therapist localized the joint or the body tissue into the position of the initial range of motion resistance to a specific movement. Once the therapist feels the restriction, the participant's cervical spine was positioned in that range and then a resistive force was applied. In this regard, the patient was asked to isometrically contract for 5 seconds, but not to overcome the force of the therapist; then the counterforce by the therapist was ceased slowly and the participant was asked to relax. The therapist then took the joint to a new barrier and the same procedure was repeated 3 times (10, 18).



**Figure 1.** Flow of the participants for the study

### 3.4. Protocol for Neck Care Education

Participants were advised to relax, activate, and adopt stress-coping skills, workplace ergonomics, and self-care strategies (19). The NPRS is an 11-point scale for patient's self-report of pain. The NPRS can be administered verbally or graphically for self-completion, scores ranged from 0 - 10 points, with higher scores indicating greater pain intensity. It has a construct validity ranging from 0.86 to 0.95 (20).

#### 3.4.1. The NDI

This is a self-administered questionnaire listing activities that can be compromised by neck pain. The NDI consists of 10 items to measure disability secondary to neck pain. The score ranges from 0 - 50, with 0 - 4 representing no disability and 34 and above representing severe disability with test-retest reliability of 0.55 (21).

#### 3.4.2. The ISI

This is a self-administered questionnaire, which is an outcome measure to determine the severity of sleep disorder. It is a 7-point scale listing the problems associated with falling and staying asleep. The score range from 0 - 28 with a reliability of 0.74 (22).

#### 3.4.3. The HADS

This is a widely used self-report questionnaire for detecting overall states of anxiety and depression in non-psychiatric medical contexts (23). It consists of 14 items, which are statements to be scored on 4-point Likert scale (0 - 3), generating 'anxiety' or 'depression' scores ranging from 0 to 21 (total score = 0 - 42). It has a reliability of 0.73 for anxiety and 0.77 for depression.

### 3.5. Data Analysis

Statistical Package for Social Science (SPSS Inc., Chicago, Illinois, USA) version 22.0 for windows pack-

age was used for data analysis. Quantitative data were expressed as mean and standard deviation (SD). Baseline and 8-week intervention values were recorded using Wilcoxon sign rank test and paired *t*-test. Analysis of variance (ANOVA) test and Kruskal Wallis test were used to summarize baseline, end of 4th week and 8th week values post-intervention. Least significant difference (LSD) post hoc analysis was done to compare the mean changes in the three groups in order to determine the significant difference at the alpha level of 0.05.

#### 4. Results

A total of forty-one (41) participants with non-specific chronic neck pain participated in the study, while 35 subjects completed the study. Twenty-three (65.7%) of the participants were females and 12 (34.3%) were males. The 3 groups did not differ significantly in their physical characteristics (Table 1).

##### 4.1. Outcome Measure Parameters Across the Three Groups at the End of 4th Week, and 8th Week

The result showed that there was a significant difference at the end of the 4th and 8th week post-intervention for pain severity ( $P = 0.01, 0.004$ ), neck disability ( $P = 0.01, 0.001$ ), and sleep disturbance ( $P = 0.02, 0.002$ ). The post-hoc analysis showed that there were significant differences between MET and NCE groups and NSE & NCE for pain, neck disability, and sleep disturbance (Table 2). Paired *t*-test showed that there was a significant difference ( $P < 0.05$ ) between pre- and post-treatment interventions for pain in all the groups. Wilcoxon test showed that there was a significant difference between the pre- and post-treatment interventions for the outcome measures across the groups (Table 3).

#### 5. Discussion

This study revealed that MET, NSE, and NCE provided considerable benefit to NSCNP patients when it was administered to them. There was a noticeable improvement in outcome measure parameters of pain and neck disability in the MET group, NSE group as well as the control group post-intervention. This finding supports the reports of the study outcome by Dusunceli et al. (7) who reported that multimodal care approach or intervention in the management of NSCNP is beneficial in the treatment of patients with neck pain. The outcome of this study revealed a considerable improvement in pain associated with NSCNP in both MET and NSE groups in comparison to the control group after 8 weeks of treatment. This is consistent with

the findings of Phadke et al. (18) who revealed that MET reduced pain in patients with non-specific neck pain.

The reduction in pain in MET is as a result of painful inhibition, through both the ascending and descending neurological passageway, after the activation of muscle and joint mechano-receptors over the course of the isometric contractions. It is noteworthy to know that throughout the contractions, endogenous pain-inhibiting chemicals are released, including endocannabinoids, enkephalins, and endorphins (24). This finding did not conform to the report of Strunk and Hondras (25) who revealed that the pain of the studied participants worsened in the MET group. Abdel-Aziem and Draz (26), concluded in their study that neck flexor exercises improved pain and physical disability in patients with neck pain. The mechanism by which stabilization exercises cause reduction of pain in patients with NSCNP is that the exercise may increase the movement in the neural pathways, thus causing a restrictive effect on pain centers in the central nervous system leading to contraction of muscle and tension on different tendons and ligaments as well as stimulation of the mechanoreceptors and enhancement of the activity of the sensory nerve; consequently, results in the inhibition of the mediating pain pathways (13).

In this study, there was an improvement in the neck disability in both MET and NSE groups compared to the control. This corroborates the findings of a previous study by Ylinen et al. (27) on NSE and Phadke et al. (18) on MET among CNP patients. The impact of MET was moderated by the afferent input from the proprioceptive sensory receptor organ, which occurs when a muscle is contracted isometrically, the afferent feedback inhibits the muscle, resulting in relaxation when the contraction is released. It is useful when the tightness of the muscle is a major causal factor to somatic dysfunction. The outcome of this study revealed improvement in sleep disturbance in the MET group, NSE, as well as the control groups post-intervention. To the best of the researcher's knowledge, this study is the only one in this situation that measures the effect of these interventions on sleep disturbance. The improvement in sleep disturbance following the intervention could be due to the relaxing effect of exercise, as well as sedative effect of IRR on superficial nerve endings, which can also facilitate muscle relaxation.

It was observed that all the intervention groups (MET and NSE) improved the psychological status (anxiety and depression) post-intervention. This agrees with the result of other studies (17, 28), which recorded an improvement in the level of depression when neck muscles were treated with therapeutic exercises. The reason for the marked improvement in the psychological status may be that there was an improvement in the pain and disability of patients

**Table 1.** Characteristics of the Participants<sup>a</sup>

Variables	Group 1 <sup>b</sup> , N = 12	Group 2 <sup>c</sup> , N = 12	Group 3 <sup>d</sup> , N = 11	F <sup>e</sup>	P Value
Age, y	49.50 ± 17.50	42.00 ± 14.58	49.27 ± 11.32	1.09	0.35
Weight, kg	73.25 ± 13.96	75.67 ± 12.42	73.45 ± 13.95	0.19	0.83
Height, m	1.74 ± 0.12	1.69 ± 0.09	1.65 ± 0.11	2.27	0.12
BMI, kg/m <sup>2</sup>	24.22 ± 4.64	26.56 ± 4.14	27.05 ± 4.90	1.48	0.24

Abbreviation: BMI, body mass index; N, number of participants in each group.

<sup>a</sup> Values are expressed as mean ± SD.

<sup>b</sup> Muscle energy technique group.

<sup>c</sup> Neck stabilization exercise group.

<sup>d</sup> Control group.

<sup>e</sup> ANOVA.

**Table 2.** Across Group Comparison of Pain, Neck Disability, Depression, Anxiety and Sleep Disturbance at Baseline, End of 4th Week, and 8th Week Post-Intervention<sup>a</sup>

Outcome Measure	Group 1 <sup>b</sup>	Group 2 <sup>c</sup>	Group 3 <sup>d</sup>	F <sup>e</sup>	H <sup>f</sup>	P Value
<b>Pre-Rx Baseline<sup>g</sup></b>						
Pain	5.92 ± 2.11	7.67 ± 1.83	5.36 ± 1.91	4.42		0.02 <sup>h</sup>
ND	28.67 ± 14.53	34.50 ± 13.81	27.27 ± 11.32		2.41	0.30
P (ANX)	4.75 + 4.372	9.00 ± 5.39	5.09 + 3.42		4.80	0.09
P (DEP)	5.00 + 3.954	9.00 ± 5.71	5.09 + 3.75		4.44	0.11
SD	6.00 + 3.814	11.08 + .055	9.27 + 6.635		6.87	0.03 <sup>h</sup>
<b>Mid-Rx 4th week</b>						
Pain	2.92 ± 1.51	5.08 ± 1.31	3.91 ± 1.81	5.89		0.01 <sup>h</sup>
ND	12.50 + 4.83	23.33 + 9.43	23.27 + 11.77		9.88	0.01 <sup>h</sup>
P (ANX)	2.67 + 3.393	4.67 + 2.90	3.91 + 3.05		3.01	0.22
P (DEP)	2.67 + 3.143	5.75 + 4.67	4.18 + 2.96		3.39	0.18
SD	3.75 + 2.896	7.42 + 2.746	7.91 + 5.683		7.73	0.02 <sup>h</sup>
<b>Post-Rx 8th week</b>						
Pain	1.75 ± 1.14	1.83 ± 0.72	3.18 ± 1.25	6.58		0.004 <sup>h</sup>
ND	7.17 ± 3.56	12.00 ± 6.21	9.27 ± 6.64		13.85	0.001 <sup>h</sup>
P (ANX)	1.58 + 2.109	2.50 + 2.02	3.27 + 2.45		3.44	0.18
P (DEP)	2.00 + 2.796	3.00 + 3.30	3.18 + 2.82		1.57	0.46
SD	1.67 + 2.270	2.17 + 1.467	6.91 + 5.338		12.29	0.002 <sup>h</sup>

Abbreviations: ND, neck disability; P (Anx), psychological status (anxiety); P (Dep), psychological status (depression); SD, sleep disturbance.

<sup>a</sup> Values are expressed as mean ± SD.

<sup>b</sup> Muscle energy technique.

<sup>c</sup> Neck stabilization exercise.

<sup>d</sup> Control group.

<sup>e</sup> ANOVA.

<sup>f</sup> Kruskal-Wallis test.

<sup>g</sup> Rx, treatment.

<sup>h</sup> Significant difference at P < 0.05.

with NSCNP after undergoing MET and NSE. The control (NCE) group showed improvement in the clinical outcome of pain, neck disability, depression, anxiety, and sleep disturbance. This is consistent with the previous study by Chen et al. (29) on relief of pain symptoms while the report of the study by Dusunceli et al. (7) revealed the lack of reduction in the level of depression. This result is not in ac-

cordance with a report of a systematic review by Gross et al. (19), which revealed that neck care education has limited effect in the management of neck pain. The improvement of outcome measures in the control group may be due to a number of factors, including the psychological effect of being treated, biological variation in the participants, and spontaneous or natural recovery.

**Table 3.** Within Group Comparison of Pain, Depression, Anxiety, and Sleep Disturbance at Pre-Treatment (Baseline) and Post-Treatment (End of 8th Week)<sup>a</sup>

Outcome Measure	Pre-Rx <sup>b</sup> Baseline	Post-Rx <sup>b</sup> End of 8th Week	t <sup>c</sup>	Z <sup>d</sup>	P Value <sup>e</sup>
<b>Group 1<sup>f</sup></b>					
Pain	5.92 ± 2.11	1.75 ± 1.14	-7.42		0.001
ND	28.67 ± 14.53	7.17 ± 3.56		-3.06	0.002
P (ANX)	4.75 ± 4.37	1.58 ± 2.11		-2.43	0.02
P (DEP)	5.00 ± 3.95	2.00 ± 2.80		-2.55	0.01
SD	6.00 ± 3.81	1.67 ± 2.27		-2.61	0.01
<b>Group 2<sup>g</sup></b>					
Pain	7.67 ± 1.83	1.83 ± 0.72	-12.31		0.001
ND	34.50 ± 13.81	12.00 ± 6.21		-3.07	0.002
P (ANX)	9.00 ± 5.39	2.50 ± 2.02		-3.07	0.002
P (DEP)	9.00 ± 5.71	3.00 ± 3.30		-3.06	0.002
SD	11.08 ± 0.55	2.17 ± 1.47		-3.06	0.002
<b>Group 3<sup>h</sup></b>					
Pain	5.36 ± 1.91	3.18 ± 1.25	8.28		0.001
ND	27.27 ± 11.32	9.27 ± 6.64		-2.99	
P (ANX)	5.09 ± 3.75	3.27 ± 2.45		-2.21	0.03
P (DEP)	5.09 ± 3.75	3.18 ± 2.82		-2.38	0.02
SD	9.27 ± 6.64	6.91 ± 5.34		-2.53	0.01

Abbreviations: ND, neck disability; P (Anx), psychological status (anxiety); P (Dep), psychological status (depression); SD, sleep disturbance.

<sup>a</sup> Values are expressed as mean ± SD.

<sup>b</sup> Rx, treatment.

<sup>c</sup> t value, paired t-test.

<sup>d</sup> Wilcoxon test.

<sup>e</sup> Significant difference at P < 0.05.

<sup>f</sup> Muscle energy technique.

<sup>g</sup> Neck stabilization exercise.

<sup>h</sup> Control group.

### 5.1. Limitation

The sample size for this study was small and the follow-up was a short duration (8 weeks). Therefore, caution should be considered in generalizing the outcome of this study.

### 5.2. Conclusions

In this study, NSE, MET, and NCE were shown to be effective in the improvement of pain, disability, psychological status, and sleep disturbance of patients with NSCNP. It was concluded that neck stabilization exercise provides a better benefit when compared with the other 2 interventions (MET and NCE) in the improvement of the outcome parameter.

### 5.3. Recommendation

It is therefore advised that physiotherapists can suitably make use of any of the three interventions (MET, NSE, NCE) in the treatment of patients with NSCNP, but preferably NSE for better effect.

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### Footnotes

**Authors' Contribution:** Rasheedah Adebola Zibiri: gathered and analyzed data; Ashiyat Kehinde Akodu: study concept and design, interpretation of data, and preparation of the manuscript; Udoka Arinze Okafor: interpretation of data and reviewing the manuscript. All authors participated in critical revision of the manuscript for important intellectual content, discussed the results, and commented on the manuscript. All authors approved the final version of the manuscript.

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## References

- Tsakitzidis G, Remmen R, Dankaerts W, Royen PV. Non-specific neck pain and evidence-based practice. *Europ Sci J*. 2013;**9**(3).
- Linton SJ. A review of psychological risk factors in back and neck pain. *Spine (Phila Pa 1976)*. 2000;**25**(9):1148–56. [PubMed: 10788861].
- Artner J, Cakir B, Spiekermann JA, Kurz S, Leucht F, Reichel H, et al. Prevalence of sleep deprivation in patients with chronic neck and back pain: A retrospective evaluation of 1016 patients. *J Pain Res*. 2013;**6**:1–6. doi: 10.2147/JPR.S36386. [PubMed: 23300350]. [PubMed Central: PMC3536352].
- Bertozzi L, Gardenghi I, Turoni F, Villafane JH, Capra F, Guccione AA, et al. Effect of therapeutic exercise on pain and disability in the management of chronic nonspecific neck pain: Systematic review and meta-analysis of randomized trials. *Phys Ther*. 2013;**93**(8):1026–36. doi: 10.2522/ptj.20120412. [PubMed: 23559524].
- Hoy D, March L, Woolf A, Blyth F, Brooks P, Smith E, et al. The global burden of neck pain: estimates from the global burden of disease 2010 study. *Ann Rheum Dis*. 2014;**73**(7):1309–15. doi: 10.1136/annrheumdis-2013-204431. [PubMed: 24482302].
- Members PP, Experts CS, Albright J, Allman R, Bonfiglio RP, Conill A, et al. Philadelphia panel evidence-based clinical practice guidelines on selected rehabilitation interventions for neck pain. *Phys Ther*. 2001;**81**(10):1701–17. [PubMed: 11589644].
- Dusunçeli Y, Ozturk C, Atamaz F, Hepguler S, Durmaz B. Efficacy of neck stabilization exercises for neck pain: A randomized controlled study. *J Rehabil Med*. 2009;**41**(8):626–31. doi: 10.2340/16501977-0392. [PubMed: 19565156].
- Hoeger Bement MK, Weyer A, Hartley S, Drewek B, Harkins AL, Hunter SK. Pain perception after isometric exercise in women with fibromyalgia. *Arch Phys Med Rehabil*. 2011;**92**(1):89–95. doi: 10.1016/j.apmr.2010.10.006. [PubMed: 21187210].
- Akodu AK, Akindutire OM. The effect of stabilization exercise on pain-related disability, sleep disturbance, and psychological status of patients with non-specific chronic low back pain. *Korean J Pain*. 2018;**31**(3):199–205. doi: 10.3344/kjp.2018.31.3.199. [PubMed: 30013734]. [PubMed Central: PMC6037811].
- Chaitow L. An introduction to muscle energy techniques. *Muscle energy techniques*. 3rd ed. Edinburgh: Churchill Livingstone; 2006. p. 13–57.
- Fryer G, Fossum C. Therapeutic mechanisms underlying muscle energy approaches. In: Fernández-de-las-Peñas C, Arendt-Nielsen L, Gerwin RD, editors. *Tension-type and cervicogenic headache: Pathophysiology, diagnosis, and management*. Sudbury, Mass., USA: Jones and Bartlett Publishers; 2010. p. 221–9. doi: 10.1016/b978-0-7020-3528-9.00035-2.
- Fryer GJ, Metre ECL. Muscle energy technique: Research and efficacy. In: Chaitow L, Crenshaw K, editors. *Muscle energy techniques*. Elsevier Churchill Livingstone; 2006. p. 109–32.
- Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine (Phila Pa 1976)*. 2001;**26**(11):E243–8. [PubMed: 11389408].
- Rupesh P, Roshma FJ, Jayavel A. Immediate effect of neck stabilization exercise on neck repositioning accuracy in chronic neck pain patients. *Int J Clin Skill*. 2017;**11**(2). doi: 10.4172/Clinical-Skills.1000114.
- Jull GA. Deep cervical flexor muscle dysfunction in whiplash. *J Muscul Pain*. 2010;**8**(1-2):143–54. doi: 10.1300/J094v08n01\_12.
- Koskimies K, Sutinen P, Aalto H, Starck J, Toppila E, Hirvonen T, et al. Postural stability, neck proprioception and tension neck. *Acta Otolaryngol Suppl*. 1997;**529**:95–7. [PubMed: 9288281].
- Kaka B, Ogwumike OO, Adeniyi AF, Maharaj SS, Ogunlade SO, Bello B. Effectiveness of neck stabilization and dynamic exercises on pain intensity, depression and anxiety among patients with non-specific neck pain: A randomised controlled trial. *Scand J Pain*. 2018;**18**(2):321–31. doi: 10.1515/sjpain-2017-0146. [PubMed: 29794305].
- Phadke A, Bedekar N, Shyam A, Sancheti P. Effect of muscle energy technique and static stretching on pain and functional disability in patients with mechanical neck pain: A randomized controlled trial. *Hong Kong Physiother J*. 2016;**35**:5–11. doi: 10.1016/j.hkpj.2015.12.002. [PubMed: 30931028]. [PubMed Central: PMC6385145].
- Gross A, Forget M, St George K, Fraser MM, Graham N, Perry L, et al. Patient education for neck pain. *Cochrane Database Syst Rev*. 2012;(3). CD005106. doi: 10.1002/14651858.CD005106.pub4. [PubMed: 22419306].
- Castarlenas E, Jensen MP, von Baeyer CL, Miro J. Psychometric properties of the numerical rating scale to assess self-reported pain intensity in children and adolescents: A systematic review. *Clin J Pain*. 2017;**33**(4):376–83. doi: 10.1097/AJP.0000000000000406. [PubMed: 27518484].
- En MC, Clair DA, Edmondston SJ. Validity of the neck disability index and neck pain and disability scale for measuring disability associated with chronic, non-traumatic neck pain. *Man Ther*. 2009;**14**(4):433–8. doi: 10.1016/j.math.2008.07.005. [PubMed: 18824393].
- Bastien CH, Vallieres A, Morin CM. Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Med*. 2001;**2**(4):297–307. [PubMed: 11438246].
- Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983;**67**(6):361–70. [PubMed: 6880820].
- McPartland JM. The endocannabinoid system: An osteopathic perspective. *J Am Osteopath Assoc*. 2008;**108**(10):586–600. [PubMed: 18948642].
- Strunk RG, Hondras MA. A feasibility study assessing manual therapies to different regions of the spine for patients with subacute or chronic neck pain. *J Chiropr Med*. 2008;**7**(1):1–8. doi: 10.1016/j.jcme.2007.10.004. [PubMed: 19674713]. [PubMed Central: PMC2647106].
- Abdel-Aziem AA, Draz AH. Efficacy of deep neck flexor exercise for neck pain: A randomized controlled study. *Turk J Phys Med Rehabil*. 2016;**62**(2):107–15. doi: 10.5606/tftrd.2016.84565.
- Ylinen J, Takala EP, Nykanen M, Hakkinen A, Malkia E, Pohjolainen T, et al. Active neck muscle training in the treatment of chronic neck pain in women: A randomized controlled trial. *JAMA*. 2003;**289**(19):2509–16. doi: 10.1001/jama.289.19.2509. [PubMed: 12759322].
- Celenay ST, Kaya DO, Akbayrak T. Cervical and scapulothoracic stabilization exercises with and without connective tissue massage for chronic mechanical neck pain: A prospective, randomised controlled trial. *Man Ther*. 2016;**21**:144–50. doi: 10.1016/j.math.2015.07.003. [PubMed: 26211422].
- Chen SC, Lin SH, Lai MJ, Peng CW, Lai CH. Therapeutic effects of near-infrared radiation on chronic neck pain. *J Exp Clin Med*. 2013;**5**(4):131–5. doi: 10.1016/j.jecm.2013.06.011.