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Effect of scapular stabilization exercises on dorsal pain and function on multiparous women with large size breast

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Abstract:

Background: Women with Large, hypertrophic breast sizes suffering from a functional and back pain problems in upper trunk especially with multiparous. **Aim**: The primary goal of the present academic study is to figure out the effect of scapular stabilization exercises on function and dorsal pain of upper trunk in multiparous women with large size breast. **Subjects and methods:** In this study, two equivalent study groups of thirty multiparous women with large size breast aged from 35- 40 years old were randomized into 2 groups. Group (A) was given a treatment plan in the form of scapular stabilization exercise & Strengthening exercises, the mean of this group was 35.1± 0.32, 69.7±7.22, 159.8±4.11 and 27.29±4.73 for age, weight, height, and body mass index respectively. Group (B) was given a treatment strategy in the form of strengthening exercises for scapular muscles (Trapezius, Serratus anterior, Levator Scapulae, Rhomboids major and minor) only, the mean of this group were 37.5 ± 0.31, 71.3±7.77, 162.8±8.11 and 26.90±9.91 for age, weight, height, and body mass index respectively. Both groups received (IR, US & TENS) 3 times a week for six weeks. The visual analogue scale (VAS) and the disabilities of the upper trunk questionnaire were utilized as dependent variables. **Results**: Results showed significant improvements in functional level as well as pain alleviation for both groups. The 1st group showed significantly higher improvements in functional level as well as pain reduction when compared to the 2nd group. **Conclusion:** Scapular stabilization exercises were effective in the treatment of multiparous women with large sized breast.

Keywords: scapular stabilization exercises, Strengthening exercises, multiparous women, and large size breast.

1. Introduction

Large, hypertrophic breast sizes considered a problem can cause back pain and poor posture especially with multiparous.[1] Altered postures can increase breast sizes and lead to more muscle activation. [2] there's a direct relation between thoracic flexion torque and breast size whereas it increased as breast size increased. Reporting musculoskeletal pain at total dorsal, upper back, [3] shoulders and neck when compared with women who had small, medium breast. [1]

Mammaplasty weighing less than 1000 g significantly reduces the symptoms associated with macromastia, including pain in the upper and lower back, neck, arm, as well as shoulder. Additionally, a decline in mammaplasty led to a significant enhancement across all quality-of-life aspects evaluated such as difficulties purchasing bras and clothing, trouble engaging in sports, such as running [4] [5].

Additionally, studies have indicated that a large breast may lead to chronic tension within the middle as well as lower fibers of the trapezius muscle, and related muscle groups cause thoracic kyphosis and cervical lordosis because they shift the center of gravity further away from the vertebral column and needs a lot of muscle for keeping balance [6]

The literatures documented that larger breasts and increased body mass index (BMI) may lead to thoracic spine pain, especially at the mid-thoracic levels (T7-8). [7]-[8]. The pulley-like action of brassiere straps and the associated downward drag of breast weight is the cause of pain in the Levator scapulae muscles and upper and middle trapezius. [9]

In addition to altering the cervical as well as thoracic spine's structure, FHP abnormalities might impair respiratory function due to breast enlargement.[10] [11] The thorax elevates in individuals who have FHP because of a rise in sternocleidomastoid muscle myotonia. As a result, the diaphragm's ability for breathing declines and mobility in the thoracolumbar region decreases. Consequently, there is a decline in respiratory function. In addition, there are psychological symptoms, worrying about one's body, restrictions on every day or athletic activity, headaches, and pain in the neck, shoulders, middle back, lower back, and breasts [13].

Numerous studies, particularly those conducted in the last 20 years, have shown psychological and physical symptoms linked to large breast size. According to the majority of these research, having large breasts can result in severe physiological symptoms such as breathing difficulties, bra strap chafing, as well as pain from bad posture (headache, neck, shoulder, middle, lower back, in addition to breast pain with altered scapulothoracic kinematics) [13].

One of the most important aspects of appropriate shoulder function is the alignment and motion of the scapula within the thorax. It greatly influences the ability of the cervical as well as thoracic spine to support ideal shoulder movements. The surrounding musculature of the scapula determines its stability. The Levator Scapulae, Rhomboids major as well as minor, Serratus anterior, along with Trapezius are the primary stabilizers of the scapula. To regulate the scapular motion, these muscle groups work in synergy with the rotator cuff via co-contraction. further combines with the complex movements of the neck and shoulder [14][15]

Patients suffering from thoracic pain as well as shoulder disorders can effectively control their pain and disability with exercise therapy which incorporates stretching and strengthening programs with different physiotherapy methods like heat, transcutaneous electrical nerve stimulation (TENS), as well as ultrasound (US) [16][17]

Due to the close association between the scapula as well as neck, scapular stabilization is becoming more and more popular for individuals with neck pain [18]. The scapula plays a crucial part in maintaining the stability of the shoulder as well as neck complex. [19]. The scientific basis for the training impact of scapular stability exercises is less evident, despite the fact that these exercises are frequently included in shoulder rehabilitation regimens.

This study was designed to examine the impact of scapular stabilization exercises on dorsal pain and function of upper limb on multiparous women with large size breast.

2.Materials & Methods:

2.1. Design:

A randomized controlled experimental pre-post measurements that conducted at physical therapy center of faculty of physical therapy, modern university for technology and information, Cairo, Egypt, carried out to distinguish the impact of scapular stabilization exercises on dorsal pain and function of upper limb on multiparous women with large size breast.

2.2. Ethical Approval

In accordance with the principles outlined in the Declaration of Helsinki, this study was authorized by the faculty of physical therapy at Cairo University's ethical research committee (No: P.T.REC/012/004406).

2.3. The Sample Size Power Analysis

The sample size was determined by a sensitivity analysis. The goal was to obtain 80% power and find the desired effect size, which is the difference in mean change among the groups, assuming an alpha of 0.05 as well as a sample size of Thirty for both groups. Based on these findings, the effect size needs to be 0.9 for the selected sample size to be considered statistically significant. We used G*power (version 3.1.) to conduct the power analysis.

2.4. Participants

This study included thirty multiparous women with large size breast suffering from dorsal pain for more than 3 months, aged between 35 and 40 years old, BMI ranged from 25 to 30 and with large size breast, using bra size (> 22) with cup size DD in American measures.

This study excluded any patient with kyphosis, patients with postmenopausal osteoporosis, which is a major source of postural abnormalities; patients with systemic or vertebral disorders who experienced spinal surgery, shoulder disorder, scoliosis, or any of several other conditions [2]. Additionally, pregnant women have alterations in spinal alignment or lactating women (milk secretion increases breast size and weight) [3], and women using soft bra. Each participant signed an informed consent form.

2.5. Randomization and allocation:

The subjects were split into two groups using the randomly allocated numbers. Subjects were randomly divided into two groups; **Group (A):** was given 18 sessions of scapular stabilization exercises and strengthening exercise for scapular muscles (trapeziums, serratus anterior, Levator Scapulae, Rhomboids major and minor). **Group (B):** was given 18 sessions of strengthening exercise for scapular muscles (trapeziums, serratus anterior). Over the course of six weeks in succession (three sessions per week). Both groups were given physical therapy modalities in form of (IR, US & TENS).

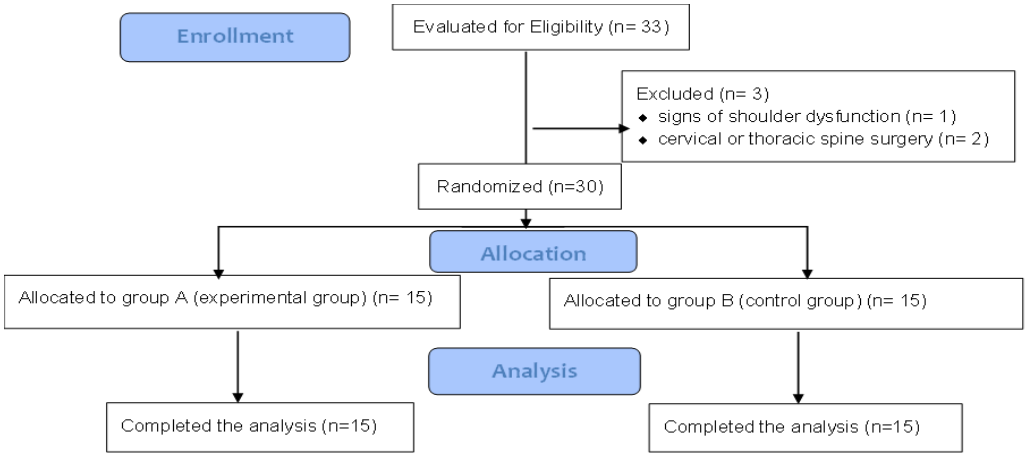

Figure (1): Flow chart of the participants

3. Treatment procedures

3.1. Scapular stabilization exercises

1- Serratus anterior punch. Using the TheraBand held as a resistance tool, the individual is requested to execute a Serratus anterior punching in this exercise. [20][21].

2- Scapular-clock exercise: When the patient is standing, they should extend their arm fully and point their index finger towards the twelve, three, six, and nine o'clock positions upon the wall. At 12 as well as 6 o'clock, elevation and depression of the shoulder is done while at 3 and 9 o'clock, protraction and retraction of shoulder is done [22].

3- **Ball stabilization exercise**: The patient performed this exercise while standing close to a wall, using the affected hand to grip a ball. Directions such as 3, 6, 9, or 12 o'clock were given to the patient for moving the ball in according to an imagined clock he was thinking about. For each exercise, perform three sets of ten repetitions, with a one-minute break in between [21] [23].

3.2. Strengthening exercises:

In order to strengthen the middle and lower fibers of the trapezius, serratus anterior, levator scapulae, as well as rhomboids major and minor muscles, we used 1-meter color-coded elastic resistance bands (TheraBand; The Hygenic Corporation, Akron, OH). Every exercise should be performed three times, with a one-minute break in between each set of ten repetitions [21][24] [25]

3.3. Physical therapy agents:

1. Infrared therapy Positioned 45-50 cm away from the painful location, the infrared lamp (500-Watt, Philips Co., Nederland) was used.

2. Ultrasound therapy that, for six weeks, was carried out three sessions a week. The para-thoracic area received ultrasound therapy (US frequency: 1 MHz; US mode: continuous; duration: 5 minutes; probe size: 5 cm^2; intensity: 1 W/cm^2).

3. TENS, utilized two electrode para-thoracic technology at the patient's preferred intensity level (with pulse width: 50-250 ms, and pulse rate: 90-130 Hz).

4. Outcomes

4.1. Measurement Instrumentation

1. The weight, height and body mass index

A individual's weight in kilograms divided by their height in meters squared yields their body mass index (BMI), which is determined by using a weight scale and measuring tape to determine their height and weight (National Heart Foundation 2007) [25].

a)- Over bust and under band measurements: In addition to recording each subject's breast size, cup sizes were also calculated for each female by subtracting the under band measurement, which is under the breast, from the over bust measurement, which is over the highest point of the breast: A cup size is <6.5 cm, B cup size is 6.5 to 13 cm, C cup size is 13 to 19.5 cm, D cup size is 19.5 to 22 cm, and DD cup size is > 22 cm [2].

b)- Pain intensity (VAS): evaluated with a visual analogue scale (VAS) to assess pain level prior to and following treatment. On a scale of 0 (no pain) to 10 (severe pain), participants were requested to rate their level of pain. The visual depiction of the scale was particularly a line that accounted for 10 cm. The participant's estimated level of discomfort was then calculated using the distance between zero and the respondent's mark [27][28].

C)- The Disabilities of the Arm, Shoulder and Hand (DASH) is a 30-item assessment that evaluates a patient's capability to carry out specific upper limb tasks [24][25][26]. Patients can score the difficulty as well as interference with everyday living on a 5-point Likert scale using this self-report questionnaire [24][25]. The DASH is a valid as well as reliable questionnaire for a range of upper-limb problems, and it has recently been translated into other languages [32]

4.2 Data Analysis

1. The descriptive statistics used in this study were mean as well as standard deviation (SD).

2. The before and after treatment outcomes in the same study domain were compared utilizing two tail-independent t-tests.
3-We used two tail-independent-tests using a 0.05 degree of confidence to compare the difference among the two study domains. Version 20 of the SPSS program was used to examine all the data.

5. Results

Descriptive analysis for the cases in the two study domains encompasses the mean as well as standard deviation for age, weight, height, in addition to BMI. There were no clear variances between the groups (Table1).

Table 1. Physical characteristics of study cases:

Variable	Group A (Mean ±SD)	Group B (Mean ±SD)	T	p-value	S
Age	35.1 ± 0.32	37.5 ± 0.31	0.67	0.4	NS
Weight (Kg)	69.7±7.22	71.3±7.77	0.52	0.6	NS
Height (Cm)	159.8±4.11	162.8±8.11	0.44	0.6	NS
BMI (Kg/m^2)	27.29±4.73	26.90±9.91	0.25	0.8	NS

NS: non-significant

Visual analog scale (VAS)

As presented in table (2) and illustrated in figure (2), the mean value of pain level for **Group A** at the entry of study was 6.3 ± (0.97872) and decreased to 2.3± (0.47016) after 18 sessions. A significant difference has been detected in the dependent t-test of the pain values between pre and post assessment where the t-value was (16.283) and P-value was (.000). The mean value of pain level for **Group B** at the entry of study was 5.3± (.97872) and decreased to 2.55± (0.14593) after 18 sessions. A significant difference has been detected in the dependent t-test of the pain values between pre and post assessment where the t-value was (19.256) and P-value was (.000).

Functional disability level

As presented in table (2) and illustrated in figure (2), the mean value of function level for **Group A** at the entry of study was 27.48± (3.92503 and decreased to 14.45 ± (3.13226) after 18 sessions. A significant difference has been detected in the paired t-test of the function values between pre and post assessment where the t-value was (33.930) and P-value was (.000). The mean value of function level for **Group B** at the entry of study was 25.315 ± (4.25432) and decreased to 19.225± (4.58107) after 18 sessions. A significant difference has been detected in the paired t-test of the function values between pre and post assessment where the t-value was (41.064) and P-value was (.000).

Table 2. Mean as well as standard deviation of pain and function level of both groups pre and post treatment

		Mean Std. Deviation		t-value	p-value
		Pre	Post		
Group A	**VAS**	6.3± (.97872)	2.4± (.59824)	16.283	.000
	DASH	27.48± (3.92503)	14.45± (3.13226)	33.930	.000
Group B	**VAS**	5.3± (.97872)	2.55± (.14593)	19.256	.000
	DASH	25.315 ± (4.25432)	19.225± (4.58107)	41.064	.000

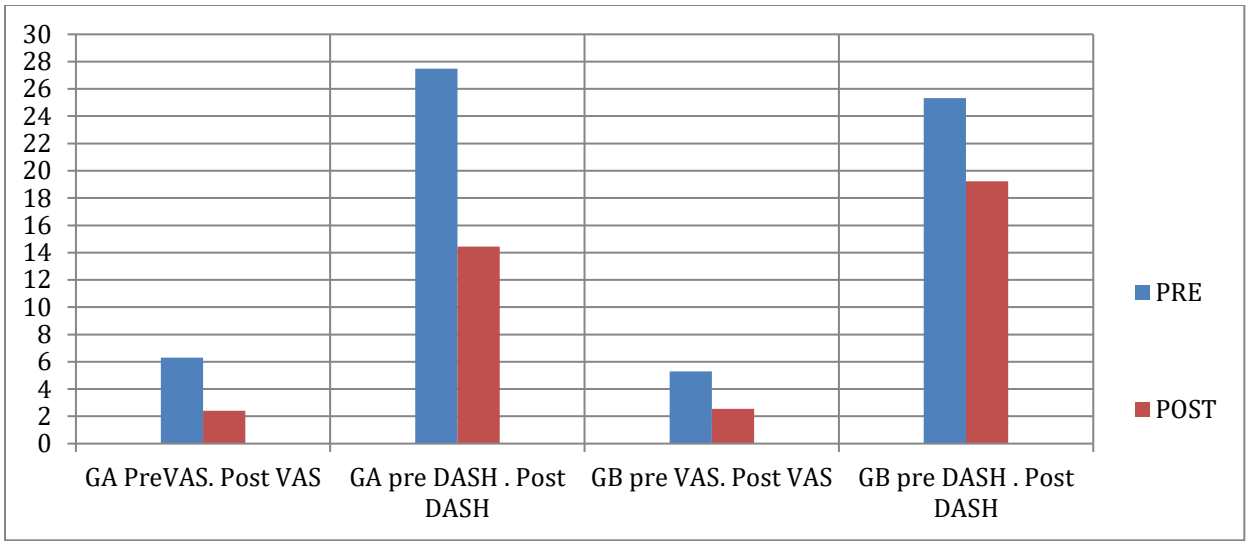

Figure (2): Mean as well as standard deviation of pain and function level of both groups pre and post treatment.

Table 3. the independent t-test results for pain level and functional disability between groups A and B

Outcome measure	GA (Mean ±SD)	GB (Mean ±SD)	t value	P value	S
Visual analog scale VAS	2.4 ± 0.59824	2.55 ± 1.14593	-0.519	0.011	S
DASH	14.45± 3.13226	19.225±4.58107	-3.848	0.019	S

The two Groups comparison:

Table (3) Figure (3), revealed the independent t-test results for pain level and functional disability among groups A and B. A statistically significant difference has been detected among the post-measures of Group (A) and the post-measures of Group (B) in pain. Where the t-value was (-0.519) and p-value was (0.011). Similarly, a statistically significant difference has been detected among the post-measures of Group (A) and the post-measures of Group (B) in function (DASH). Where the t-value was (-3.848) and p-value was (.019).

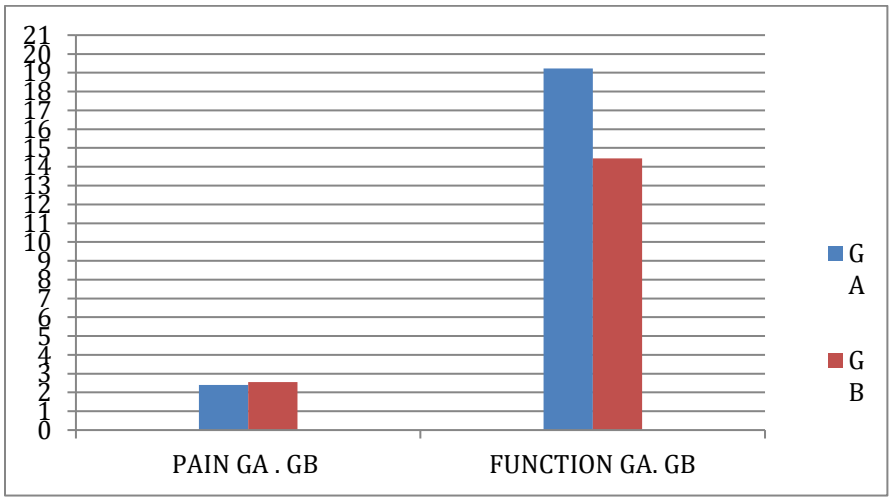

Figure (3) Mean as well as standard deviation of pain and function level of both groups post treatment.

6. Discussion

This study was designed to examine the impact of scapular stabilization exercises on function level and dorsal pain for multiparous women with large size breast with a traditional physiotherapy in form of strengthening exercises & physical therapy agents, for 3 times per week for 6 weeks for both groups.

The current study's analysis of the before and after treatment pain level as well as function values showed statistically significant differences in both groups. Furthermore, a comparison among the two revealed a significant difference, in scapular stabilization exercises plus strengthening exercises being more successful in decreasing pain and enhancing function than strengthening exercises isolated. This finding was consistent with prior studies that discovered scapular stabilization exercises alone or in conjunction with other therapies were successful in decreasing pain.[33][34][35]

It is well known that women with large, heavy breasts suffer from spinal pain. However, the precise impact of the forces exerted by the breast on the spine has not yet been studied. So, it is important for women to understand the load that the spine sustains. But even without scientific knowledge, people recognize the possibility that breast augmentation and upsizing will increase the load that the spine sustains, whereas weight loss will reduce breast size, as will breast reduction procedures.

Thoracic flexion torque was shown to rise significantly with increasing breast size in earlier research. There was a statistically significant increase in the reported levels of upper back, shoulder, neck, as well as breast musculoskeletal pain among women whose breasts were hypertrophic compared to those whose breasts were small, medium, or large. The thoracic kyphosis angle did not differ significantly among the four categories [37].

Musculoskeletal pain, especially pain in the upper torso, is more common and more severe in women with large breasts [38][39][40].

Due to the interconnected nature of the musculoskeletal system's structure and function, it is believed that women experiencing increasing pain in the upper torso from their breasts may be experiencing impaired function as a result of changes in the musculoskeletal system's construction, particularly in the vertebral column. [40][41].

In other words, the flexion torque pressing on the thoracic spine will be greater when carrying heavy breasts forward of the body [40].

A rise in thoracic kyphosis due to prolonged excessive thoracic flexion torque can cause secondary changes within cervical lordosis, greater stress in the neck extensor muscles, decreased endurance strength in the thoracic extensor muscles, as well as a development in musculoskeletal pain [40][41].

A number of research investigated scapular stabilization in relation to neck pain in the past several years [28][29]. General training, which includes strengthening as well as endurance activities for the neck region, was found to be useful in treating nonspecific neck pain as well as improving functional impairment in two systematic reviews [30] [31].

Scapular kinematics were unaffected by a 6-week regimen of conventional exercises, according to Ludewig and Reynolds. [14]

This study has some limitations. Study limitations, such as small sample sizes, highlight the need for additional research with varying intervention durations to address this problem.

7. Acknowledgements

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8. References

1) Coltman CE, Steele JR, McGhee DE. Effect of Breast Size on Upper Torso Musculoskeletal Structure and Function: A Cross-Sectional Study. Plast Reconstr Surg. 2019 Mar;143(3):686-695. doi: 10.1097/PRS.0000000000005319. PMID: 30817639.

2) Schinkel-Ivy A, Drake JD. Breast size impacts spine motion and postural muscle activation. J Back Musculoskelet Rehabil. 2016 Nov 21;29(4):741-748. doi: 10.3233/BMR-160680. PMID: 26966826.
3) Breast size, bra fit and thoracic pain in young women: a correlational study Katherine Wood1, Melainie Cameron*2,3 and Kylie Fitzgerald1 Chiropractic & Osteopathy 2008, 16:1 doi:10.1186/1746-1340-16-1
4) Spector JA, Karp NS: Reduction mammaplasty: A significant improvement at any size. Plast Reconstr Surg 2007, 120:845-850.
5) Schnur PL, Schnur DP, Petty PM, Hanson TJ, Weaver AL: Reduction Mammaplasty: An Outcome Study. *Plast Reconstr Surg* 1996, 100(4):875-883.
6) Letterman G, Schurter M: The effects of mammary hypertrophy of the skeletal system. Ann Plast Surg 1980, 5:425-431. 3
7) Spencer L, Briffa K. Breast size, thoracic kyphosis & thoracic spine pain–association & relevance of bra fitting in post-menopausal women: a correlational study. Chiropr Man Therap 2013 ; 21(1):20. doi:10.1186/2045-709X-21-20. 6
8) Myint Oo, Zhuo W, Toshihiko S et al. Relationship Between Brassiere Cup Size and Shoulder-Neck Pain in Women Open Orthop J. 2012; 6: 140–142. 6
9) Ryan EL. Pectoral girdle myalgia in women: a 5-year study in a clinical setting. Clin J Pain. 2000 Dec;16(4):298-303. doi: 10.1097/00002508-200012000-00004. PMID: 11153784.
10) Kapreli E, Vourazanis E, Strimpakos N. Neck pain causes respiratory dysfunction. Med Hypotheses. 2008;70:1009–1013.
11) Dimitriadis Z, Kapreli E, Strimpakos N, Oldham J. Respiratory weakness in patients with chronic neck pain. Man Ther. 2013;18:248–253.
12) Perri , MA , Halford E. Pain and faulty breathing: A pilot study. *Journal of Bodywork and Movement Therapies.* 2004;8:297–306.
13) Harbo SO, Jorum E, Roald HE: Reduction mammaplasty: A prospective study of symptom relief and alterations of skin sensibility. Plast Reconstr Surg 111:103110, 2003
14) Ludewig PM, Reynolds JF. The association of scapular kinematics and glenohumeral joint pathologies. The Journal of orthopaedic and sports physical therapy. 2009;39(2):90.
15) Yano Y, Hamada J, Tamai K, Yoshizaki K, Sahara R, Fujiwara T, et al. Different scapular kinematics in healthy subjects during arm elevation and lowering: glenohumeral and scapulothoracic patterns. Journal of shoulder and elbow surgery. 2010;19(2):209-15.
16) Van der Heijden G, Van der Windt D, de Winter AF. Physiotherapy for patients with soft tissue shoulder disorders: a systematic review of randomised clinical trials. BMJ: British Medical Journal. 1997;315(7099):25.
17) Soibam I. Comparative study on the effectiveness of ultrasound (us) to transcutaneous electrical stimulation (tens) in the treatment of periarticular shoulder pain (psp). 2005.
18) Lluch E, Arguisuelas MD, Calvente Quesada O, Martínez Noguera E, Peiró Puchades M, Pérez Rodríguez JA, Falla D. Immediate effects of active versus passive scapular correction on pain and pressure pain threshold in patients with chronic neck pain. J Manipulative Physiol Ther. 2014 Nov-Dec;37(9):660-6. doi: 10.1016/j.jmpt.2014.08.007. Epub 2014 Oct 1. PMID: 25282679.
19) Helgadottir H, Kristjansson E, Mottram S, Karduna AR, Jonsson H Jr. Altered scapular orientation during arm elevation in patients with insidious onset neck pain and whiplash-associated disorder. J Orthop Sports Phys Ther. 2010 Dec;40(12):784-91. doi: 10.2519/jospt.2010.3405. Epub 2010 Oct 22. PMID: 20972341.
20) Cagnie B, Struyf F, Cools A, Castelein B, Danneels L, O'leary S. The relevance of scapular dysfunction in neck pain: a brief commentary. J Orthop Sports Phys Ther. 2014 Jun;44(6):435-9. doi: 10.2519/jospt.2014.5038. Epub 2014 May 10. PMID: 24816504.
21) Camargo PR, Haik MN, Ludewig PM, Filho RB, Mattiello-Rosa SM, Salvini TF. Effects of strengthening and stretching exercises applied during working hours on pain and physical impairment in workers with subacromial impingement syndrome. Physiother Theory Pract. 2009;25:463-475. http://dx.doi. org/10.3109/09593980802662145)
22) Yano Y, Hamada J, Jamai K, Yoshizaki K, Sahara R, Fujiwara T, Diagnostic Imaging Guideline For Musculoskeletal Complaints In Adults - An Evidence Based Approach: Part 2 - Upper Extremity Disorders. J Manipulative PhysiolTher 2010; 31:2-32
23) John Ebenezer, essential of orthopedics for physiotherapists. 2nd edition. 2011; 19: 270- 274.)
24) Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. Acad Emerg Med. 2001;8:1153-1157
25) Ludewig PM, Borstad JD. Effects of a home exercise programme on shoulder pain and functional status in construction workers. Occup Environ Med. 2003;60:841-849)
26) National Heart Foundation in association with the Faculty of Public Health 1. And Department of Health, 2007. Lightening the load: tackling overweight and obesity: a toolkit for developing local strategies to tackle

overweight and obesity in children and adults. [Online] London: Department of Health. Available at:http://www.dh.gov.uk/en/Publicationsandstatistics/Publicat ons/Publ icationsPolicyAndGuidance/DH_073936 [Accessed May 2009].)

27) Tosteson A. Preference- based health outcome measure in low back pain. Spine; 2000; 25(24):3161-3166,.
28) Lunderberg T, Lund E, Dahlin L, Borg E, Gustfsson S, Rosen A, Kwabk J and Ericksson S. Reliability and responsiveness of three different pain assessment. J Rehabilitation MED; 2001; 33(6):279-283,.)
29) The DASH outcome measure. Available at http://www.dash.iwh.on.ca, Accessed March 12, 2011.
30) Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts: validity, reliability, and responsiveness of the Disabilities of the upper limb outcome measure in different regions of the upper extremity. Journal of Hand Therapy. 2001 Apr 1;14(2):128-42.
31) Beaton DE, Davis AM, Hudak P, McConnell S. The DASH (Disabilities of the upper limb outcome measure: what do we know about it now. The British Journal of Hand Therapy. 2001 Dec;6(4):109-18..)
32) Sigirtmac IC, Oksuz C. Systematic review of the quality of the cross-cultural adaptations of Disabilities of the upper limb (DASH). La Medicina del Lavoro. 2021;112(4):279.")
33) Celik D, Akyuz G, Yeldan I. Comparison of the effects of two different exercise programs on pain in subacromial impingement syndrome. Acta Orthop Traumatol Turc. 2004;43(6):504-9.
34) Kromer TO, Tautenhahn UG, de Bie RA, Staal JB, Bastiaenen CH. Effects of physiotherapy in patients with shoulder impingement syndrome: a systematic review of the literature. Journal of Rehabilitation Medicine. 2009;41(11):870-80.
35) Bang MD.Comparison of Supervised Exercise With and Without~ anual Physical Therapy for Patients With Shoulder Impingement Syndrome. Journal of Orthopaedic & Sports Physical Therapy. 2000;30(3):126-37.
36) MJIRI, Vol. 28.87. 27 August 2014
37) Coltman CE, Steele JR, McGhee DE. Effect of Breast Size on Upper Torso Musculoskeletal Structure and Function: A Cross-Sectional Study. Plast Reconstr Surg. 2019 Mar;143(3):686-695. doi: 10.1097/PRS.0000000000005319. PMID: 30817639.)
38) Spencer L, Briffa K. Breast size, thoracic kyphosis & thoracic spine pain - association & relevance of bra fitting in post-menopausal women: a correlational study. Chiropr Man Ther 2013;21:20. doi:10.1186/2045-709X-21-20.
39) Coltman CE, Steele JR, McGhee DE. Can breast characteristics predict upper torso musculoskeletal pain Clin Biomech (Bristol, Avon) 2018;53:46–53.
40) McGhee DE, Coltman KA, Riddiford-Harland DL, Steele JR. Upper torso pain and musculoskeletal structure and function in women with and without large breasts: a cross sectional study. Clin Biomech (Bristol, Avon) 2018;51:99–104.
41) McGhee DE, Steele JR, Zealey WJ, Takacs GJ. Bra-breast forces generated in women with large breasts while standing and during treadmill running: implications for sports bra design. Appl Ergon 2013;44:112–8.