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Original Research Article

Prevalence of Myofascial Pain Syndrome in Chronic Non-Specific Neck Pain: A Population-Based Cross-Sectional Descriptive Study

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Abstract

Background. Chronic non-specific neck pain is a frequent complaint. It is a recognized medical and socioeconomic problem and a frequent cause of job absenteeism. In recent years, case reports about myofascial pain syndrome (MPS) are emerging among patients suffering from pain. MPS is a regional pain syndrome characterized by myofascial trigger points (MTrP) in palpable taut bands of skeletal muscle that refer pain to a distance, and that can cause distant motor and autonomic effects.

Objective. To assess the prevalence of active and latent MTrPs in subjects suffering from chronic non-specific neck pain.

Design. A population-based cross-sectional descriptive study was carried out from January 2012 to December 2014.

Setting. Three primary healthcare centers in Alcalá de Henares, Madrid (Spain).

Subjects. Two hundred and twenty-four participants diagnosed by their family doctor with chronic non-specific neck pain.

Methods. Participants were examined by a physical therapist to determine the presence of MPS. Pain descriptions from the subjects and pain body diagrams guided the physical examination. The subjects were not given any information concerning MPS or other muscle pain syndromes.

Results. All participants presented with MPS. MTrPs of the trapezius muscles were the most prevalent, in 93.75% of the participants. The most prevalent active MTrPs were located right (82.1%) and left (79%) in the nearly-horizontal fibers of the upper trapezius muscle. Furthermore, active MTrPs in the levator scapulae, multifidi, and splenius cervicis muscles reached a prevalence of 82.14%, 77.68%, and 62.5%, respectively.

Conclusions. MPS is a common source of pain in subjects presenting chronic non-specific neck pain.

Key Words. Myofascial Pain Syndromes; Physical Therapy; Prevalence; Neck Pain; Myofascial Trigger Point

Introduction

Neck pain is a frequent complaint in healthcare centers with a prevalence ranging from 5.9% to 38.7% in the general population [1,2], reaching a prevalence of 19.5% in Spain [3] and a prevalence of 13.8% in the USA [4]. Each year, 0.6% of the general population develops disabling neck pain [5], leading to persistent pain

in 67% of cases [6]. The literature suggests that the main long-term consequences of neck pain are individual disability and job absenteeism, which are recognized as significant public health and socioeconomic problems [6,7]. Musculoskeletal injuries and disorders are the most common medical causes the majority of illness-related work absenteeism of more than 2 weeks in Spain [7], Norway [8] and Germany [9]; in the United States back pain is the most common reason for filing workers' compensation claims and often causes lost workdays [10]. In Spain, workers with chronic pain are more likely to be absent from work and the duration of this absenteeism tends to be prolonged [7]. The prevalence and incidence of work absenteeism involving neck pain in Ontario, Canada, is 14.4% in women and 10.1% in men [6]. Most of these studies described traumatic or neurological chronic neck pain, classified according to its origin. When the etiology of chronic neck pain is unknown, however, it is considered "non-specific neck pain." Non-specific neck pain, also referred to as mechanical neck pain, is diagnosed as cervical pain with or without radiation without a known pathological basis as the underlying cause of the complaints [11–13].

In recent years, several studies have emerged about myofascial pain syndrome (MPS) among patients suffering from neck pain [14,15]. A recent study suggested that dry needling of trapezius myofascial trigger points (MTrPs) in office workers suffering from neck pain may decrease subjective neck pain significantly [16].

MPS is the presentation of sensory, motor, and autonomic symptoms caused by MTrPs [17]. It is a regional pain problem characterized by MTrPs in palpable taut bands of skeletal muscle that refer pain to a distance from the area where the point is located, and that can cause distant motor and autonomic effects. An MTrP is a hyperirritable nodule within a taut band of a muscle that is thought to be caused by motor endplate dysfunction. The MTrP area is painful on compression and can present with a characteristic referred pain pattern, motor dysfunction, and autonomic phenomena [17]. MTrP were categorized by Travell and Simons as either active or latent. While active MTrPs produce a spontaneous clinical complaint of pain, latent MTrPs are clinically silent, and they are painful only when properly stimulated by different stimuli, such as pressure or needling. Both active and latent MTrPs may cause restricted range of motion and weakness of the muscles harboring the MTrPs [17].

The aim of this study was to determine the prevalence of MPS in subjects suffering from chronic non-specific neck pain and to determine the prevalence of active and latent MTrPs in this population.

Methods

Participants

Subjects diagnosed by their family physician with non-specific neck pain lasting more than 6 months, between January 2012 and December 2014 at three primary healthcare centers in Alcalá de Henares, Madrid, Spain were considered for inclusion in the study. Physicians considered non-specific neck pain as cervical pain with or without radiation whose etiology was unknown, without a known pathological basis as the underlying cause of the complaints [11–13].

Participants who were taking antidepressant medication [18], had fibromyalgia syndrome, infection, fever, cancer, or any systemic disease were excluded [19], as well as participants with shoulder pathology, such as tendinopathy, impingement syndrome, capsulitis, or direct trauma, and participants with pain of a traumatic, neurological or surgical origin, or who suffered from severe disease, were pregnant or had had a recent delivery.

Once the participants were included in the study and signed the informed consent, they were contacted for a physical therapy (PT) assessment.

Two hundred and twenty-four participants (18 years or older; 35.7% men and 64.3% women), out of 536 potential participants who met the inclusion criteria, agreed to participate and gave their written informed consent. The progression of the subjects through the various phases of the study is shown in Figure 1.

Design

A population-based cross-sectional prospective study was conducted. A non-probabilistic consecutive sampling design was used to select participants, forming a representative sample of a population with chronic non-specific neck pain. The study was approved by the Ethics and Clinical Investigation Committee of the Principe de Asturias Hospital (Madrid), and written informed consent was obtained from all participants. Specific PT treatment for pain management was made available to all participants identified with MPS after the PT assessment.

Physical Therapy Assessment

During the PT assessment, demographic data were collected, including age, race, gender, marital status, body mass index (BMI), work status, educational level, socioeconomic status, and information regarding the medical history. Participants were asked about their neck pain. The location, duration, and intensity of pain were recorded. Each participant marked the location of the pain on a multiple-view diagram. The pain intensity was recorded on a visual analogue scale. The participants' pain descriptions and drawings of their pain pattern guided the physical examination, to determine the cause of pain. The participants were not given any information concerning MPS or other muscle pain syndromes. A physical therapist, experienced in the diagnosis of MPS, performed the physical examinations. The diagnosis of MPS was based on the four essential criteria proposed by Simons et al. [17], shown in Table 1.

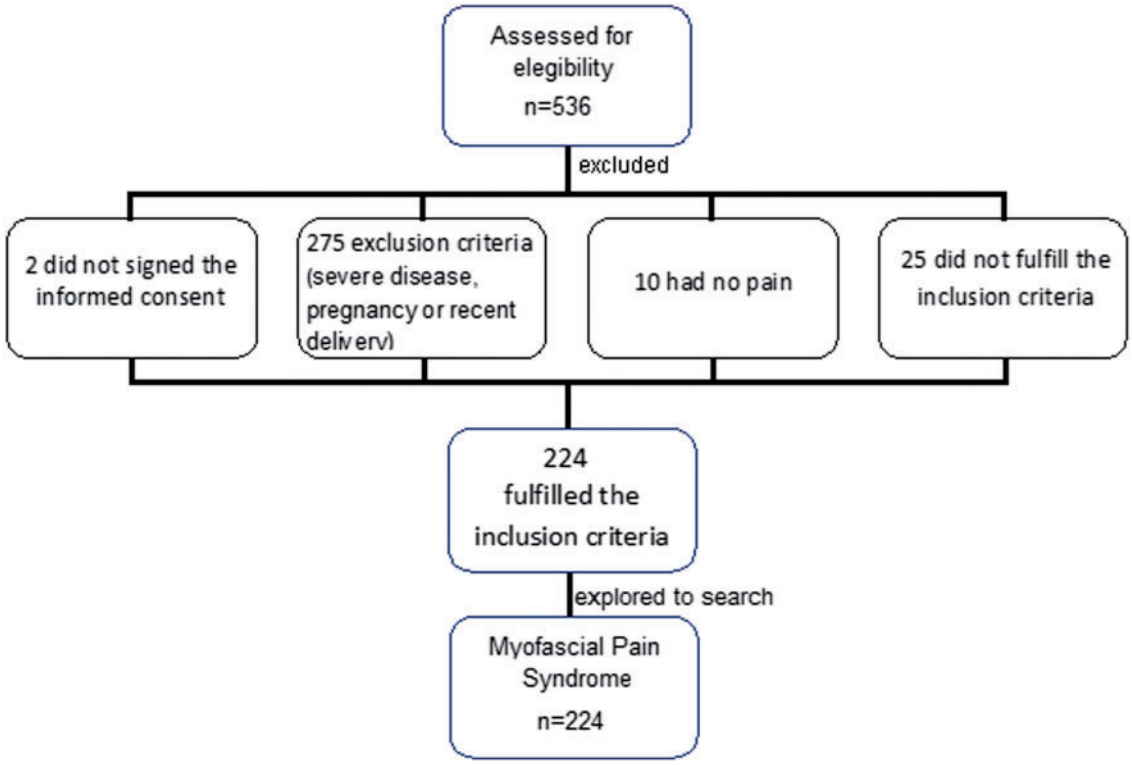

Figure 1 Participant flow chart.

Table 1 Recommended criteria for identifying myofascial trigger points [17]

Recommended essential criteria for identifying myofascial trigger points
Taut band palpable (if muscle accessible)
Exquisite spot tenderness of a nodule in a taut band
Patient's recognition of current pain complaint by pressure on the tender nodule (for active myofascial trigger points)
Painful limit to full stretch range of motion

In the clinical setting, MTrPs are identified by physical examination [18]. Recent studies have shown that clinicians with adequate training in muscle palpation techniques have a high degree of reliability in identifying MTrPs [17,20–23]. The most widely used diagnostic criteria [17] (Table 1) have good overall interrater reliability [20–22]. The examiner in this study had extensive experience in the examination and treatment of MTrPs.

According to Simons et al. [17] the muscles that refer pain to the posterior neck area are the trapezius, multifidi, splenius cervicis, levator scapulae, and infraspinatus muscles. All these muscles, except the infraspinatus, were examined for the presence of active or latent MTrPs. The infraspinatus muscle is mostly involved in shoulder pain. Once participants had described their pain pattern, the examiner started the physical examination by locating MTrPs. The trapezius, levator scapulae and splenius cervicis muscles are easily identified. All essential diagnostic criteria for the diagnosis of their MTrPs were present (Table 1) [17]. Due to their deep location, MTrPs in the multifidi muscles are more difficult to diagnose. Subjects were in the supine position to facilitate optimal relaxation of the overlying muscles. The finding of a painful nodule when rubbing the muscle in a longitudinal direction halfway between the spinous and transverse processes [17] was considered indicative of the possible location of an MTrP. As stated by the diagnostic criteria proposed by Simons et al. [17], the finding of a taut band is not considered essential in non-accessible muscles. In the multifidi muscles, the diagnosis of active MTrPs was made when the subjects presented with exquisite spot tenderness in a palpable nodule, with recognition of the current pain complaint with 10-second pressure, and a painful limit on cervical flexion.

Data Analysis

Sample Size Calculations

To evaluate the prevalence of MPS in subjects suffering from chronic neck pain, we recruited 224 participants. Sample-size estimation was done assuming a MPS

prevalence of 83%, based on an earlier study [24]. With such a sample size, a prevalence difference of 20% can be detected with a power of 95%, setting the type 1 error at 0.05, and allowing for a 3% drop-out rate using GRANMO (7.12 version. Research Institute del Mar Hospital, Spain, 2012).

Statistical Analysis

The Statistical Package for the Social Sciences software (15.0 version) (SPSS Inc., Chicago, IL, USA, 2008) was used for the statistical analysis.

Qualitative data were represented by absolute and relative frequencies, and quantitative data were calculated by computing the mean and standard deviation (SD) or median and interquartile range (IQR) of each variable, for parametric and non-parametric data respectively. The Kolmogorov Smirnov or Shapiro-Wilk tests were used to determine normality.

The Kruskal Wallis and Mann-Whitney U tests were used to analyze the association between MPS in participants suffering from non-specific neck pain and occupation, exercise, analgesics and sex. Differences were considered statistically significant when the P value < 0.05.

Results

All contacted participants completed the assessment. For a descriptive summary of the variables see Table 2. No associations were found between neck pain and occupation, exercise and analgesics use (Table 3).

Prevalence of MPS

The prevalence of MPS among non-specific-neck-pain patients was 100%. The prevalence of the MTrPs included in this study is summarized in Table 4. The most prevalent active MTrPs in the trapezius muscles were identified in 93.75% of the subjects, in the levator scapulae in 82.14%, and in the multifidi in 77.68% of the subjects. MTrPs in the splenius cervicis reached a prevalence of 62.5%.

The most prevalent active MTrP diagnosed were located right and left (82.1% and 79%, respectively) in the middle of the more nearly-horizontal fibers of the upper trapezius muscle.

Discussion

Although the prevalence and incidence of MPS have been studied in various patient populations [23], including patients in an internal medicine practice [25], patients diagnosed with fibromyalgia [26], and patients with shoulder girdle pain [27], among others, to the best of our knowledge, this is the first published study addressing the prevalence of MPS among subjects with chronic non-specific neck pain. In addition, this study determines the prevalence of both active and latent MTrPs in this population, for individual muscles (left trapezius, right trapezius, etc.) and more in general (general prevalence of trapezius muscle, etc.).

According to the predominant MTrP hypothesis, pain and muscle dysfunction are well-known consequences of active and latent MTrPs [17,28]. Contributing factors to the high prevalence of MPS among subjects with chronic non-specific neck pain are a variety of mostly mechanical factors, such as postural dysfunction, inadequate rest, and overstretching, over-shortening or more generally, overloading of muscles [29,30]. Several research studies have confirmed increased concentrations of multiple biochemicals associated with inflammation, pain and intercellular signaling in the immediate vicinity of active MTrPs [31–33]. Muscles can refer pain to the posterior neck area [17], and in the current study all 224 participants with chronic non-specific neck pain presented with MTrPs relevant for their current pain complaint. Furthermore, when subjects suffer from neck pain, they often present with a loss of strength [34,35], a decrease in cervical range of motion [36], and altered muscle activation patterns [34], which may act as perpetuating factors [17,18] leading to a vicious cycle, that can be broken with the comprehensive treatment of the patients [16].

Patients with chronic neck pain present with electromyographic abnormalities [37,38]. In addition, mechanical stress applied to the endplate region by tensing the motor nerve may, at least in rodents, produce similar EMG abnormalities as in MTrPs [39,40], reinforcing that muscle tightness, produced by static positioning of the head and neck may lead to the development of MTrPs, neck pain and eventually to chronic non-specific neck pain.

The results of the current study are in agreement with the findings of a recent study of dry needling treatments of MTrPs in the trapezius muscles in patients with neck pain. After treatment the complaints of neck pain resolved [16], which suggests that MTrPs could be considered causative in the development of neck pain. Although the researchers reported excellent results, they suggested that other muscles besides the multifidi, splenius cervicis, and levator scapulae muscles should be taken into account for future studies of neck pain [16]. The evaluation of patients with non-specific neck pain should include an assessment of the presence of MTrPs to better establish optimal treatment programs.

Some researchers have reported that high visual stress combined with static positions of the neck and shoulder during work activities may predispose the cervical muscles to getting tight and to the development of MTrPs [18,30,41–43]. The current study offers some support for this notion, although only 30% of our participants were office workers exposed to high visual stress

Table 2 Characteristics of participants

Variables	N = 224
Demographic data	
Women	144 (64.3%)
Men	80 (35.7%)
Age (years) mean (SD)	51.4 (15.4)
Body mass index mean (SD)	26.3 (4.2)
Right-handed	199 (88.8%)
Physical activity practice mean (SD)	111 (66.5)
Physical activity hours/week	2 (6)*
Any medical treatment**	111 (49.1%)
Osteopenia	4 (1.8%)
Osteoporosis	9 (4%)
Artrosis	80 (35.7%)
Metal allergy	2 (0.8%)
Hypothyroidism	12 (5.4%)
Anti-agregants	5 (2.2%)
Anticoagulants	0
Computer (hours/day)	0 (2)*
Job characteristics* **	
Mean hours/day work mean (SD)	7,8 (1)
Prolonged standing	130 (58.8%)
Highly repetitive work	162 (72.3%)
Working with the hands lifted to shoulder height or higher	174 (76.6%)
Heavy lifting	127 (56.7%)
Vibratory tool	18 (8%)
Typing	72 (32.1%)
Sedentary work positions (working, sitting)	77 (34.4%)
Static position of neck and shoulder	84 (37.5%)
Symptoms*	
VAS scores	5 (2,15)
PPT trapezius (kg/cm^2)	2 (0,75)
PPT levator scapulae (kg/cm^2)	2 (0,74)
PPT splenius cervicis (kg/cm^2)	1.9 (1)
PPT multifidi (kg/cm^2)	2.2 (0.98)
ROM flexion/extension °	100 (20)
ROM rotation °	105 (30)
ROM inclination °	60 (10)
Strength right rotation (N)	75 (30)
Strength left rotation (N)	75 (37.5)
Strength right inclination (N)	75 (37.75)
Strength left inclination (N)	75 (40)
Strength flexion (N)	70 (48)
Strength extension (N)	80 (43.5)

° = degrees; N = Newtons.

*Median (interquartile range) for non-parametric data [Md (IQR)].

**Includes: NSAIDs, paracetamol, statins, anti-diabetes medication, antihistamines, calcium, chondrosan/chondrosulf/chondroitin, anticonceptive pills, antihypertensive drugs, anti-agregant drugs, anti-coagulant drugs.

***Excluded retired and unemployed.

and static positions of the neck and shoulders. Others have reported, that during low-level contractions of the trapezius muscle, specific smaller motor units may be recruited first and de-recruited last [29,44,45] which can also lead to the development of work-related MTrPs in the upper trapezius muscle [17,25,41,43]. Our study seems to support a correlation between neck pain and the trapezius muscle as 93.2% of our participants presented with active MTrPs in the trapezius muscle, taking into account that only approximately one-third of our participants were office workers. Thus, neck pain could be related more to the postural issue, inadequate rest or overload [29,46] than related to the computer work itself.

Regarding latent MTrPs, Lucas et al. established a high prevalence of latent MTrPs (89%) in healthy subjects [28], which seems to conflict with our 12.95% prevalence of subjects with latent MTrPs in the trapezius muscle. All participants suffered from chronic non-specific neck pain, while the subjects of Lucas et al. [28] were healthy subjects. Moreover, the majority of the subjects of our study presented with active MTrPs, and MTrPs cannot be diagnosed simultaneously as active and latent [28]. Latent MTrPs in healthy subjects, however, could become active when the muscle is exposed to temporary or sustained mechanical overload [17,25,29,30,41,43–46]. We suggest that chronic neck pain may be initiated and maintained as a consequence of the MTrPs themselves.

The diagnosis of MTrPs is actually one of the limitations of our study. Despite the lack of validated diagnostic criteria for the identification of MTrPs [18], the diagnostic criteria used in our study [17] are commonly used in scientific studies and in clinical practice. The use of trained experienced examiners makes these criteria highly reliable [21,22,47]. The examiner of our study was a fully qualified trained physical therapist with more than 15 years of experience in the diagnosis and treatment of MTrPs.

Although experience and training do contribute to improved reliability, we may have introduced a potential bias as only one examiner collected the data, which could be considered a limitation of our study. Future studies may want to consider having multiple examiners, which unfortunately was not possible in our clinical setting.

Another possible limitation of the study is the fact that all subjects came from three primary care centers of Alcalá de Henares, Madrid.

Although this study found a high prevalence of MPS among subjects with chronic non-specific neck pain,

Table 3 Association between pain pressure threshold and profession, exercise, medication, and sex

	Profession*					Exercise**			Pain killers**			Sex**		
Md(IQR)	Static head position	Hands over shoulders	Hands under shoulder	Inactive	*P* value	Yes	No	*P* value	Yes	No	*P* value	Men	Women	*P* value
Trapezius	1.96 (0.84)	2.08 (1.01)	1.97 (0.95)	1.75 (0.66)	0.033	2 (0.77)	1.75 (0.825)	0.172	2 (1.03)	1.9 (0.74)	0.559	1.8 (0.75)	1.96 (0.59)	0.344
Levator scapulae	1.4 (0.575)	1.82 (1)	1.95 (0.49)	2.03 (0.75)	0.137	1.6 (0.7)	2 (0.695)	0.499	1.45 (0.69)	1.875 (0.65)	0.136	1.85 (0.85)	1.75 (0.7)	0.477
Cervical esplenius	1.33 (1.27)	1.9 (1.01)	1.65 (0.68)	1.6 (0.8)	0.121	1.6 (0.9)	1.9 (1.18)	0.286	1.35 (1.43)	1.675 (1)	0.559	1.6 (1)	1.65 (1.02)	0.69
Cervical multifidi	2.25 (0.795)	2.55 (1.19)	2 (0.89)	2.5 (1.13)	0.685	2.2 (0.85)	2.36 (0.97)	0.353	2.6 (1.07)	2.25 (0.9)	0.404	2.06 (0.76)	2.45 (0.97)	0.129

Md (IQR) = median (interquartile range).
*Kruskal Wallis Test.
**Mann-Whitney U Test.

Table 4 Prevalence of MTrPs in muscles and muscle group with N = 224. PPTs values are expressed in median (interquartile range). Percentages represent number of participants who present with that MTrP

	Active	MTrPs	Latent	MTrPs		Active	MTrPs	Latent	MTrPS
Muscles one by one	Md (IQR) PPT (kg/m^2)	Total (%)	Md (IQR) PPT (kg/m^2)	Total (%)	Group of muscles	Md (IQR)	Total (%)	Md (IQR) PPT (kg/m^2)	Total (%)
Right trapezius	2 (0.51)	196 (87.5%)	2 (0.75)	22 (9.82%)					
Left trapezius	2 (0.98)	190 (84.82%)	2 (0.43)	18 (8.04%)	Trapezius	2 (0.75)	210 (93.75%)	2.15 (0.75)	29 (12.95%)
Right levator scapulae	2 (0.8)	143 (63.84%)	2 (1.15)	9 (4.02%)	Levator				
Left levator scapulae	2 (0.5)	121 (54.02%)	2.3 (1.05)	14 (6.25%)	Scapulae	2 (0.74)	184 (82.14%)	2.025 (0.1)	20 (8.93%)
Right splenius	1.6 (1)	104 (46.43%)	2 (0.575)	6 (2.68%)	Splenius				
Left splenius	1.8 (0.5)	104 (46.43%)	2.3 (0.55)	10 (4.46%)	Cervicis	1.9 (1)	140 (62.5%)	2.3 (0.5)	15 (6.7%)
Right multifidi	2.1 (1)	144 (64.29%)	2.75 (1.35)	14 (6.25%)	Multifidi				
Left multifidi	2.5 (1)	136 (60.71%)	5 (3.95)	11 (4.91%)	Trapezius	2.2 (0.98)	174 (77.68%)	2.75 (0.55)	21 (9.38%)

Md(IQR) = median (interquartile range) for non-parametric data; PPT (kg/m^2) = pressure pain threshold.

diagnostic associations between a diagnosis of chronic non-specific neck pain and MTrPs have not yet been performed. Thus, establishing MPS as one of the diagnostic criteria for non-specific neck pain could be a new interesting line of research for future studies. It could also be interesting to obtain data about the prevalence of latent MTrPs in these muscles in people without neck pain. Larger multicenter studies taking into account longer pain duration, high pain intensity, poor quality of sleep and repetitive stress [48] are needed to confirm that our results can be extrapolated to other samples.

Conclusions

Myofascial pain syndrome is a common source of pain in chronic non-specific neck pain. All participants of the study presented with MTrPs in the trapezius, multifidi, splenius cervicis, or levator scapulae muscles associated with their neck pain. We conclude that the MPS examination is essential in the diagnosis of non-specific neck pain [49].

Acknowledging the prevalence of MPS and understanding the severity and persistent nature of MPS are important when evaluating and treating patients with chronic non-specific neck pain.

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References

1 Badley EM, Tennant A. Changing profile of joint disorders with age: Findings from a postal survey of the population of Calderdale, West Yorkshire, United Kingdom. Ann Rheum Dis 1992;51(3):366–71.

2 March LM, Brnabic AJ, Skinner JC, et al. Musculoskeletal disability among elderly people in the community. Med J Aust 1998;168(9):439–42.

3 Fernandez-de-las-Penas C, Hernandez-Barrera V, Alonso-Blanco C, et al. Prevalence of neck and low back pain in community-dwelling adults in Spain: A population-based national study. Spine 2011;36(3): E213–9.

4 Deyo RA, Mirza SK, Martin BI. Back pain prevalence and visit rates: Estimates from U.S. national surveys, 2002. Spine 2006;31(23):2724–7.

5 Cote P, Cassidy JD, Carroll LJ, Kristman V. The annual incidence and course of neck pain in the general population: A population-based cohort study. Pain 2004;112(3):267–73.

6 Côte P, Kristman V, Vidmar M, et al. The prevalence and incidence of work absenteeism involving neck pain: A cohort of Ontario lost-time claimants. Spine 2008;33(4 suppl):S192–8.

7 Mesas AE, Gonzalez AD, Mesas CE, et al. The association of chronic neck pain, low back pain, and migraine with absenteeism due to health problems in Spanish workers. Spine 2014;39(15):1243–53.

8 Brage S, Nygard JF, Tellnes G. The gender gap in musculoskeletal-related long-term sickness absence in Norway. Scand J Soc Med 1998;26(1):34–43.

9 Cimmino MA, Grassi W, Cutolo M. Best practice & research clinical rheumatology. Imaging and musculoskeletal conditions. Preface. Best Pract Res Clin Rheumatol 2008;22(6):949.

10 Guo HR, Tanaka S, Halperin WE, Cameron LL. Back pain prevalence in US industry and estimates of lost workdays. Am J Public Health 1999;89(7):1029–35.

11 Borghouts JA, Koes BW, Bouter LM. The clinical course and prognostic factors of non-specific neck pain: A systematic review. Pain 1998;77(1):1–13.

12 Schellingerhout JM, Verhagen AP, Heymans MW, et al. Which subgroups of patients with non-specific neck pain are more likely to benefit from spinal manipulation therapy, physiotherapy, or usual care? Pain 2008;139(3):670–80.

13 Vonk F, Verhagen AP, Twisk JW, et al. Effectiveness of a behaviour graded activity program versus conventional exercise for chronic neck pain patients. Eur J Pain 2009;13(5):533–41.

14 Fernandez-de-las-Penas C, Alonso-Blanco C, Miangolarra JC. Myofascial trigger points in subjects

presenting with mechanical neck pain: A blinded, controlled study. Man Ther 2007;12(1):29–33.

15 Fernandez-de-Las-Penas C, Cuadrado ML, Pareja JA. Myofascial trigger points, neck mobility, and forward head posture in episodic tension-type headache. Headache 2007;47(5):662–72.

16 Cerezo-Téllez E, Torres-Lacomba M, Fuentes-Gallardo I, et al. Dry needling of the trapezius muscle in office workers with neck pain: A randomized clinical trial. J Man Manip Ther 2015;23:1–10.

17 Simons DG, Travell JG, Simons LS. Myofascial Pain and Dysfunction. The Trigger Point Manual. Upper Half of Body, 2nd edition. Baltimore, MD: Williams & Wilkins; 1999.

18 Simons DG. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. J Electromyogr Kinesiol 2004;14(1):95–107.

19 Baldry PE. Acupuncture, Trigger Points and Musculoskeletal Pain, 3rd edition. London: Elsevier-Churchill-Livingstone; 2005.

20 Bron C, Franssen J, Wensing M, Oostendorp RA. Interrater reliability of palpation of myofascial trigger points in three shoulder muscles. J Man Manip Ther 2007;15(4):203–15.

21 Gerwin RD, Shannon S, Hong CZ, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. Pain 1997;69(1–2):65–73.

22 Sciotti VM, Mittak VL, DiMarco L, et al. Clinical precision of myofascial trigger point location in the trapezius muscle. Pain 2001;93(3):259–66.

23 Torres Lacomba M, Mayoral del Moral O, Coperias Zazo JL, Gerwin RD, Goni AZ. Incidence of myofascial pain syndrome in breast cancer surgery: A prospective study. Clin J Pain 2010;26(4):320–5.

24 Fishbain DA, Goldberg M, Meagher BR, Steele R, Rosomoff H. Male and female chronic pain patients categorized by DSM-III psychiatric diagnostic criteria. Pain 1986;26(2):181–97.

25 Skootsky SA, Jaeger B, Oye RK. Prevalence of myofascial pain in general internal medicine practice. West J Med 1989;151(2):157–60.

26 Ge HY. Prevalence of myofascial trigger points in fibromyalgia: The overlap of two common problems. Curr Pain Headache Rep 2010;14(5):339–45.

27 Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. BMC Musculoskelet Disord 2011;12:139.

28 Lucas KR, Rich PA, Polus BI. How common are latent myofascial trigger points in the scapular positioning muscles? J Muscoskel Pain 2008;16(4): 279–86.

29 Kadefors R, Forsman M, Zoega B, Herberts P. Recruitment of low threshold motor-units in the trapezius muscle in different static arm positions. Ergonomics 1999;42(2):359–75.

30 Kostopoulos D, Rizopoulos K. The Manual of Trigger Point and Myofascial Therapy. Thorofare, NJ: Slack Inc.; 2001.

31 Shah JP, Gilliams EA. Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: An application of muscle pain concepts to myofascial pain syndrome. J Bodyw Mov Ther 2008;12(4):371–84.

32 Hsieh Y-L, Yang S-A, Yang C-C, Chou L-W. Dry needling at myofascial trigger spots of rabbit skeletal muscles modulates the biochemicals associated with pain, inflammation, and hypoxia. Evid Based Complement Alternat Med 2012;2012:342165. doi: 10.1155/2012/342165.

33 Hsieh Y-L, Yang C-C, 2 Liu S-Y, Chou L-W, Hong C-Z. Remote dose-dependent effects of dry needling at distant myofascial trigger spots of rabbit skeletal muscles on reduction of substance P levels of proximal muscle and spinal cords. BioMed Research International 2014; Article ID 982121, 11 pages. http://dx.doi.org/10.1155/2014/982121.

34 Vasavada AN, Li S, Delp SL. Three-dimensional isometric strength of neck muscles in humans. Spine 2001;26(17):1904–9.

35 Ylinen J, Salo P, Nyka ¨nen M, Kautiainen H, Ha ¨kkinen A. Decreased isometric neck strength in women with chronic neck pain and the repeatability of neck strength measurements. Arch Phys Med Rehabil 2004;85:1303–8.

36 Highland TR, Dreisinger TE, Vie LL, Russell GS. Changes in isometric strength and range of motion of the isolated cervical spine after eight weeks of clinical rehabilitation. Spine 1992;17(6 suppl): S77–82.

37 Falla D, Bilenkij G, Jull G. Patients with chronic neck pain demonstrate altered patterns of muscle

activation during performance of a functional upper limb task. Spine 2004;29(13):1436–40.

38 Falla DL, Jull GA, Hodges PW. Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine 2004;29(19):2108–14.

39 Liley AW. The effects of presynaptic polarization on the spontaneous activity at the mammalian neuromuscular junction. J Physiol 1956;134(2):427–43.

40 Liley AW. An investigation of spontaneous activity at the neuromuscular junction of the rat. J Physiol 1956;132(3):650–66.

41 Zennaro D, Laubli T, Krebs D, Klipstein A, Krueger H. Continuous, intermitted and sporadic motor unit activity in the trapezius muscle during prolonged computer work. J Electromyogr Kinesiol 2003;13(2): 113–24.

42 Irnich D, Behrens N, Gleditsch JM, et al. Immediate effects of dry needling and acupuncture at distant points in chronic neck pain: Results of a randomized, double-blind, sham-controlled crossover trial. Pain 2002;99(1–2):83–9.

43 Lucas KR, Polus BI, Rich PA. Latent myofascial trigger points: Their effects on muscle activation and movement efficiency. J Bodyw Mov Ther 2004;8(3): 160–6.

44 Kitahara T, Schnoz M, Laubli T, Wellig P, Krueger H. Motor-unit activity in the trapezius muscle during rest, while inputting data, and during fast finger tapping. Eur J Appl Physiol 2000;83(2-3):181–9.

45 Strom V, Knardahl S, Stanghelle JK, Roe C. Pain induced by a single simulated office-work session: Time course and association with muscle blood flux and muscle activity. Eur J Pain 2009;13(8):843–52.

46 Gerwin RD, Dommerholt J, Shah JP. An expansion of Simons' integrated hypothesis of trigger point formation. Curr Pain Headache Rep 2004;8(6):468–75.

47 Myburgh C, Lauridsen H, Larsen A, Hartvigsen J. Standardized manual palpation of myofascial trigger points in relation to neck/shoulder pain; the influence of clinical experience on inter-examiner reproducibility. Man Ther 2011;16:136–40.

48 Huang YT, Lin SY, Neoh CA, et al. Dry needling for myofascial pain: Prognostic factors. J Altern Complement Med 2011;17(8):755–62.

49 Freeman MD, Nystrom A, Centeno C. Chronic whiplash and central sensitization; an evaluation of the role of a myofascial trigger points in pain modulation. J Brachial Plex Peripher Nerve Inj 2009;4:2.