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Original Research

The Prevalence of Latent Trigger Points in Lower Limb Muscles in Asymptomatic Subjects

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Abstract

Background: Latent trigger points (LTrPs) are prevalent in persons with musculoskeletal pain. Because they could be present in healthy persons, it is necessary to evaluate the prevalence of LTrPs in asymptomatic subjects.
Objectives: To assess the prevalence of LTrPs in lower limb muscles, to evaluate the relationship between LTrP prevalence, gender, and leg dominance, and to determine intra-rater reliability for the diagnosis of LTrPs.
Design: Cross-sectional study.
Setting: University community.
Patients: A total of 206 asymptomatic subjects (113 women and 93 men, aged 23.2 $\pm$ 5.2 years).
Intervention: Not applicable.
Main Outcomes Measures: The prevalence of the LTrPs located in the gastrocnemius, soleus, peroneus longus, peroneus brevis, tibialis anterior, extensor digitorum longus, flexor digitorum longus, rectus femoris, vastus medialis, and vastus lateralis was studied, using the diagnosis criteria recommended by Simons, Travell, and Simons. The pressure pain threshold was also evaluated.
Results: Of the 206 subjects evaluated, 166 (77.7%; 95% confidence interval [CI], 72-83.4) were found to have at least one LTrP in the lower limb muscles. The average number of LTrPs found per individual was 7.5 $\pm$ 7.7. The prevalence in each muscle group ranged from 19.9% (95% CI, 14.4-25.4) to 37.4% (95% CI, 30.8-44), with gastrocnemius LTrPs being the most prevalent. Women had more LTrPs (9.6 $\pm$ 7.8) than did men (4.9 $\pm$ 6.6) ($P < .01$). No relationship was found between the LTrPs and leg dominance ($P > .05$). The most prevalent diagnosis criteria were the presence of a taut band and a tender spot (98%-100%); the local twitch response was the least prevalent diagnosis criteria (0%-3.5%). Intra-rater reliability was excellent for all the diagnosis criteria in all the muscles evaluated ($\kappa = 0.762$-1), except for the jump sign and the referred pain in several LTrPs.
Conclusion: LTrPs were prevalent in the lower limb muscles of asymptomatic subjects. Women have more LTrPs than do men. No differences in LTrP prevalence were found between sides. The presence of the taut band and the tender spot were the most prevalent and reliable diagnosis criteria. It is necessary to determine if the evaluation of LTrPs in the lower limb muscles of asymptomatic subjects has clinical relevance.

Introduction

A myofascial trigger point (MTrP) is a hyperirritable spot located in a palpable taut band of skeletal muscle that produces local and referred pain; it is painful upon compression, stretching, or overload of the muscle [1]. An MTrP can be classified as active (ATrP) or latent (LTrP) [1]. ATrPs can produce local and referred spontaneous pain, motor dysfunction (eg, muscle weakness, decreased work tolerance, and loss of coordination), autonomic phenomena (including pilomotor activity, abnormal sweating, or persistent lacrimation), and, when they are correctly stimulated, a local twitch response (LTR) [2]. ATrPs have been shown to have endplate noise on electrodiagnostic evaluation [3]; in addition, proinflammatory and pain substances have been found at these sites [4]. The prevalence of pain due to ATrPs has been reported to range from 29%-92% [5-8], depending on the underlying pain condition [5,9].

LTrPs do not cause spontaneous pain; however, pain and other symptoms can be induced by stimulation with a needle or manually [1,10]. Simons et al [1] suggested

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that LTrPs may be a potential source of sensory motor dysfunction, may cause muscle damage, and easily become ATrPs if the root causes of LTrPs are not treated [1,11]. In a case report, it was shown that LTrPs are visible on ultrasound images [12]. Similar to ATrPs, they also show biochemical alterations [13,14] and spontaneous electrical activity [3,15,16]. In addition, LTrPs affect reciprocal inhibition [16], increase muscle cramps [17], and produce changes in muscular activity. Lucas et al [18] demonstrated that the presence of LTrPs in the scapular rotator muscles changes the muscle activation pattern of these muscles, decreasing the efficiency of movement. LTrPs also provoke a restriction of range of motion (ROM) [13]. In fact, it has been demonstrated that the treatment of LTrPs increases joint ROM in several joints, including the ankle [19] and the knee [20].

LTrPs are prevalent in patients with musculoskeletal pain [13]. Thus LTrPS are prevalent in persons with lateral epicondylalgia [8] and shoulder pain [7], in persons who have had a meniscectomy [21], and in persons with patellofemoral pain [22], triceps surae dysfunction [23], knee osteoarthritis [9], chronic nonspecific low back pain [24], chronic tension-type headache [25], or neck pain [26]. LTrPs are also prevalent in healthy subjects. Sola et al [27] studied the presence of LTrPs in several muscles of the upper shoulder girdle in 200 asymptomatic subjects. They found one or more LTrPs in 49.5% of the sample. In 2008, Lucas et al [5] evaluated the prevalence of LTrPs in the scapular muscles of 154 asymptomatic subjects. These investigators observed that nearly 90% of 154 subjects had at least one LTrP. In relation to the lower extremities, in 2013, Grieve et al [28] showed that the prevalence of LTrPs in the gastrocnemius and soleus ranged from 16%-30% in 220 healthy subjects. Zuil-Escobar et al [29] studied the prevalence of LTrPs in several lower limb muscles in subjects with lower medial longitudinal arch and in control subjects, with prevalence ranging from 18%-43%. Although LTrPs are considered a minor injury [1], they may affect muscular activity [16-18], including movement efficiency [18] and ROM [13], and they may turn into ATrPs [1,11]; therefore, it is necessary to evaluate their prevalence in asymptomatic subjects.

The principal aim of this study is to evaluate the prevalence of LTrPs in the muscles of the lower limbs in asymptomatic subjects. The secondary aims are to evaluate the relationship between LTrP prevalence, gender, and leg dominance and the intra-rater reliability for the diagnosis of LTrP, as well as for the specific diagnosis criteria.

Methods

A cross-sectional study was used to evaluate the prevalence of LTrPs in several muscles of the lower limb in asymptomatic subjects on a university campus. Volunteers (white students) were recruited to participate in the study. Each subject was informed about the aims and procedure and completed a consent form before being included in the study. The principles outlined in the Declaration of Helsinki of 1975 were observed, and the study was approved by the Research Ethics Committee of the CEU San Pablo University. Participants completed a form to ensure that they did not meet the exclusion criteria. Participants who had undergone lower extremity surgery, had lower limb deformities, had experienced acute injuries in the lower limbs, had reduced normal ROM in the lower limbs, and/or had systemic or neurologic diseases affecting pain perception were excluded. Demographic data, including age, gender, height, weight, body mass index, and lower limb dominance, were collected from eligible subjects. Lower limb dominance was determined by a kick-ball test [30].

The first 30 subjects (age, 23 $\pm$ 4.26 years; 17 women and 13 men) were used to calculate the intra-rater reliability of the procedures and the sample size. Intra-rater reliability was calculated using a test-retest study with a period of 48 hours between the evaluations, with both the subjects and the rater being blinded to the results. To calculate the sample size, and using the ENE 3.0 program (GlaxoSmithKline, Barcelona, Spain), the mean prevalence value (26%) obtained in the first 30 subjects, with a precision level of 6% and a confidence level of 95%, was used. The sample size obtained was 206 subjects, including 113 women (54.9%) and 93 men (45.1%). Table 1 shows the demographic variables.

LTrPs were diagnosed by a physical therapist with 15 years' experience in the management of myofascial pain syndrome. The procedures and locations identified by Simons, Travell, and Simons [31] have been used for the identification of LTrPs in the following muscles: medial gastrocnemius (MTrP1), lateral gastrocnemius (MTrP2), soleus (MTrP1), peroneus longus (PL), peroneus brevis (PB), tibialis anterior (TA), extensor digitorum longus (EDL), flexor digitorum longus (FDL), rectus femoris (RF), vastus medialis (VM) of quadriceps (MTrP1 and MTrP2), and vastus lateralis (VL) of quadriceps (MTrP1 and MTrP2). Quadriceps MTrPs were explored with the subject in a supine position and using flat

Table 1
Participant characteristics

	Mean	Standard Deviation	n (%)
Age, y	23.2	5.2	
Height, m	1.7	0.1	
Weight, kg	69.4	12.2	
BMI	24.1	2.3	
Gender			
Female			113 (54.9)
Male			93 (45.1)

BMI = body mass index.

palpation. For RF MTrP, the lower limb was placed in moderate abduction and the knee was extended. For VM, the lower limb was in moderate abduction and the knee was in 90° of flexion, whereas for VL, the knee was extended. For gastrocnemius, soleus, and FDL MTrPs, subjects lay on their side. Pincer palpation was used to explore the heads of the gastrocnemius and flat palpation for FDL. For soleus MTrP, the subject was placed in the same position but with the knee flexed; MTrP was palpated using flat palpation. For examination of TA, EDL, PL and PB, the subject lay supine and flat palpation was used (Figure 1). Subjects were examined bilaterally. The order for evaluating the MTrPs was randomized for each subject, using a computer algorithm.

The criteria recommended by Simons, Travell, and Simons [1] were used to diagnose LTrPs:

- A palpable taut band in a skeletal muscle
- A hypersensitive tender spot
- Referred pain of the MTrP in response to compression
- Jump sign (a response of the patient, who winces, may cry out, and may withdraw)
- LTR provoked by the snapping palpation of the taut band

LTrPs were considered positive if 2 or more criteria were identified [28].

In addition, pain pressure threshold (PPT) was evaluated in potential LTrP sites. An analogic algometer (Wagner Instruments, Greenwich, CT) was used to evaluate PPT, which was defined as the minimum pressure that induces pain or discomfort [31]. To obtain PPT, the potential MTrP site (the point of maximum tenderness) was located with the fingers and then the tip of the algometer was applied to the skin surface in a perpendicular position. Pressure was continuously increased at a rate of 1 kg/sec. Subjects were asked to report when they felt pain or discomfort [32]. Three measurements per potential LTrP site were calculated, using the mean to calculate the PPT. A 30-second interval was given between each of the measurements [5].

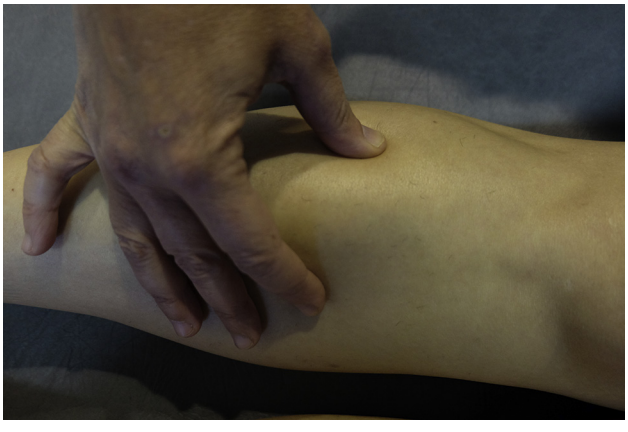

Figure 1. Identification of a latent trigger point in the extensor digitorum longus

Statistical Analysis

Statistical analysis was conducted using SPSS Statistics version 20 (IBM Corp, Armonk, NY) and executed at a 95% confidence level. The normal distribution of the quantitative variables was assessed using the Kolmogorov-Smirnov test, in this case using parametric tests. Descriptive analysis was conducted using means and standard deviations (SDs) for quantitative variables and frequencies and percentages for categorical variables. Intra-reliability of diagnosis criteria was evaluated in the first 30 subjects, using Cohen kappa (κ) for categorical variables and intraclass correlation coefficient (ICC) for quantitative variables. Reliability was interpreted as follows: poor, 0-0.39; moderate, 0.4-0.74; and excellent, $\geq$0.75 [33]. The unpaired Student *t*-test was used to analyze the differences in the total number of LTrPs between male and female subjects and the dominant and nondominant lower limbs. The χ^2 test was conducted to evaluate the difference in the LTrP prevalence for each specific muscle and gender and dominant side. The paired Student *t*-test was used to compare PPT in muscles with and without LTrPs.

Results

Reliability

The diagnosis of LTrP showed excellent intra-rater reliability ($>$0.85) for all the muscles studied except for the nondominant soleus (0.792; Tables 2 and 3 show κ and ICC values). Regarding the specific diagnosis criteria, intra-rater reliability was excellent for the taut band and tender spot in all the muscles evaluated; the referred pain was also excellent in all the muscles, except for the dominant RF LTrP. The jump sign presents the lowest κ values, which were moderate in the dominant medial gastrocnemius MTrP, the dominant PL MTrP, the dominant RF MTrP, the nondominant soleus MTrP, and the nondominant RF MTrP. The LTR reliability was not calculated, given that it was absent in the majority of the evaluated muscles. ICCs were superior to 0.8 for PPT in all the evaluated muscles.

Prevalence of LTrPs

Of the 206 subjects evaluated, 166 (77.7%; 95% confidence interval [CI], 72-83.4) were found to have at least one LTrP in the lower limb muscles, whereas the average number of LTrPs found per individual was 7.5 $\pm$ 7.7. One hundred thirty-three participants (64.6%; 95% CI, 58.1-71.1) had at least one LTrP in the dominant lower limb (mean, 3.8 $\pm$ 3.8), and 154 (74.8%; 95% CI,

Table 2
Cohen κ for diagnosis criteria and intraclass correlation coefficient for pain pressure threshold (kg/cm^2) in the dominant lower limb (n = 30; $P < .01$)

	Taut Band	Tender Spot	Jump Sign	Referred Pain	LTrP	PPT
Gastrocnemius MTrP1	0.861	0.932	0.651	0.839	0.930	0.901
Gastrocnemius MTrP2	0.927	0.830	1	0.783	0.918	0.903
Soleus MTrP1	0.911	0.814	1	1	0.902	0.839
PL MTrP	0.831	0.842	0.651	0.870	1	0.884
PB MTrP	0.902	0.792	1	1	0.889	0.842
EDL MTrP	0.842	0.851	1	0.870	0.918	0.863
TA MTrP	0.841	0.851	0.783	1	0.926	0.919
FDL MTrP	1	0.911	1	1	1	0.858
RF MTrP	0.814	0.911	0.651	0.714	0.902	0.845
VM MTrP1	0.930	0.930	0.839	0.889	0.927	0.913
VM MTrP2	0.911	0.923	0.783	0.889	0.918	0.893
VL MTrP1	0.932	0.933	0.889	0.815	0.932	0.882
VL MTrP2	0.927	0.930	0.902	0.902	1	0.888

LTrP = latent trigger point; PPT = pressure pain threshold; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; TA = tibialis anterior; FDL = flexor digitorum longus; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

68.9-80.7) had at least one LTrP in the nondominant lower limb (mean, 3.7 ± 4.1).

Table 4 and Figure 2 show the prevalence of LTrPs in the specific muscles evaluated, ranging from 19.9% (95% CI, 14.4-25.4) to 37.4% (95% CI, 30.8-44). The most prevalent LTrPs were the medial and lateral gastrocnemius (both dominant and nondominant), showing a prevalence of >30%. Other muscles with LTrP prevalence above or near 30% were the PL (both dominant and nondominant sides), EDL (dominant lower limb), TA (dominant lower limb), VM (both dominant and nondominant MTrP1) and VL (both dominant and nondominant MTrP1 and nondominant MTrP2). Lower LTrP prevalence was shown in the soleus, PB, and RF, ranging from 19.9 (95% CI, 14.4-25.4) to 23.8% (95% CI, 18-29.6).

Women had more LTrPs (mean, 9.6 ± 7.8) than did men (mean, 4.9 ± 6.6), with statistical differences ($P < .01$). When the prevalence of each specific LTrP was compared between genders, statistical differences were observed in all muscles ($P < .05$), except in the dominant and nondominant soleus, the dominant TA, and the nondominant RF.

The same number of LTrPs on both lower extremities was presented by 40.8% (95% CI, 34.1-47.5) of the subjects, whereas 30.6% (95% CI, 24.3-36.9) had more LTrPs on the dominant lower limb and 28.6% (95% CI, 22.4-34.8) had more on the nondominant lower limb. No statistical differences were found when the prevalence of each specific LTrP for dominant and nondominant sides was compared.

Criteria Diagnosis

Tables 5 and 6 show the prevalence of the LTrP diagnosis criteria evaluated. The most prevalent diagnosis criteria were the presence of a taut band and a tender spot, ranging from 97.8%-100% in subjects with LTrPs. The LTR was the least frequent diagnosis criterion (0%-3.5%), as it was not present in all the muscles

Table 3
Cohen κ for diagnosis criteria and intraclass correlation coefficient for pain pressure threshold (kg/cm^2) in the nondominant lower limb (n = 30; $P < .01$)

	Taut Band	Tender Spot	Jump Sign	Referred Pain	LTrP	PPT
Gastrocnemius MTrP1	0.932	0.864	1	0.839	0.856	0.929
Gastrocnemius MTrP2	1	0.864	1	1	1	0.918
Soleus MTrP1	0.814	0.902	0.651	0.783	0.793	0.851
PL MTrP	0.918	0.918	1	1	1	0.877
PB MTrP	0.902	0.902	1	0.839	1	0.889
EDL MTrP	0.923	0.923	0.783	1	0.918	0.904
TA MTrP	0.923	0.923	1	0.839	1	0.880
FDL MTrP	0.911	0.831	1	0.889	0.911	0.888
RF MTrP	0.911	0.831	0.651	0.839	0.815	0.858
VM MTrP1	0.861	0.930	1	1	0.927	0.902
VM MTrP2	0.830	0.851	1	0.762	0.830	0.865
VL MTrP2	0.861	0.864	0.762	0.902	0.861	0.879
VL MTrP2	0.851	0.856	0.793	0.793	0.927	0.881

LTrP = latent trigger point; PPT = pressure pain threshold; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; TA = tibialis anterior; FDL = flexor digitorum longus; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

Table 4
Prevalence of latent trigger point in the muscles evaluated

Dominant Lower Limb	LTrP Prevalence, n (%; 95% CI) (Total N = 206)	Nondominant Lower Limb	LTrP Prevalence, n (%; 95% CI) (Total N = 206)
Gastrocnemius MTrP1	77 (37.4; 95% CI 30.1-44)	Gastrocnemius MTrP1	75 (36.1; 95% CI 29.5-42.7)
Gastrocnemius MTrP2	70 (34.0; 95% CI 27.5-40.5)	Gastrocnemius MTrP2	64 (31.1; 95% CI 24.8-37.4)
Soleus MTrP1	49 (23.8; 95% CI 18-29.6)	Soleus MTrP1	41 (19.9; 95% CI 14.5-25.4)
PL MTrP	63 (30.6; 95% CI 24.3-36.9)	PL MTrP	61 (29.6; 95% CI 23.4-35.8)
PB MTrP	45 (21.9; 95% CI 16.3-27.6)	PB MTrP	45 (21.9; 95% CI 16.3-27.6)
EDL MTrP	61 (29.6; 95% CI 23.4-35.8)	EDL MTrP	57 (27.6; 95% CI 21.5-33.7)
FDL MTrP	49 (23.8; 95% CI 18-29.6)	FDL MTrP	47 (22.8; 95% CI 17.1-28.5)
TA MTrP	62 (30.1; 95% CI 23.8-36.4)	TA MTrP	56 (27.2; 95% CI 21.1-33.3)
RF MTrP	45 (21.9; 95% CI 16.3-27.6)	RF MTrP	43 (20.9; 95% CI 15.4-26.5)
VM MTrP1	67 (32.5; 95% CI 26.1-38.9)	VM MTrP1	65 (31.6; 95% CI 25.3-38)
VM MTrP2	58 (28.2; 95% CI 22.1-34.3)	VM MTrP2	55 (26.7; 95% CI 20.7-32.7)
VL MTrP1	66 (32.0; 95% CI 25.6-38.4)	VL MTrP1	71 (34.5; 95% CI 28-41)
VL MTrP2	60 (29.1; 95% CI 22.9-35.3)	VL MTrP2	67 (32.5; 95% CI 26.1-38.9)

LTrP = latent trigger point; CI = confidence interval; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; FDL = flexor digitorum longus; TA = tibialis anterior; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

studied in subjects with LTrPs. Table 7 shows the PPT in muscles with and without LTrPs ($P < .01$).

Discussion

Reliability

The intra-rater reliability of the diagnosis of the LTrPs was excellent in all the muscles evaluated. Regarding the criteria for LTrP diagnosis, the taut band and the tender spot have been the most reliable, with the Cohen κ values higher than 0.8 in all the muscles and higher than 0.9 in several muscles (Tables 1 and 2). The referred pain also shows excellent intra-rater reliability (except for the dominant RF LTrP), and the jump sign presents the lowest κ values. An important outcome is that the reliability of the LTR could not be calculated, because this diagnosis criterion was absent in several of the muscles studied. Other authors found similar results: Bron et al [34] found that LTR presented the least reliability in the shoulder muscles, and Grieve et al [28] found LTR only in 1% of the LTrPs located in the medial gastrocnemius. These findings could be due to the fact that the LTR is the most difficult diagnosis criterion to elicit by manual palpation [1]. The reliability of PPT was excellent, with ICCs ranging from 0.839-0.929. These results are similar to those obtained by Lucas et al [5].

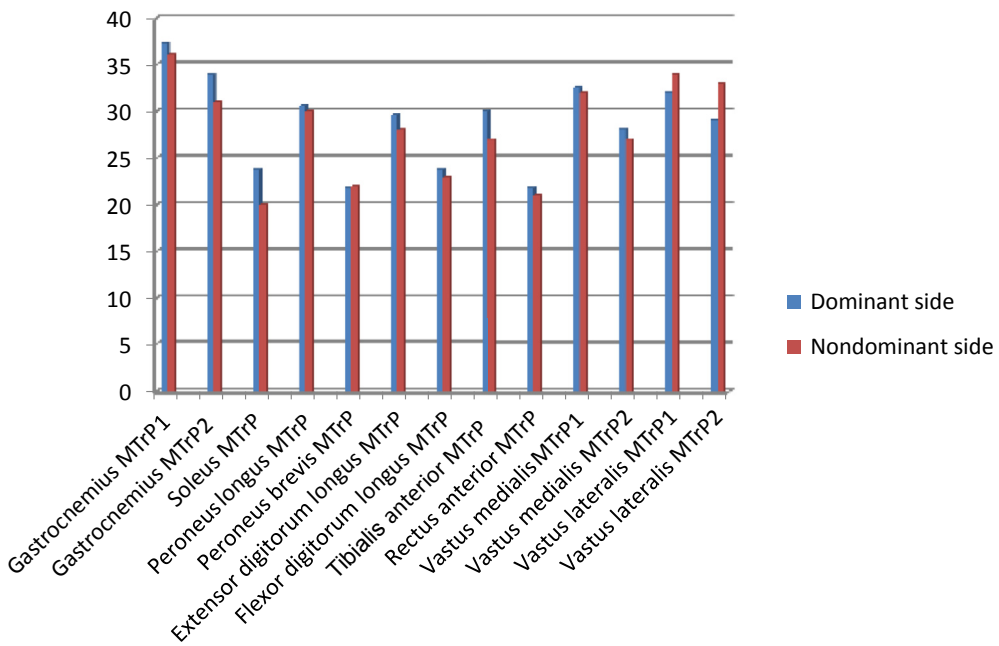

Figure 2. Prevalence (%) of latent trigger points in the dominant and nondominant lower limb (n = 206). MTrP = myofascial trigger point.

Table 5
Prevalence of the specific latent trigger point diagnosis criteria on the dominant lower limb

	Taut Band, n (%)	Tender Spot, n (%)	Jump Sign, n (%)	Referred Pain, n (%)	LTR, n (%)
Gastrocnemius MTrP1 (n = 77)	77 (100)	77 (100)	16 (20.8)	34 (44.2)	1 (1.3)
Gastrocnemius MTrP2 (n = 70)	70 (100)	70 (100)	12 (17.1)	27 (38.6)	1 (1.4)
Soleus MTrP1 (n = 49)	49 (100)	49 (100)	6 (12.3)	16 (32.7)	0 (0)
PL MTrP (n = 63)	63 (100)	63 (100)	11 (17.5)	24 (38.1)	2 (3.2)
PB MTrP (n = 45)	44 (97.8)	45 (100)	4 (8.9)	14 (31.1)	0 (0)
EDL MTrP (n = 61)	61 (100)	61 (100)	8 (13.1)	18 (29.5)	1 (1.6)
TA MTrP (n = 62)	62 (100)	62 (100)	10 (16.1)	24 (38.7)	2 (3.2)
FDL MTrP (n = 49)	49 (100)	48 (98)	3 (6.1)	17 (34.7)	0 (0)
RF MTrP (n = 45)	45 (100)	50 (100)	5 (11.1)	16 (35.6)	0 (0)
VM MTrP1 (n = 67)	67 (100)	66 (98.5)	7 (10.5)	23 (34.3)	2 (3)
VM MTrP2 (n = 58)	58 (100)	58 (100)	8 (13.8)	22 (37.9)	1 (1.7)
VL MTrP1 (n = 66)	66 (100)	66 (100)	10 (15.2)	25 (37.9)	1 (1.5)
VL MTrP2 (n = 60)	60 (100)	60 (100)	8 (13.3)	20 (33.3)	0 (0)

LTR = local twitch response; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; TA = tibialis anterior; FDL = flexor digitorum longus; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

Prevalence of LTrPs

With regard to the principal aim of the study, LTrPs are indeed prevalent in the lower limb muscles that were evaluated. Of the evaluated subjects, 77.7% (95% CI, 72-83.4) had at least one LTrP in the muscles studied. Every subject evaluated had several LTrPs; the average number of LTrPS found were 7.5 ± 7.7 per individual. These results confirm that LTrPs are common in the lower limb muscles in asymptomatic subjects.

The prevalence of LTrPs in each specific muscle ranged from 19.9% (95% CI, 14.4-25.4) to 37.4% (95% CI, 30.8-44). Medial gastrocnemius LTrPs were the most prevalent, whereas soleus, PB, and RF LTrPs were the least prevalent.

Other studies have evaluated the prevalence of specific LTrPs in lower limb muscles. In 2013, Grieve et al [28] evaluated the prevalence of LTrPs in the gastrocnemius (medial and lateral) and soleus in 220 healthy subjects; these investigators found a prevalence of LTrPs ranging from 19%-30% in the gastrocnemius and from 16%-21% in the soleus. Other studies compared lower limb LTrP prevalence in symptomatic subjects with that of control subjects. Bajab et al [35] compared the presence of MTrPs (including LTrPs) in subjects with lower limb osteoarthritis (n = 14) and control subjects (n = 14) in several lower limb muscles, including the gastrocnemius, soleus, PL, PB, VM, and VL. Although subjects with osteoarthritis had significantly greater numbers of LTrPs than did control subjects, noninjured subjects had LTrPs in the gastrocnemius (right, 7.14%; left, 4.3%), PL (right, 7.1%), and PB (left, 14.3%). Torres-Chica et al [21] compared MTrP prevalence in subjects who had undergone a meniscectomy (n = 33) and control subjects (n = 33) in the medial and lateral gastrocnemius, RF, VM, and VL. These investigators found a similar number of LTrPs in the control subjects (4 ± 1) as in the subjects who had undergone a meniscectomy (4 ± 4). In the control subjects, the highest LTrP prevalence was located in the medial

Table 6
Prevalence of the specific latent trigger point diagnosis criteria on the nondominant lower limb

	Taut Band, n (%)	Tender Spot, n (%)	Jump Sign, n (%)	Referred Pain, n (%)	LTR, n (%)
Gastrocnemius MTrP1 (n = 75)	75 (100)	75 (100)	14 (18.7)	28 (37.3)	1 (1.3)
Gastrocnemius MTrP2 (n = 64)	64 (100)	64 (100)	5 (7.8)	16 (25)	1 (1.6)
Soleus MTrP1 (n = 41)	41 (100)	41 (100)	5 (12.2)	12 (29.3)	0 (0)
PL MTrP (n = 61)	61 (100)	61 (100)	11 (18)	20 (32.8)	1 (1.6)
PB MTrP (n = 45)	44 (97.8)	45 (100)	3 (6.7)	15 (33.3)	0 (0)
EDL MTrP (n = 57)	57 (100)	57 (100)	10 (17.5)	14 (24.6)	2 (3.5)
TA MTrP (n = 56)	56 (100)	55 (98.2)	5 (8.9)	18 (32.1)	0 (0)
FDL MTrP (n = 47)	46 (97.9)	46 (97.9)	4 (8.5)	16 (34)	0 (0)
RF MTrP (n = 43)	43 (100)	43 (100)	4 (9.3)	14 (32.6)	0 (0)
VM MTrP1 (n = 65)	64 (98.5)	65 (100)	6 (9.2)	21 (32.3)	1 (1.5)
VM MTrP2 (n = 55)	55 (100)	55 (100)	12 (21,8)	23 (41.8)	0 (0)
VL MTrP1 (n = 71)	71 (100)	71 (100)	8 (11.3)	28 (39.4)	1 (1.4)
VL MTrP2 (n = 67)	67 (100)	67 (100)	8 (11.9)	25 (37.3)	0 (1.5)

LTR = local twitch response; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; TA = tibialis anterior; FDL = flexor digitorum longus; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

Table 7
Pain pressure threshold in muscles with and without latent trigger points

Muscle	PPT in LTrP	PPT in Non-LTrP
Dominant gastrocnemius MTrP1	2.1 (0.21)	2.8 (0.35)
Dominant gastrocnemius MTrP2	2.1 (0.14)	2.9 (0.25)
Dominant soleus MTrP	2.3 (0.21)	2.9 (0.32)
Dominant PL MTrP	2.1 (0.25)	3.0 (0.43)
Dominant PB MTrP	2.4 (0.14)	3.3 (0.21)
Dominant EDL MTrP	2.1 (0.31)	3.1 (0.37)
Dominant FDL MTrP	2.4 (0.20)	3.4 (0.18)
Dominant TA MTrP	2.2 (0.40)	2.9 (0.52)
Dominant RF MTrP	2.5 (0.31)	3.3 (0.40)
Dominant VM MTrP1	2.4 (0.20)	3.1 (0.42)
Dominant VM MTrP2	2.3 (0.21)	3.1 (0.22)
Dominant VL MTrP1	2.4 (0.31)	3.1 (0.32)
Dominant VL MTrP2	2.4 (0.16)	3.1 (0.22)
Nondominant gastrocnemius MTrP1	2.1 (0.25)	2.7 (0.38)
Nondominant gastrocnemius MTrP2	2.1 (0.16)	2.9 (0.21)
Nondominant soleus MTrP	2.2 (0.14)	2.9 (0.28)
Nondominant PL MTrP	2.2 (0.26)	2.9 (0.41)
Nondominant PB MTrP	2.4 (0.24)	3.2 (0.23)
Nondominant EDL MTrP	2.1 (0.20)	3.1 (0.31)
Nondominant FDL MTrP	2.4 (0.12)	3.2 (0.19)
Nondominant TA MTrP	2.2 (0.27)	3 (0.32)
Nondominant RF MTrP	2.4 (0.15)	3.2 (0.20)
Nondominant VM MTrP1	2.2 (0.27)	2.8 (0.25)
Nondominant VM MTrP2	2.2 (0.23)	3.1 (0.19)
Nondominant VL MTrP1	2.3 (0.26)	3.1 (0.22)
Nondominant VL MTrP2	2.4 (0.39)	3.1 (0.21)

Values are mean, kg/cm^2 (standard deviation).

Statistical difference ($P < .01$) was found in all sites.

PPT = pain pressure threshold; LTrP = latent trigger point; MTrP = myofascial trigger point; PL = peroneus longus; PB = peroneus brevis; EDL = extensor digitorum longus; FDL = flexor digitorum longus; TA = tibialis anterior; RF = rectus femoris; VM = vastus medialis; VL = vastus lateralis.

gastrocnemius (from 63.6%-57.6%) and the lowest prevalence was in the RF (from 3%-6.1%). Other LTrPs were located in the lateral gastrocnemius (27.3%-36.4%), VM (36.4%-39.4%), and VL (30.3%-63.7%).

Grieve et al [23] studied the prevalence of ATrPs and LTrPs in the medial and lateral gastrocnemius and the soleus in subjects with calf pain (n = 10). These investigators showed an LTrP prevalence ranging from 30%-50%. Zuil-Escobar et al [29] compared the prevalence of LTrPs in several muscles of the lower limb between subjects with lower medial longitudinal arch and control subjects. Subjects with lower medial longitudinal arch had a greater total number of LTrPs (4.46 $\pm$ 4.10) than did control subjects (3.32 $\pm$ 3.24) ($P < .05$). In addition, more LTrPs were found ($P < .05$) in the lower medial longitudinal arch group compared with the control group in the FDL (40% versus 18%), TA (38% versus 23%), and VM LTrP1 (43% versus 26%) and VM LTrPs (42% versus 24%).

Other authors have evaluated LTrP prevalence in other lower limb muscles that were not evaluated in the present study. Roach et al [22] studied the prevalence of LTrPs in the gluteus medius and the quadratus lumborum, comparing subjects who had patellofemoral pain with control subjects. The control group showed a 23% rate of LTrPs in the gluteus medius and a 34.6% rate in the quadratus lumborum.

LTrPs are present in persons with several dysfunctions located in the lower limbs, such as patellofemoral pain syndrome [21], postmeniscectomy pain [20], or knee osteoarthritis [9]. In addition, the treatment of LTrPs and ATrPs is recommended in the management of chronic calf pain [22,36]. Our results show that LTrPs are also prevalent in lower limb muscles, as they were present in more than 77% of the subjects evaluated.

It is necessary to evaluate whether the presence of LTrPs in the lower limb muscles of asymptomatic subjects has clinical relevance. Although LTrPs do not cause spontaneous pain, several investigators affirm that the presence of LTrPs produces changes in different functions. In fact, LTrPs can affect the muscular activity and efficiency of the shoulder rotator muscles in healthy subjects [37], as well as reciprocal inhibition [16]. In addition, the LTrPs located in the upper trapezius showed increased intramuscular electromyographic activity during synergistic muscle activation [15] and are associated with accelerated muscle fatigability [38]. In the lower limb, the presence of LTrPs in the gastrocnemius could increase muscle cramps [17] and reduce the ROM of the ankle [18] and the knee [19]. However, it is necessary to evaluate other effects and implications regarding the presence of LTrPs in the lower limb muscles in healthy subjects, especially in muscular activity. These findings would enable the determination of whether the presence of LTrPs in the lower limb muscles could be relevant in clinical practice or whether they have no clinical significance.

No statistical differences were found between the dominant/nondominant sides and the total number of LTrPs. In addition, when the prevalence of specific LTrPs was compared, no statistical differences were found between the dominant and nondominant sides. Regarding LTrPs in lower limb muscles, Lucas et al [5] found a higher number of LTrPs in the dominant side ($P < .01$) in the scapular positioning muscles. It is speculated that muscle overload can be a cause of MTrP development [1], and the greater use of the dominant upper limb could be the cause of a higher prevalence in the dominant side [5]. However, in our study we did not find similar results. One reason to explain this discrepancy could be that the dominant overload is not present in the lower limb as it is in the upper limb. We have not found other studies to compare with our results. Grieve et al [28] studied both the medial and the lateral gastrocnemius and both soleus muscles; however, they talked about the right and the left limbs instead of the dominant or nondominant lower limb.

In our study we found a difference related to gender and the total number of LTrPs, with women showing more LTrPs (mean, 9.6 ± 7.8) than men (mean, 4.8 ± 6.6). When LTrP prevalence in specific muscles was compared, statistical differences were also shown in all muscles, except for the dominant and nondominant soleus, the dominant TA, and the nondominant RF. Grieve et al [28] obtained a higher LTrP prevalence for women in the right and left gastrocnemius and the right soleus, with no statistical difference between genders in the left soleus. To our knowledge, no other studies have been performed to evaluate this relationship.

Criteria Diagnosis

The taut band and the tender spot were the most prevalent diagnosis criteria. These findings are similar to those of Grieve et al [28], who found a prevalence of this criteria ranging from 89%-100% in the gastrocnemius and soleus. Although there is no consensus on the diagnosis of MTrPs [39,40], the presence of a taut band and a tender spot are considered to be the minimum criteria for an MTrP diagnosis [1]. Our findings confirm that the taut band and the tender spot are the most prevalent diagnosis criteria. Statistical differences are found in the PPT between muscles with and without LTrPs. In LTrPs, the PPT ranged from 2.1-2.5 kg/cm^2. It was reported that MTrP showed lower PPT than did non-MTrP muscle tissues [27,31]. In fact, Lucas et al [5] used algometric PPT measurements to diagnose LTrPs in their study of LTrP prevalence in the shoulder.

Our study has limitations. We evaluated the presence of LTrPs in several muscles of the lower limb but did not include other important muscles, such as hamstrings or adductors. To our knowledge, only one study [21] has evaluated the presence of the LTrPs in adductors and hamstrings, comparing the prevalence between persons who had undergone a meniscectomy and control subjects. Further research including these muscles is necessary. In addition, we evaluated a sample of white persons, and thus the results of our study cannot be generalized to other populations.

Other limitations are related to the reliability of the diagnosis of LTrPs and specific diagnosis criteria. According to the intra-rater reliability, only 2 measurements were performed. Three measurements would be optimal. In addition, in our study, the LTrP diagnosis was carried out by one qualified physical therapist, and the inter-rater reliability was not evaluated.

Another limitation is related to the diagnosis criteria for LTrPs. We used the diagnosis criteria proposed by Simons, Travell, and Simons [1]—that is, we considered LTrPs to be present when 2 diagnosis criteria were found [28]. However, consensus on MTrP diagnosis criteria is limited. Manual palpation is commonly used in the diagnosis of LTrPs [8,20-22,28]. On the other hand, PPT was also used for the diagnosis of LTrPs [5,18,41]. We included PPT as a confirmatory criterion, but we did not include control points within each subject. In our study, the most prevalent and reliable diagnosis criteria were the presence of the taut band and the tender spot, with other criteria presenting a lower prevalence. Our findings are similar to those of other researchers; Gerwin et al [42] found that the presence of the taut band and tender spot were the most reliable diagnosis criteria, and Grieve et al [28] showed that these were also the most prevalent diagnosis criteria. Several authors have included the palpable taut band and the tender spot in LTrP diagnosis, but other diagnosis criteria, such as the referred pain, the jump sign, or the LTR, were not included in several studies [11,16,20,35,43-46]. Only referred pain may be elicited when the compression used is strong enough [10], and the LTR is the most difficult to elicit by manual palpation; it is inconsistently present in several muscles [10]. The LTR showed the lowest prevalence in our study. Another diagnosis criterion proposed for confirming LTrP diagnosis, the ROM limitation, could also be used in our study, because it is an exclusion criterion. However, this diagnostic criterion is not commonly used for the diagnosis of LTrPs [11,16,20,35,43-46].

Conclusion

From our research findings, it can be concluded that LTrPs are prevalent in lower limb muscles of asymptomatic subjects. Women have more LTrPs than do men. No differences in LTrP prevalence were found between sides. The presence of the taut band and the tender spot are the most prevalent and reliable diagnosis criteria. It is necessary to determine if the evaluation of LTrPs in the lower limb muscles of asymptomatic subjects has clinical relevance.

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Disclosure

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