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Runners have more latent myofascial trigger point than non-runners in medialis gastrocnemii

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ABSTRACT

Objectives: The goals of this study were to i. describe the prevalence of latent myofascial trigger points (MTrPs) in the medialis gastrocnemius in runners versus non-runners, and ii. examine their level of pain and stiffness.
Methods: Healthy runners and non-runners were recruited. Each participant's medialis gastrocnemius MTrPs count was recorded in both legs. The mean pain and the most painful MTrPs pain levels were recorded using an algometer, and the stiffness was evaluated using myotonometry (MyotonPro device) on the most painful MTrP.
Results: With a medium effect size ($p = 0.001$), runners ($n = 20$) showed significantly more latent MTrPs than non-runners ($n = 26$). Runners also reported higher overall pain on the latent MTrPs site than non-runners ($p = 0.003$) and a significant difference ($p = 0.001$) for the most painful latent MTrP. Runners were substantially stiffer than non-runners in the most painful latent MTrP, with a mean stiffness difference of +9.98 N/m ($p = 0.018$, medium effect size).
Conclusions: Runners have a higher number of latent MTrPs than non-runners. The MTrPs found in runners' legs were more painful and stiff than those found in non-runners' legs.

1. Introduction

Despite running's countless health benefit, many runners suffer from various lower limb injuries (van et al., 2008; Dias Lopes et al., 1947; Francis et al., 2018). Francis et al. (2018) found in their 2018 systematic review that 70% of injuries occurred below the knee. More specifically, knee and ankle-foot regions cause almost half of runner injuries. In the leg, running injuries and calf pain usually involve myofascial tissue, especially the gastrocnemii (Hamner and Delp, 2013). Achilles tendon (10%), medial tibial stress syndrome (8%), plantar fasciitis (7%), and calf strain (4%) are in the top 10 injuries (Francis et al., 2018).

Runners often have gastrocnemius muscle strains and calf soreness (Fields et al., 2016). Only 30% of female individuals reported such injuries, while 70% of male participants did (Hamner and Delp, 2013). Studies suggest that the triceps surae are particularly active during running and accelerate the body mass center most during propulsion (Fields et al., 2016; Hamner and Delp, 2013). Many investigations found that the gastrocnemius medialis (GM) is active during running stance (Fukunaga et al., 2001; Lichtwark and Wilson, 2006; Ishikawa et al., 2007). In addition, Koulouris et al. (Travell and Simons, 1992) found that the GM caused 48.7% of calf injuries. Running could work the gastrocnemii and increase myofascial tissue tension, but no studies tested this concept. To the best of our knowledge, no study has examined the gastrocnemius myofascial condition of runners versus non-runners. Runners and non-runners hold the same popular viewpoint, allowing non-runners to be used as a control group in comparison to an "exposed group" of runners (Nguyen et al., 2023).

The myofascial tissue assessment could be relevant, especially to

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identify myofascial pain. The myofascial pain may be due to muscle injuries that do not necessarily lead to muscle tears like fatigue-induced muscle disorder (due to overuse), delayed-onset muscle soreness, or neuromuscular muscle disorder (Mueller-et al., 2013). Travel et Simons (Travell and Simons, 1992) suggested a consensus term to describe these muscle pain conditions induced by myofascial pain: the *Myofascial Pain Syndrome*. More recently, Fernández-de-las-Peñas and Dommerholt (Fernández-de-las- et al., 2018) defined myofascial pain as myofascial trigger points (MTrPs) that represent a hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band. The spot is painful on manual compression and can give rise to characteristic referred pain, referred tenderness, motor dysfunction, and autonomic phenomena (Travell and Simons, 1992). Currently, there is a lack of certainty regarding the potential association between the discomfort induced by MTrPs and either overuse or neuromuscular disorders. Nevertheless, research has demonstrated that MTrPs tend to be often observed in muscle frequently used such as triceps surae in running. There are two types of MTrPs: latent and active. A latent MTrP, upon digital pressure, does not reproduce any symptom previously experienced by the patient, nor are the symptoms that are elicited familiar. Compression must replicate patient symptoms to diagnose active MTrP (Travell and Simons, 1992; Fernández-de-las- et al., 2018).

The primary aim of this study is to establish the prevalence of latent trigger points in healthy runners compared with non-runners control in clinical and quantitative points of view. The secondary aim of this study is to evaluate the muscle stiffness between latent MTrPs of runners and non-runners as well as between latent MTrPs and healthy muscle points. We hypothesized that latent MTrPs prevalence would be greater and stiffer in runner's GM than in non-runners one.

2. Methods

2.1. Study design

This observational cross-sectional cohort study was conducted in Belgium at the Catholic University of Louvain to compare the prevalence of latent MTrPs between healthy runners and non-runners.

2.2. Participants

A sample of convenience was recruited. The participants were recruited around the university surrounding voluntarily without any financial compensation. Participants received one week before measurements, an information letter explaining the study conduct and a letter of consent which was signed the day of the measurements. The study was approved by the local ethic committee (B403201942384).

A participant was considered as a runner if he reported at least one year of running experience, perform running at least twice a week and had a weekly volume of 10 km minimum, and was able to run 1 h without rest. The non-runner participant was defined as if he did not respond to the runners 'criteria and if he was not engaged in any regular physical and sports activity in the last year. A regular activity was defined as any weekly activity. Inclusion criteria were as follows: 1. be a male, 2. Be above 18 years old and below 40 years old, 3. Be free of any musculoskeletal or neurological disorders. Exclusion criteria were defined as 1. Having any sign or symptoms of musculoskeletal disorders, infection, chronic disease, cardiovascular disease, metabolic disorder, lower limb osteosynthesis device, skin conditions that counter-indicates the use of the MyotonPRO, 2. consulted a medical specialist within the year, 3. if they were taking medications affecting properties and characteristics of skeletal muscle and 4. if they were barefoot runners.

2.3. Outcomes measures

The primary outcome was the number of latent MTrPs found in each GM in both groups. The secondary outcomes were pain measured with the Numerical Pain Rating Score (NPRS, from 0, no pain at all; to 10, the worst imaginable pain) as well as the mechanical stiffness if MTrPs and healthy muscle area of each GM.

To quantify pressure applied on latent MTrPs and healthy sites, an electronic mobile digital algometer has been chosen. The *Triggerplus* device from *Palpatronic* (Hagen, *Germany*) was used by the examiner to standardize the applied pressure, i.e., around 40 N/cm^2, on latent MTrPs sites and to spot healthy sites. MyotonPro device (*Myoton AS, Tallin, Estonia)* was used to measure muscle stiffness. Stiffness can be defined as the ratio between the stress applied and the amount of deformation on a structure (Michener et al., 2011). The MyotonPro is a transportable and non-invasive device that can be used on many body parts. MyotonPro is user-friendly and easy to handle. The device could extract several biomechanical and viscoelastic variables such as the muscle tone, the elasticity, the stiffness, the relaxation time, and the creep (Nguyen et al., 2022). The stiffness ($N.m^{-1}$) measured by the MyotonPro was recently validated and reported excellent reliability and agreement in the gastrocnemii (Nguyen et al., 2022; Zinder and Padua, 2011; Pruyn et al., 2016).

2.4. Procedure

Participants were told to not practice any sports 24 h before measurements. Descriptive information, i.e., runner or not, age, height, weight, steps per day, and staircase per day, were collected by a standardize interview at the beginning of the session after the informed consent signature. All the assessments were done at the Université catholique de Louvain (UCLouvain) facilities. The session lasted for about 30 min.

One investigator (A) collected descriptive information and recorded their group assignment. The assessments were made by two other investigators (B and C) blinded to the group assignment. The experiment consisted of two phases and were identical for both runners and non-runners (Fig. 1). In the first phase, participants were lying down on their belly, fully relaxed, with a cushion placed under their ankles to relieve any residual tension. The cushion was the same for all participants. A 5-min rest was performed to standardize each measurement. The dominant leg was determined by asking the participant which leg(s) they used to kick a ball, such as the definition by Paillard et al. (Paillard and Noé, 2020). Then, one investigator assessed the GM of both legs to identify latent MTrPs. Then, the same investigator report the pain on each identified latent MTRP. In the second phase, muscle stiffness was measured using a MyotonPRO device by the second investigator. The MyotonPRO measurement has been performed on both legs at the site of the most painful MTrPs as well as in a pain-free muscle site.

2.5. Outcomes measures

For the identification of MTRP, the investigator briefly explained to the participant what an MTrP was and what he expected from him during palpation, e.g., what to expect when he felt a referred pain. Each time, the investigator began the palpation by first assessing the non-dominant leg. MTrPs were identified by the examiner considering the following cluster of criteria (Fernández-de-las- et al., 2018).

- Presence of a palpable taut band in skeletal muscle;
- Presence of a hypersensitive tender spot within the taut band;
- Reproduction of referred pain in response to the compression of MTrP.

Based on this Delphi study, at least two of the three criteria should be present for a diagnosis of an MTrP (Fernández-de-las- et al., 2018). To have a diagnosis as reliable as possible, only MTrPs respecting all three criteria were selected. A taut band was identified using a skin rolling method with a thumb-index grip performed in transversal (from external to internal side) along the length of the muscle (from proximal to distal

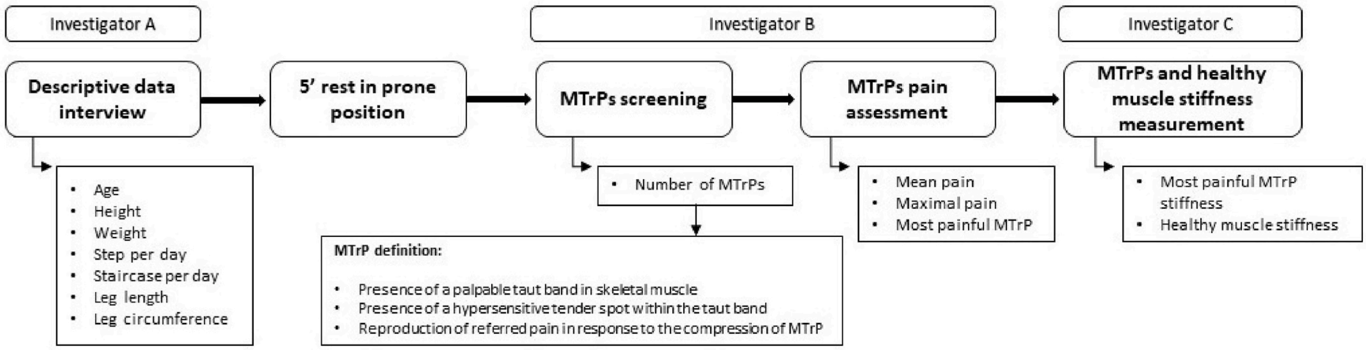

Fig. 2. Flowchart of the procedure. MTrP = latent Myofacial TRigger Point.

extremity) (Kordi et al., 2021). The presence of nodules was assessed by deep thumb palpation along with the taut band. Each latent trigger point was marked by a cross of a one-by-one centimeter. A 40 N/cm^2 pressure was applied and standardized with an electronic algometer on each MTrP, and participants were asked to give a score using a Numerical Pain Rating Scale, or NPRS (from 0, no pain at all; to 10, the worst imaginable pain).

Stiffness measurement was performed with MyotonPRO measurement on the most painful MTRP and has also been performed outside the latent trigger point's site which was the first pain-free area found horizontally or vertically starting from the trigger point site (or at the belly of the muscle if no trigger point was identified). The examiner placed the MyotonPRO perpendicular to the previously crossed-marked sites (Fig. 2).

2.6. Data analysis

The data was analyzed using MedCalc® Statistical Software 20.104 (MedCalc Software Ltd, Ostend, Belgium). A preliminary investigation showed no difference between dominant and non-dominant legs. All statistical analysis were done on both legs. A student t-test or a Mann-Whitney U analysis were performed on (van et al., 2008) the number of MTrPs, (Dias Lopes et al., 1947) their mean pain, (Francis et al., 2018) their maximal pain, and (Fields et al., 2016) their stiffness and a healthy muscle location in both groups. A two-way ANOVA or Kruskal Wallis analysis (group, runner or non-runner x muscle site, MTrP or healthy muscle) was also done to evaluate stiffness between runner and non--runner's latent MTrP and healthy muscle. To determine the link between latent MTrPs prevalence, pain, stiffness, and anthropometric factors, a Pearson or spearman correlation coefficient was determined. The alpha level was 0.05.

3. Results

3.1. Participants

Sixty healthy individuals were recruited and nine of them were excluded for reason, i.e., musculoskeletal symptoms in the lower leg. Twenty-five eligible individuals were assigned to the runner group (RG). Twenty-six eligible individuals were assigned to the non-runner group (NRG). A T-test was performed on the demographic data at the start to compare the two groups. Runners took substantially more steps per day and were more active than non-runners. Runners, of course, engaged in more running activity than non-runners (Table 1).

3.2. Myofascial trigger point

Runners had significantly more latent MTrPs than non-runners. ($p = 0.001$, 95%IC [0.68 to 2.59]) (Table 2). Runners' MTrP was significantly stiffer among runners than non-runners ($p = 0.018$, 95%IC [1.71 to 18.37], medium effect size). Furthermore, runners experienced more mean pain under 40 N/cm^2 pressure on the latent MTrP site ($p = 0.003$, 95%IC [0.73 to 2.9]) and more maximal pain than non-runners ($p < 0.001$, 95%IC [0.75 to 2.26]). There was no difference in passive stiffness on healthy points between the GM of runners and non-runners ($p = 0.075$, 95%IC [−0.66 to 13.62], Cohen $d = 0.36$). The two-way ANOVA

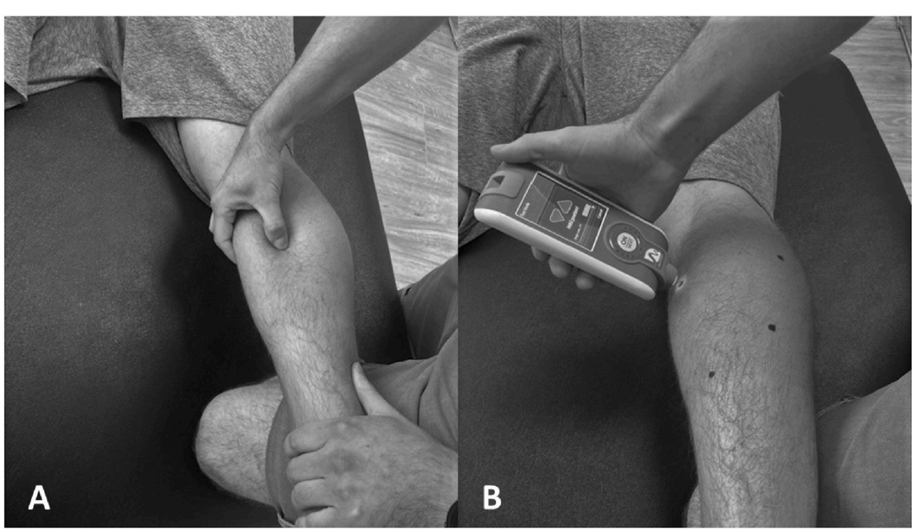

Fig. 2. A: palpation of a latent myofascial trigger point. B: MyotonPro measurement of the most painful Myofascial trigger point.

Table 1
Descriptive data of non-runners and runners.

	Non-runners (N = 26)				Runners (N = 25)				T-test
	Mean	SD	Min	Max	Mean	SD	Min	Max	p-value
Age (years)	22.7	2.28	19	31	23.6	6.12	18	47	0,487
Height (m)	1.8	0.07	2	2	1.8	0.06	2	2	0.999
Weight (kg)	74.7	12.73	51	101	70.1	8.54	57	88	0.138
BMI (%)	22.4	3.29	18	31	21.7	2.08	18	29	0.371
Steps per day	5342	3068	3000	12500	10145	3345	1624	10000	<0.001[a]
Stair per day	128.6	94.4	18	325	113	74.34	5	300	0.519
Running activity per week (min)	0	0	0	0	183.6	100.3	60	450	<0.001[a]
Sport activity per week (min)	76.8	189.6	0	750	358.5	211.5	80	800	<0.001[a]
Dominant LL length (cm)	98.12	5.61	87.5	107	97.46	4.36	90	108	0.642
Non-dominant LL length (cm)	97.96	5.54	87	107	97.64	5.1	90	110	0.831
Dominant LL circumference (cm)	36.98	3.73	29.5	45	37	2.62	31	43	0.983
Non-dominant LL circumference (cm)	36.85	3.65	29.5	44	36.82	2.37	31	43	0.973

T-test values were set at alpha = 0.05 significance test.
Abbreviations: BMI = Body Mass Index. SD = standard deviation. Min = Minimum. Max = maximum.
[a] represents a significant difference between both groups.

Table 2
Student t-test between runners and non-runners.

	Runners		Non-runners		difference	95%CI	pvalue	Effect size
	mean	sd	mean	sd				
MTrPs (n)	6,1	2,43	4,4	2,43	1,64	0,68 to 2,59	0,001	0,67
Mean pain (/10)	4,08	2,14	2,62	1,39	1,46	0,73 to 2,9	0,003	0,81
Max pain (/10)	5,43	1,83	3,92	1,99	1,51	0,75 to 2,26	<0,001	0,79
MTrPS triffness (N/m)	261,16	19,39	251,12	22,47	10,04	1,71 to 18,37	0,018	0,48
Healthy site stiffness (N/m)	254,44	16,63	247,96	19,42	6,47	−0,66 to 13,62	0,075	0,36

Alpha significance level was set at 0.05. MTrPs = latent myofascial trigger point expressed as absolute frequency. All data are presented as mean and standard deviation (sd). The effect size was a cohen d and could be interpreted as follow: 0.2 is considered a small effect size, 0.5 a medium effect size and 0.8 a large effect size.

(group x muscle site) did not demonstrate significant stiffness difference between latent MTrP and healthy muscle site ($p = 0.07$, −4.939 N/m, 95%IC [−10.39 to 0.51]), nor any interaction effect ($p = 0.52$).

3.3. Correlation

The Pearson correlation coefficients for runners showed that the more latent MTrPs they had, the higher the NPRS mean was, with a high correlation for the dominant leg ($r = 0.80$, $p < 0.001$) and non-dominant leg (correlation = 0.95, $p < 0.001$). There was a weak to moderate positive correlation between the number of latent MTrPs and the maximum NPRS (dominant leg: $r = 0.48$, $p = 0.015$; non-dominant leg: $r = 0.66$, $p = 0.004$). The healthy site stiffness in the dominant leg was positively correlated to the latent MTrPs stiffness in both legs, with a moderate to high correlation (dominant leg: $r = 0.73$, $p < 0.0001$; non-dominant leg: $r = 0.49$, $p = 0.012$). The healthy site stiffness in the non-dominant leg was positively correlated to the latent MTrP site stiffness in the non-dominant leg, with a moderate correlation ($r = 0.61$, $p < 0.05$). The latent MTrP site stiffness in the dominant leg was positively correlated to the latent MTrP site stiffness in the non-dominant leg, with a weak correlation ($r = 0.5$, $p < 0.05$) (Table 3).

4. Discussion

This was the first study to observe latent MTrPs in both runner and non-runner population. Based on our results, runners have shown more latent MTrPs than non-runners. Moreover, latent MTrPs of runners seem to be more painful and demonstrated higher stiffness than these in non-runners.

Running is a strenuous activity that puts a lot of strain on the lower limb muscles and joints. Ankle and foot structures initially absorb impacts. Plantar flexor muscles contribute to absorption through eccentric contraction during foot impact (Money, 2017). Because MTrPs have been found in overused myofascial tissues (Michener et al., 2011; Childs et al.), MTrPs in runners' muscles implicated in the run could be considered normal. On the same line, Money et al. (Money, 2017) have stated that MTrPs can develop as a result of athletic training and muscle strain. Running is also known as a plyometric activity that induces stereotypical muscle contraction of the triceps surae and more specifically the gastrocnemius medialis, which is especially really active during the stance phase. (Hamner and Delp, 2013). In the present study, runners have experienced more pain at MTRP sites than non-runners. More specifically, a mean NPRS of 1.46 and a mean maximum NPRS of 1.51 could not be considered clinically significant in regard of pain. However, a minimal clinical important difference is set to demonstrate a significant difference between two scores given by the same person (Michener et al., 2011; Childs et al.). Thus, it is safer to say that runners seem to feel more painful than non-runners.These findings taken together are concordant with our finding of a higher number of latent MTrPs in gastrocnemius medialis in runners.

Following the study conducted by Lucas et al. (2004) on scapular rotators muscles, the presence of latent MTrPs could alter the motor control. The treatment of these MTrPs, on the other hand, resulted in a normalization of the muscle activation pattern. The presence of latent MTrPs may also cause noxious effects on muscles and ankle joints, such as an increase in muscle cramps or a restriction in ankle range of motion (Trampas et al., 2010; Sánchez-et al., 2021). Trampas et al. (Albin et al., 2019) studied the effects of various treatments on young athletes with stiff hamstrings (football, basketball, and volleyball players). They found that latent MTrPs treatment combined with stretching had several benefits such as improvement of the range of motion and reduction of pain intensity (Trampas et al., 2010). Taken together, our findings and the findings of previous studies suggest that treating latent MTrPs in runners may have several beneficial effects, including lowering the risk of muscle cramps, reducing pain intensity, and increasing joint range of motion.

In terms of stiffness, the fact that an MTrP is located on a taut band implies that the passive stiffness at this location could be greater than at

Table 3
Pearson correlation table for anthropometrics measurements, number of MTrP and Pain (NPRS) in both Dominant (D) and Non-Dominant (ND) leg.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Age	1																			
2	BMI	0.283	1																		
3	Leg circumference	0.076	**0.676*****	1																	
4	Stair per day	−0.178	0.038	0.108	1																
5	Max NRPS D	−0.06	0.146	−0.017	−0.158	1															
6	Mean NRPS D	−0.051	−0.096	−0.001	−0.041	**0.723*****	1														
7	Stiffness of healthy site D	0.149	**0.404***	0.182	0.127	−0.224	−0.364	1													
8	Stiffness of Healthy site ND	−0.047	0.214	0.225	0.224	−0.163	−0.211	**0.453***	1												
9	Stiffness of MTrP D	0.167	0.199	0.104	0.075	−0.15	−0.367	**0.731***	0.322	1											
10	Stiffness of MTrP ND	−0.177	0.161	0.103	0.153	−0.114	−0.306	**0.492***	**0.606****	**0.498***	1										
11	Total Max NRPS	0.121	0.181	0.119	−0.342	0.325	−0.054	0.049	−0.24	0.117	−0.028	1									
12	Max NRPS ND	−0.341	−0.003	0.008	0.011	**0.672*****	**0.68*****	−0.052	−0.102	−0.098	−0.096	0.157	1								
13	Mean NRPS ND	−0.294	−0.105	0.326	0.112	0.301	**0.565****	−0.161	−0.021	−0.182	−0.246	−0.163	**0.668*****	1							
14	Total mean NRPS	−0.241	0.074	−0.004	−0.074	**0.905*****	**0.764*****	−0.182	−0.143	−0.144	−0.115	0.261	**0.926*****	**0.541****	1						
15	Numer of MTrP ND	0.121	0.181	0.119	−0.342	0.325	−0.054	0.049	−0.24	0.117	−0.028	**1*****	0.157	−0.163	0.261	1					
16	Step per day	−0.172	**−0.464****	**−0.497****	−0.294	−0.032	0.169	−0.209	−0.18	−0.33	−0.2	−0.192	0.142	0.142	0.067	−0.192	1				
17	Weight	0.189	**0.828*****	**0.607****	0.121	0.009	−0.193	0.361	0.194	0.203	0.233	0.163	−0.1	−0.109	−0.057	0.163	**−0.416***	1			
18	Height	−0.05	0.106	0.153	0.175	−0.219	−0.233	0.096	0.059	0.086	0.206	0.022	−0.21	−0.078	−0.235	0.022	−0.088	**0.644*****	1		
19	Number of MTrP D	0.065	0.103	−0.002	−0.177	**0.431***	−0.054	−0.024	−0.225	0.252	0.1	**0.807*****	0.073	−0.279	0.264	**0.807*****	−0.351	0.158	0.111	1	
20	Total number of MTrP	−0.321	−0.202	0.202	0.108	**0.48***	**0.803*****	**−0.429***	−0.077	−0.367	−0.293	−0.205	**0.655*****	**0.945*****	**0.692*****	−0.205	0.192	−0.237	−0.17	−0.193	1

Pvalue Significance: *** <0.001, ** <0.01, *<0.05. Abbrevation: MTrP = Myofascial Trigger Point, NPRS = Numeric Pain Rating Scale, D = Dominant, ND = Non Dominant, BMI = Body mass Index.

a healthy muscle site. Kubo et al. (Sánchez-et al., 2021) discovered that passive stiffness of the plantar flexor muscle was significantly higher in long-distance runners than in untrained men. On the contrary, our findings revealed no difference in passive stiffness in healthy points between runners and non-runners, nor between legs. Runners, on the other hand, had a stiffer latent MTrP spot. This can be explained by discrepancies in their methods such as a measurement taken during a slow stretch or the material used (i.e., dynamometer [Applied Office, Tokyo, Japan]). Sanchez-Infante et al. (Sánchez-et al., 2021) compared the effects on muscle stiffness of dry needling treatment with placebo control. They found that dry needling decreases muscle stiffness and improves the pressure pain threshold, which corresponds to the minimal pressure needed to generate pain. Albin et al. (2019) investigated the effects of a latent MTrPs treatment (dry needling) on the gastrocnemius muscle stiffness and strength. They found that the treatment induces a decrease in passive muscle stiffness, particularly on the MTrP site, but did not significatively change the muscle strength. Another similar study conducted on soleus muscle demonstrated a decrease of passive muscle stiffness on the MTrP site with dry needling treatment, but no change of stiffness on a site located on the same taut band as the MTrP (Sánchez-et al., 2021). Future research may extend this work by evaluating whether the treatment of latent MTrPs has clinical relevance in running performance.

5. Limitations

We had several research limitations. First, the participants were largely young men. We only focus on men to prevent gender bias due to biological, anatomical, and physiological differences with women. Second, the results of this study only apply to runners, not to athletes in other sports. Thirdly, one operator assessed all MTrPs, which may be biased. Nascimento et al. reported intra-examiner reliability is moderate to perfect for MTrP identification in clinical practice in examiners with no clinical expertise and minimal training (Nascimento et al., 2018). They also found moderate to nearly perfect inter-examiner reliability (PABAK: 0.46–0.92). Finally, the MyotonPro device engineers have stated that the MyotonPRO is not reliable concerning the assessment of muscles covered by subcutaneous fat over 20 mm. It would have been interesting to measure fat mass to be sure of the measurement precision.

5.1. Clinical perspectives

By observing for the first time a possible correlation between running and latent MTrPs prevalence in GM, our findings spark new interest and understanding of latent MTrPs. This research could provide a baseline for determining modulation opportunities in a pathological population, such as lower extremity myofascial disorders in runners, ankle sprain rehabilitation, and performance outcomes.

6. Conclusion

A greater latent MTrPs prevalence in runners' GM was found. Runners tend to experience higher pain intensity on the latent MTrPs. Stiffness measured on latent MTrPs spots was higher in the runners' group. This study is surely the starter of a new interest and understanding of latent MTrPs correlated to running practice by offering novel perspectives on injury prevention and performance management.

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CRediT authorship contribution statement

Anh Phong Nguyen: Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Christophe Broy:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization. **Louise Cardon:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Gregoire Jet:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Christine Detrembleur:** Writing – review & editing, Validation, Supervision, Software, Resources, Project administration, Methodology, Data curation, Conceptualization. **Philippe Mahaudens:** Writing – review & editing, Validation, Supervision, Software, Resources, Project administration, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

Albin, S.R., Koppenhaver, S.L., Bailey, B., Blommel, H., Fenter, B., Lowrimore, C., et al., 2019. The effect of manual therapy on gastrocnemius muscle stiffness in healthy individuals. Foot 38, 70–75.
Childs JD, Piva SR, Fritz JM. Responsiveness of the Numeric Pain Rating Scale in Patients with Low Back Pain. Vol. 30, SPINE.
Dias Lopes, A., Carlos, L., Junior, H., Yeung, S.S., Oliveira, Pena Costa L., 1947. What are the main running-related musculoskeletal injuries? Syst. Rev.
Fernández-de-las-Peñas, C., Dommerholt, J., 2018. International consensus on diagnostic criteria and clinical considerations of myofascial trigger points: a delphi study. Pain Med. 19 (1), 142–150.
Fields, Karl B., Rigby, Michael, D.D.O., 2016. Muscular calf injuries in runners. Curr. Sports Med. Rep. 15 (5), 320–324. https://doi.org/10.1249/JSR.0000000000000292.
Francis, P., Whatman, C., Sheerin, K., Hume, P., Johnson, M.I., 2018. Proportion of lower limb running injuries by gender, anatomical location and specific pathology: a systematic review. ©Journal of Sports Science and Medicine 18.
Fukunaga, T., Kubo, K., Kawakami, Y., Fukashiro, S., Kanehisa, H., Maganaris, C.N., 2001. In vivo behaviour of human muscle tendon during walking. Proc. Biol. Sci. 268 (1464), 229–233.
Hamner, S.R., Delp, S.L., 2013. Muscle contributions to fore-aft and vertical body mass center accelerations over a range of running speeds. J. Biomech. 46 (4), 780–787.
Ishikawa, M., Pakaslahti, J., Komi, P v, 2007. Medial gastrocnemius muscle behavior during human running and walking. Gait Posture 25 (3), 380–384.
Kordi Yoosefinejad, A., Samani, M., Jabarifard, F., Setooni, M., Mirsalari, R., Kaviani, F., et al., 2021. Comparison of the prevalence of myofascial trigger points of muscles acting on knee between patients with moderate degree of knee osteoarthritis and healthy matched people. J. Bodyw. Mov. Ther. 25, 113–118.
Lichtwark, G.A., Wilson, A.M., 2006. Interactions between the human gastrocnemius muscle and the Achilles tendon during incline, level and decline locomotion. J. Exp. Biol. 209 (21), 4379–4388.
Lucas, K.R., Polus, B.I., Rich, P.A., 2004. Latent myofascial trigger points: their effects on muscle activation and movement efficiency. J. Bodyw. Mov. Ther. 8 (3), 160–166.
Michener, L.A., Snyder, A.R., Leggin, B.G., 2011. Responsiveness of the numeric pain rating Scale in patients with shoulder pain and the effect of surgical status. J. Sport Rehabil. 20.
Money, S., 2017. Pathophysiology of trigger points in myofascial pain syndrome. J. Pain Palliat. Care Pharmacother. 31 (2), 158–159.
Mueller-Wohlfahrt, H.W., Haensel, L., Mithoefer, K., Ekstrand, J., English, B., McNally, S., et al., 2013. Terminology and classification of muscle injuries in sport: the Munich consensus statement. Br. J. Sports Med. 47 (6), 342–350.
Nascimento, JDS do, Alburquerque-Sendín, F., Vigolvino, L.P., Oliveira, WF de, Sousa, C. de O., 2018. Inter- and intraexaminer reliability in identifying and classifying myofascial trigger points in shoulder muscles. Arch. Phys. Med. Rehabil. 99 (1), 49–56.
Nguyen, A.P., Detrembleur, C., Fisette, P., Selves, C., Mahaudens, P., 2022. MyotonPro is a valid device for assessing wrist biomechanical stiffness in healthy young adults. Front Sports Act Living 4.
Nguyen, A.P., Gillain, L., Delieux, L., Detrembleur, C., Mahaudens, P., Esculier, J.F., 2023. Opinions about running shoes in runners and non-runners. Footwear Sci. 15 (1), 43–54.
Paillard, T., Noé, F., 2020. Does monopedal postural balance differ between the dominant leg and the non-dominant leg? A review. Hum. Mov. Sci. 74.
Pruyn, E.C., Watsford, M.L., Murphy, A.J., 2016. Validity and reliability of three methods of stiffness assessment. J Sport Health Sci 5 (4), 476–483.
Sánchez-Infante, J., Bravo-Sánchez, A., Jiménez, F., Abián-Vicén, J., 2021. Effects of dry needling on muscle stiffness in latent myofascial trigger points: a randomized controlled trial. J. Pain 22 (7), 817–825.
Trampas, A., Kitsios, A., Sykaras, E., Symeonidis, S., Lazarou, L., 2010. Clinical massage and modified Proprioceptive Neuromuscular Facilitation stretching in males with latent myofascial trigger points. Phys. Ther. Sport 11 (3), 91–98.
Travell, J., Simons, D.G., 1992. Myofascial Pain and Dysfunction: the Trigger Point Manual, 2. Lippincott Williams & Wilkins.
van Middelkoop, M., Kolkman, J., van Ochten, J., Bierma-Zeinstra, S.M.A., Koes, B.W., 2008. Risk factors for lower extremity injuries among male marathon runners. Scand. J. Med. Sci. Sports 18 (6), 691–697.
Zinder, S.M., Padua, D.A., 2011. Reliability, validity, and precision of a handheld myometer for assessing in vivo muscle stiffness. J. Sport Rehabil.