A randomized controlled trial concerning the implementation of the postural Mézières treatment in elite athletes with low back pain

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ABSTRACT

Objective: This study aimed to evaluate the impact of adding the Mézières Method (MM) to the standard rehabilitation protocol for the elite athletes with low back pain (LBP) in reducing lumbar pain rather than only using the traditional rehabilitation protocol treatment. The disciplines considered in this study were soccer, rhythmic gymnastics, and basketball.
Design: Randomized controlled trial.
Setting: Training Camp.
Participants: One hundred and thirty-nine elite athletes with low back pain of whom 69 were assigned to the experimental group.
Intervention: The intervention consists of treatment with three lying postures in a 40-minute-long session twice a week. The session's goal was to focus on breathing exercises, spine mobility, and stretching of the back muscles, with particular attention to the diaphragmatic, paravertebral, and latissimus dorsi muscles.
Outcome measures: Assessments such as Visual Analogue Scale (VAS), Sit and Reach flexibility test, Roland-Morris Questionnaire, and health status questionnaire (SF12) were used.
Results: The evaluation of all outcomes in four measurement periods of the study (baseline, 4, 12, and 24 weeks) showed a significant difference between the groups. Also, at the 6 months of the intervention, a significant difference in the means (SD) was observed in pain (VAS), back flexibility (Sit & Reach) and back disability (QRM) outcomes in favor of the experimental group with a medium-large effect size compared with the control group.
Conclusion: The MM approach can also be applied to established conventional protocols to alleviate pain and functionality. The obtained results include improving the quality of life of the athletes and their physical and emotional states.

KEYWORDS
Postural treatment; elite athlete; stretching; back pain treatment

Introduction

Scientific literature is rich in studies related to the incidence of back pain in young athletes. The percentage of incidence determined in this population is between 1% and 30% [1,2]. Back pain represents 10–15% of all cases of sport-related injuries [1–4].

The data provided by the research community related to the incidence of back pain in sports show that gymnastics stands out with 11% and soccer with 50% [5].

There is a lack of abundant studies on low back pain (LBP) in the discipline of basketball. However, some descriptive epidemiological studies have reported that 8% of basketball injuries affect the lower back [6,7]. Pesanen et al. (2016) argue that 45% of 207 basketball players analyzed had suffered low back pain at some point in their lives, and almost the same percentage of players (44.4%) had experienced low back pain during the previous 12 months [6]. Heneweer, Staes and Aufdmekampe (2011) have studied the incidence of low back pain in these cases. They argue that the cause of the pain is insufficient strength of the abdominal muscles, muscular imbalances, and inadequate flexibility of the lower extremities [8]. In addition to the abdominal muscles, the hip muscles play a crucial role in transferring forces from the lower extremities to the spine, while the athlete is active or in an upright position [9,10].

Similarly, poor resistance in hip extensors, such as the gluteus maximus and gluteus medius, was related to low back pain [8].

In the case of lack of muscular work, the literature recommends working on the upper part of the body. Improvements in the isometric strength of the abdominal muscles, as well as the work of flexibility in the muscles of the back of the thigh, provide stability and protection to the lumbar spine [11–13]. Wang et al. (2012) demonstrated that stability exercise is more effective in reducing pain than general exercise and can improve physical function in patients with low back pain [14].

Wang et al. (2012) demonstrated that stability exercise is more effective in reducing pain in the short term than general exercise and can improve physical function in patients with

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LBP [14]. With stability exercise, Wang et al. (2012) refer to core stability training that includes exercises associated with the prior activation of the local trunk muscles. This training should be advanced to include more intricate static, dynamic, and functional exercises that involve the coordinated contraction of local and superficial spinal muscles [14]. According to Geneen et al. (2017), the general exercise term includes aerobic, strength, flexibility, core, or balance training programs compared with stability exercise associated with the prior activation of the local trunk muscles [15].

Based on these data, the Mézières Method (MM) can adopt a therapeutic treatment for athletes with low back pain. This adoption is possible because the therapeutic principle of MM is based on working in a stable, correct position by lengthening the muscle chains and progressively balancing the muscle work without making any compensation [16,17].

The shortened muscles are never tense through this technique because of tonic imbalances. The patient is induced to perform voluntary muscular contractions located at distant points of the found imbalance. When these contractions are performed, the relaxation effect of the contraction causes the initial tonic imbalance, and consequently, a morphological correction is obtained [18]. This study aims to evaluate whether adding the MM to the standard rehabilitation protocol in elite athletes with LBP as soccer, rhythmic gymnastics, and basketball is more helpful in reducing lumbar pain than only the rehabilitation protocol treatment.

Method

Design and participants

A double-blind, parallel group randomized controlled design was implemented to evaluate the MM efficacy in athletes with LBP with data evaluation at baseline, at the 4th, 12th, and 24th weeks of treatment. This randomized controlled trial was carried out by Catholic University of Murcia Elite athletes with low back pain. The study protocol was approved by the institutional research ethics committee (Catholic University of Murcia, protocol No. 6572) UCAM, which followed the Declaration of Helsinki for the ethical principles of medical research involving humans. The consent informed was written and signed. All participants provided complete consent after having read and accepted the conditions of participation. Even minors presented a paternal authorization document.

The study was registered at Clinicaltrial.gov with ID: *NCT03849053*. Regardless of the kind of sport they practice, participants were randomly assigned to two groups: a Mezieres group and the control group. Both groups received the same volume of training per week. Allocation was performed by an investigator who was not involved in the treatment of participants using a computer random number generator from the Excel program. Trained research assistants prepared the sealed, sequentially numbered envelopes containing the treatment assignments.

The Participants were recruited between December 2016 and May 2018. The study was finalized in December 2019. In order to be eligible for inclusion, participants had to be professional elite athletes ages 15–40 years old, with a medical diagnosis of chronic nonspecific back pain persisting for ≥3 months [19], with the presence of kyphosis or scoliosis, training time at least 9 hours a week, and sports practice for a minimum of 2 years. Nonspecific back pain, as per reference [20] is diagnosed when pathologies such as osteoporosis, stenosis, tumor, fracture, spinal deformities, inflammations or infectious disease, lumbar radiculopathy, and others have not been recognized in a patient. Also, it is considered chronic when the duration of pain persists for more than 12 weeks [20]. Athletes who had suffered moderate or severe musculoskeletal injuries in the last 6 months (e.g. recent lumbar spinal surgery, osteoporosis, inflammation, etc.) received treatments with analgesic/anti-inflammatory drugs. Athletes with fractures, vertebral implants, low training intensity, spondylolysis, spondylolisthesis, and respiratory disorders that precluded their normal sports participation were excluded from the study.

For the effect size estimates, a traditional power calculation was performed (G * Power 3.1.9.2) and an alpha = 0.05, power = 0.88 with a medium-to-large effect size determined that approximately 102 participants were required.

Randomization

After collecting all primary data, patients were randomly allocated to the intervention or control group by applying a method of concealed randomization. Both groups received therapeutic treatment for LBP. The intervention group received the Mezieres treatment by a physical therapist with more than 5 years' experience in this method. The control group received the conventional treatment for LBP. All participants attended a physical therapy session consecutively once or twice a week for 24 weeks. Concealed allocation (1:1 ratio) was performed using a computer-generated random number table created before the start of data collection by an investigator who was not involved in patient recruitment or treatment. Then, opaque envelopes were used consecutively and stamped with the numbers of each participant. According to the group assignment, the Mezieres therapist, blinded to baseline data, opened the envelope and proceeded with treatment. Outcome measures were assessed at baseline, during 12 weeks of treatment and

immediately after the 24-week intervention period by an assessor blinded to the treatment allocation of the patients.

Intervention

A conservative treatment program for athletes such as soccer players, rhythmic gymnastics, and basketball was implemented twice a week in the control group (CG) group. MM was implemented as a complementary therapy for low back pain and was added to the other group named Mezieres group (MG) composed of the same type of athletes.

The Mezieres group received the Mezieres method once a week and a one-week session of the conservative low back pain treatment protocol. The control group received only the same treatment twice a week from the conservative low back pain protocol without using the same additional Mezieres treatment.

The time of the duration of the treatment and weekly frequency in the two groups were the same.

Experimental group

Mezieres method. The MM was applied as an individual therapy session once a week for 24 weeks. The treatment was implemented by a certified therapist for this method and lasted 40–60 minutes per session. The MM regimen consists of three postures that could be adapted to each participant depending on his/her needs to correct variations in the dorsal curve. The implementation of MM in the athletes intended to recover the extensibility of the hypertonic muscle groups, particularly those in the low back muscular chain: the paravertebral muscles and latissimus dorsi [21,22].

An essential element of treatment is the reeducation and promotion of diaphragmatic breathing. During the execution of postures, the therapist required the athlete to associate the therapeutic postural modifications with breathing.

Treatment postures of mezieres method (Appendix 1)

First, posture consisted of the patient being placed in the supine position and aligned, based on his vertical line (occipital bone, 7th dorsal vertebra, and sacrum), to recreate the correct curves according to the lordosis of the spine [21–23]. This posture was associated with manual cervical traction. The athlete was asked to accompany the treatment with breathing. For any postural stretching performed, the athlete by themselves used the diaphragmatic breathing technique, indicated before by the therapist [24]. The second posture, consisted of the placement of the athlete in the supine position, with the upper limbs abducted to 120° to obtain maximum elongation of the latissimus dorsi, permitting the athlete to achieve bilateral passive stretching of the latissimus dorsi [21].

This is a passive posture aimed at achieving bilateral passive stretching of the latissimus dorsi. To change this posture from passive to active, the athlete was positioned supine with the lower extremities elevated, hips flexed more than 90°, and the knees extended, supported by the physiotherapist. This active posture aimed to stretch the posterior muscle chain, especially the latissimus dorsi.

In the third and last posture, the therapist asked the athlete to switch from supine to a straight seated position and perform isometric contraction of the latissimus dorsi in the maximum elongation [21,22].

Control group (CG)

All athletes with LBP in the control group followed the conservative standard [25,26] protocol for the LBP treatment, which consists in:

a) 48 supervised back exercise sessions twice a week with attention to back extensor muscle treatment, lumbar rotation, hamstrings, hip flexors, pelvic tilt, etc.

b) general stretching for warm-ups such as the open lizard, jumping jack, quad stretch, and McKenzie stretch.

c) deep massage for decreasing stiffness and muscle tension (longitudinal and transversal massage with 15 minutes duration) with a particular interest in the back region and trapezius, rhomboids, multifluids, and erector column muscles.

d) electrotherapy to reduce pain as transcutaneous electrostimulation and laser therapy with a 15 minutes duration each.

e) increase muscle strength, depending on the level of discomfort (cervical, dorsal, lumbar, sacral), which consists of isometric, isotonic, squats, push-ups, sit-ups, dynamic stretch, and bodyweight exercises.

Each session lasted 60 min. The treatment was similar for all athletes in soccer, basketball, and rhythmic gymnastics sports.

Assessments

All the athletes were assessed before and after the 4th, 12th, and 24th weeks of treatment. The severity of pain was evaluated using the Visual Analogue Scale (VAS) that scored in the range of 0 (for no pain) to 10 (worst pain intensity) [27].

Sit and Reach flexibility test was used to test the flexibility of the lower back and hamstring muscles. The athletes sat on the floor with the head, back, and hips against a wall, knees in extension, legs together, and soles of the feet positioned with the ankle at 90 degrees. In keeping with this position, the athlete was required to extend the arms and flex the back and, with the palm of the palms down, touch the fingers together. The distance from the finger to the hand was measured in centimeters (cm). The 0 cm mark of the measuring scale represented the first position, and the score was calculated as the distance from the finger at the initial position [28].

The physical disability of athletes was evaluated using the Roland-Morris Questionnaire (CRM) [29]. It consisted of 24 points of the functional capacity of the back. The sense of progression was as follows: the more serious, the worse is the athletes' performance.

The short form of the health status questionnaire (SF-12) [30] was used to evaluate the athletes' general health conditions. Concretely, the physical component (Physical Score-PCS) and the mental component (Mental Score-MCS) were evaluated. The questionnaire consisted in 12 items of the 8 dimensions as: physical function (2), social function (1), physical role (2), emotional role (2), mental health (2), vitality (1), body pain (1), and general health (1).

Statistics

Statistical analysis was performed using SPSS statistical software package version 25.0 (Chicago, IL, USA). Mean and standard deviation were calculated for each variable in 95% confidence intervals. For the normal distribution of the data, the Kolmogorov–Smirnov test was used ($p > .05$). Baseline characteristics and clinical variables were compared between both groups using Student *t-tests*. Covariance (ANCOVA) was used to analyze the differences between the two groups in all patient outcomes at 4-week, 12-week, and 24-week follow-up, where baseline values were used as covariates. When a significant treatment-by-time interaction was obtained, an ANOVA repeated measures was conducted. Between groups, effect sizes were calculated using the Cohen's *d* power analysis [31]. Values ≤0.2 represent a small-size effect, 0.20–0.50 represent a medium-size effect, and ≥0.8 represent a large-size

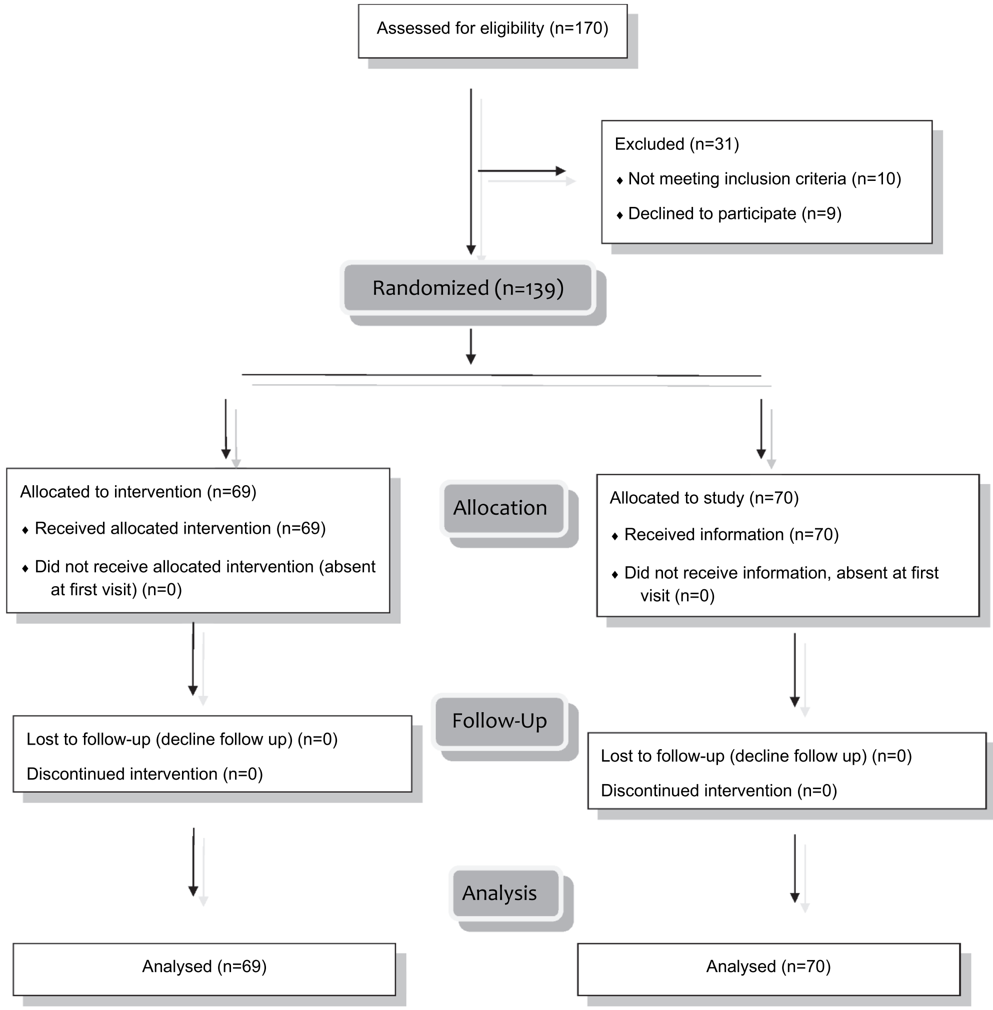

Figure 1. Flow chart of participants.

effect. A p-value of <.005 was considered statistically significant. GraphPad Prism statistic program also was executed for this experimental design.

Results

After applying our exclusion criteria, a total of 139 athletes were randomized in this study, of whom 69 were assigned to the experimental group (Figure 1. Participant flow chart).

The number of female participants was higher, with above 64% of all athletes. In total, 50 male and 89 female athletes were analyzed with a mean ± SD of 0.64 ± 0.68. The characteristics of all athletes are presented in Table 1.

The mean ± SD age of all athletes was 21.42 ± 4.56 years old, and the mean ± SD of the height was 171.22 ± 11.6 cm, with a minimum of 153 cm and a maximum of 210 cm (Table 1).

Table 2 displays the baseline and after 6-month intervention values regarding the main outcomes. At baseline, only a difference between groups was found in the PCS and MCS variables score of health status ($p > 0.005$). At the 6-month of the intervention, a significant difference in the means (SD) was observed in pain (VAS), back flexibility (Sit & Reach) and back disability (CRM) outcomes in favor of the experimental group with a medium-large effect size compared with the control group. Only the back flexibility (Sit & Reach) outcome does not show a significant difference between groups at the 6th month of the treatment ($p > 0.005$).

By considering the baseline data as a covariate, ANCOVA revealed a significant difference between groups in all the outcomes ($p < 0.005$) (Table 2). At the end of this trial, none

Table 1. Participant characteristics.

Characteristics	Groups	Gender	N	%	Mean	SD
Gender	EG	Male	31	44.90%		
		Female	38	51.10%		
		Total	69	100%	0.55	0.5
	CG	Male	19	27.10%		
		Female	51	72.90%		
		Total	70	100%	0.73	0.4
	Total	Male	50	36%		
		Female	89	64%		
		Total	139	100%	0.64	0.48
Characteristics	**Groups**	**N**	**Mean**	**SD**	**Min**	**Max**
Age	EG	69	22	4.8	15	38
	CG	70	20.8	4.2	15	34
	Total	139	21.4	4.5	15	38
Height	EG	69	172.4	12.6	153	210
	CG	70	169.9	10.4	156	199
	Total	139	171.2	11.6	153	210

Abbreviations: EG – experimental group, CG-control group, N – number of participants, SD – standard deviation, Min – Minimum, Max- Maximum.

Table 2. Between groups analysis of participants.

			Baseline /T0					24 Weeks /T1					Difference between groups	Ancova			Effect size (T1-T0)
Outcomes	Groups	N	Mean (SD)	*t*	*F*	*p*	*Cohen's d*	Mean (SD)	*t*	*F*	*p*	*Cohen's d*	*Mean Diff (95% CI)*	*F*	*p*	*η*	*Cohen's d*
VAS	EG	69	3.04(1.18)	2.63	6.92	0.009	0.447	1.17(1.07)	−12.87	165.6	0.000	2.195	1.05(0.82–1.27)	257.67	0.000	0.655	1.748
	CG	70	2.54(1.05)					3.53(1.08)					3.65(3.42–3.87)				
Sit and Reach	EG	69	11.67(6.9)	−2.7	7.33	0.008	0.462	14.78(8.6)	1.21	1.46	0.228	0.205	16.38(15.91–16.86)	187.1	0.000	0.579	−0.257
	CG	70	14.6(5.7)					13.30(5.5)					11.71(11.24–12.18)				
CRM	EG	69	4.10 (1.49)	2.01	4.05	0.046	0.344	1.81(1.32)	−15.36	236.19	0.000	2.611	1.68(1.45–1.92)	412.72	0.000	0.752	2.267
	CG	70	3.61(1.35)					4.96(1.08)					5.08(4.84–5.31)				
PCS	EG	69	35.87(5.02)	−4.84	23.46	0.000	0.823	43.12(5.4)	9.25	85.57	0.000	1.586	44.53(43.49–45.57)	215.33	0.000	0.613	0.763
	CG	70	40.29(5.69)					34.63(5.3)					33.22(32.19–34.26)				
MCS	EG	69	40.72(4.8)	−5.73	32.93	0.000	0.975	49.54(5.6)	11.97	143.34	0.000	2.041	51.28(50.22–52.35)	338.08	0.000	0.713	1.066
	CG	70	45.94(5.85)					38.31(5.4)					36.58(35.53–37.64)				

Abbreviations: EG – experimental group, CG-control group, N – number of participants, VAS, Visual Analogue Scale; Sit and Reach, Sit and Reach flexibility test; Runtastic, Runtastic Pedometer Performance; CRM, Roland-Morrison Questionnaire; SF12, Health Status Questionnaire (PCS, Physical Score; MCS, Mental Score).

of the athletes of the experimental group experienced any adverse effects related to the implementation of Mézières therapy.

GraphPad Prism Nested *t-test* showed a significant difference between the two groups at the 4th and 12th week of the treatment (Figure 2). The same situation was presented during the four measurement periods of the study in favor of the Mezieres group (Figure 3).

Discussion

This randomized controlled trial study aims to determine the effectiveness of the MM implementation in athletes with LBP compared to a control group that follows only the conservative standard rehabilitation protocol. The obtained results showed a feasible and positive impact. The study shows that a combination of the MM with the standard rehabilitation protocol can help to reduce the LBP. Athletes treated with MM for 24 weeks following two weekly sessions had better results than those who followed only the conventional treatment of LBP.

Therefore, the results supported our hypothesis that adding the MM to the rehabilitation protocol would be helpful to athletes with LBP.

An essential element in the MM approach is the postural reeducation of the participant. The objectives are proposed and reached in strong collaboration with the athlete. These objectives can also be modified during the work according to the needs of the athlete. Personalized treatment can also be considered as one of the reasons for the significant results of this study comparing the experimental and control group.

Different back pain treatments in athletes are based on disciplinary processes that exclude body awareness and are directed at performance characteristics, in which self-reflections do not exist. The body is divided into measurable parts and segments. The therapeutic act is depersonalized because it is so dosed that only vigilance is enough to achieve the desired result, excluding the corporal interaction [32].

Muscle stretching and strength exercises stand out in treating low back pain in athletes [14]. In addition, it is understood that the pain is due to the weakness of the central muscles, for which the treatment is to make movements to gain strength where it is required. These exercises are performed in common spaces (training places) where the athletes undergo their execution, while the therapist only observes [32].

The scientific community has widely explored the benefits that physical exercise brings to the health of the most active, productive, and competitive people with low back pain [14,33]. However, they cannot be generalized prescriptions since individuality and the motivation to explore movement are of a diverse nature, and in current terms, their prescription

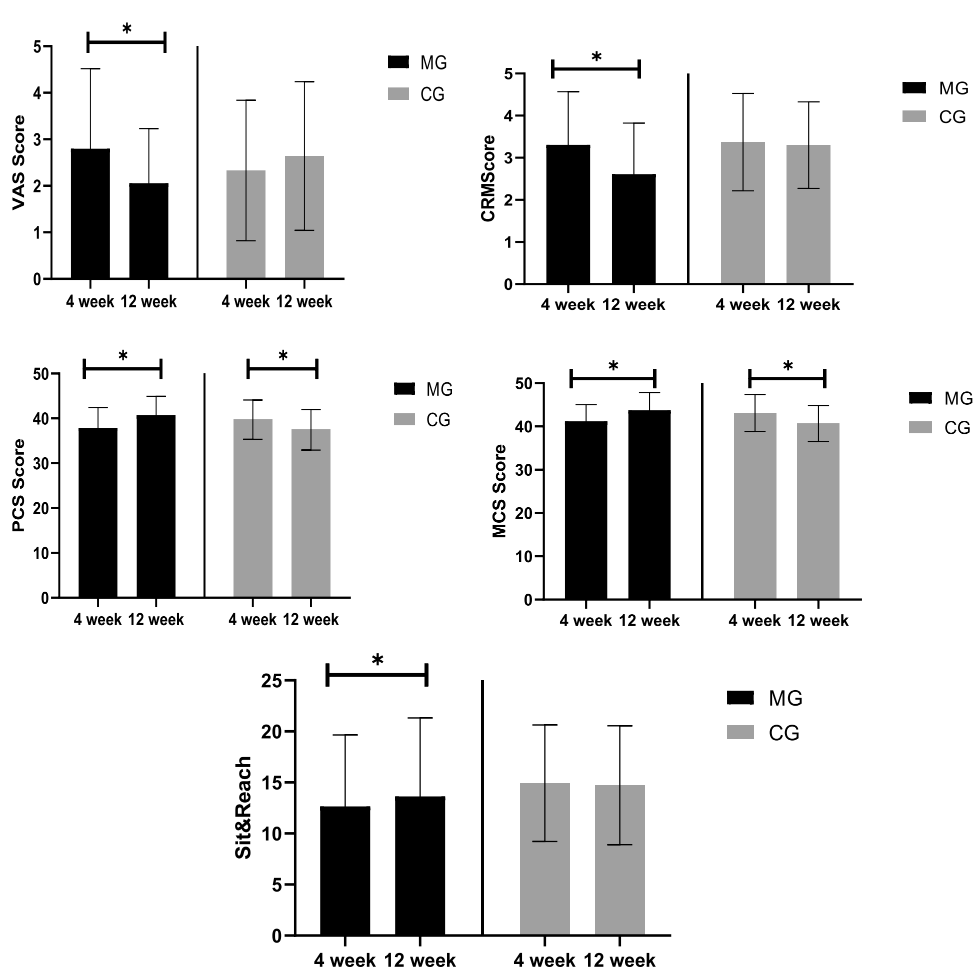

Figure 2. GraphPad prism nested *t* test for the difference between groups during the 4 and 12 week period of the treatment.

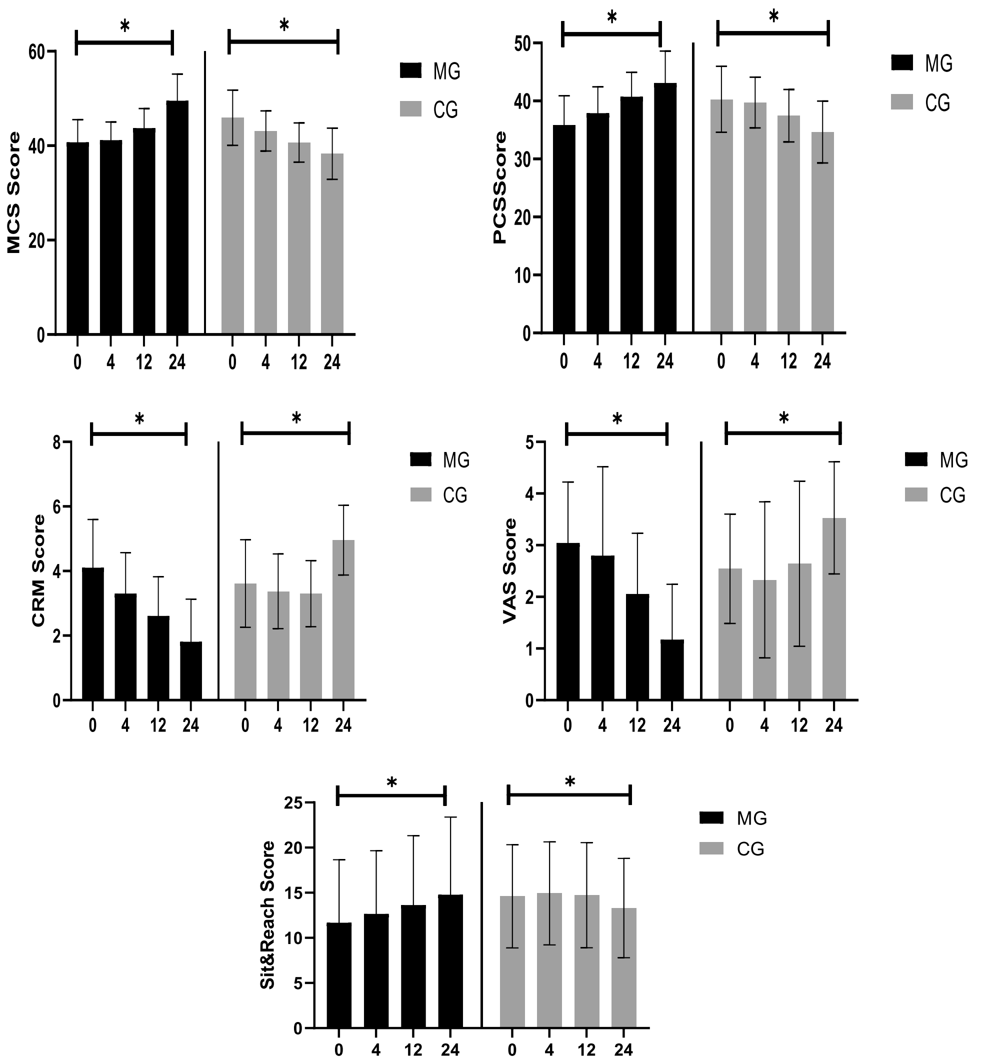

Figure 3. GraphPad prism nested *t* test analysis for the difference between groups for the 4 periods of the treatment.

must be based on a person-centered model responding to the principle of individuality as mandatory [34,35]

Keeffe et al., 2020 implemented a personalized intervention called cognitive functional therapy (CFT) in 106 participants with chronic low back pain compared with physiotherapist-delivered group-based exercise and education intervention with 100 participants. The results showed that CFT reduced disability but not pain at 6 and 12 months [36]. On the other hand, Liew et al., 2021 argue that personalized physiotherapy for low back pain appears to work predominantly by facilitating an early reduction in disability, which leads to improvements in other biopsychosocial outcomes [37]. However, the Liew et al. 2021 study cannot rule out that unmeasured mechanisms (such as tissue healing or reduction of inflammation) may mediate the relationship between personalized physiotherapy treatment and improvement in disability. Malfliet et al., 2018 concluded that a 12 months intervention of pain neuroscience education combined with cognition-target motor control training with follow-up at 3 and 6 months appears to be more effective than the education on back and neck pain and general exercise therapy for reducing pain, disability, mental, and physical functioning in participants with chronic spinal pain [38].

Our findings demonstrate that the pain significantly decreased in the 6th month of intervention in athletes who received the Mézières therapy compared with those who received the conservative treatment of LBP. Also, the physical disability reduces, while health status increases in the 6th month of intervention in the experimental group. The same results were taken in the difference between groups analysis with the exception of the back flexibility test sit and reach, which in the separate analysis at baseline and the 6th month of intervention did not present a significance ($p > 0.005$) although a significant difference between the group was shown.

A meaningful correlation was found between the young age, musculoskeletal pain, and the duration of sports practice in gymnastics with LBP [39]. These characteristics coincide with our study since we treated and evaluated young elite athletes who suffered LBP with a mean age of 21.4 years old.

The elite gymnastics characteristics of this trial also coincide with the Fari et al. (2021) observational study, which refers that artistic and rhythmic gymnastics, due to back stress, can undergo various types of overuse injuries and pain that can affect the musculoskeletal anatomical district.

Our results coincided with the results of other findings [40,41]. Fari et al. (2022) implemented a six-week postural McKenzie treatment combined with collagen peptides, hyaluronic acid, Vitamin C, Manganese, and Copper. It was shown that this integrated treatment was able to reduce pain and motor disability and improve the quality of life in patients suffering from chronic LBP due to osteoarthritis, even though the participants cannot be compared with our trial since they cannot be considered as an elite athlete with LBP.

The same authors refer that it is not sufficient to combat only with pharmacological the traumatic musculoskeletal pain as state of the art in athletes. De Sire et al. (2021) highlighted the need for effective physical treatment and rehabilitation as an optimal strategy to manage sport-related injuries [42].

Regarding the improvement of the quality of life of our participants, it can be said that the Mézières postural treatment might have a positive effect because of the duration of time. Specifically, this trial was implemented for a period of 6 months. According to Françoise Mézières [16], the benefits of this method can be observed during a long period of treatment where a morphological correction of the tonic imbalance is achieved. The basic principle of Mézières was that the mind and the body are in a close relationship. Then, the reeducation must consider the personal history of each athlete in its physical and psychic globality, which means the treatment of physical, functional, and psychological aspects can improve the attitude, the posture, and the quality of life of the athlete with LBP.

Referring to the sample, the number of female participants was higher with above 64% of all athletes because of the high number of female team members of rhythmic gymnastics and the possibility offered to treat more than one national gymnastics team, but no difference in gender was observed, also referring to the evidence [43]. In this trial, the participation of females was pure causality.

It is also important to mention that there would be differences between the two groups not because of the wide age ranges but because this range was the same in both experimental and control groups, it would not affect the overall results in this study but could be a factor to consider for future research.

Currently, the management of low back pain in sport includes a series of different strategies such as drug therapy, physiotherapy, needle-puncture, yoga, and much more [44]. The difficulty is to evaluate their effectiveness and then organize these tools to achieve therapeutic goals [45]. The significance of our results regarding outcome measures, whose analysis showed effectiveness ($p < 0.005$ in all cases), may be related to the fact that the Mézières therapy implementation in the experimental group was accompanied by other rehabilitation treatments, enabling the athlete fast recuperation. Comparing our results with Global Postural Reeducation (GPR) studies [46] that transmit the same Mézières therapy principles developed by Souchard [47], it is reflected in terms of significance that with the same weekly treatment frequency and with a follow-up of 6 months, significant changes in LBP and cervical pain are seen in non-sporting studies [48,49]. Another positive result in confronting with the GPR treatment was shown in the correlation of the postural rehabilitation attitude and the cognition in neurological patients [21,50,51].

Inspired by the positive results obtained in other studies with the implementation of the GPR and Mézières therapy [21,52,53], this trial suggests that MM can be an interesting, and valuable option to treat athletes with back pain. This noninvasive treatment is safe [52,53] and can be easily integrated with the other rehabilitation treatment. In this study, neither of the two groups experienced adverse effect of the LBP treatment.

Since this method is based on static stretch with the possibility of passive-active muscle contraction with the participation of athlete supervised by the therapist, it can be considered as a secure and adaptive treatment.

Conclusion

This study demonstrated how a postural rehabilitative approach like MM gives us better and more comprehensive management of the sport to achieve the fixed objectives and keep them long, thanks to athletes' active participation.

This research implied a positive effect on pain reduction, health, disability, and performance through the statistical results obtained. Thus, the MM approach can also be applied to established conventional protocols to alleviate pain and improve functionality by improving the quality of life of the athletes together with their physical and emotional states.

Transparency statements

Declaration of funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Disclosure of any financial/other conflicts of interest

The authors have no conflict of interest to report. Peer reviewers for this manuscript have no competing interests to declare.

Ethical Approval

This study was approved by the Ethics Committee of the Catholic University of Murcia "San Antonio" with protocol No. 6572 Clinical trial registration number ID: NCT03849053.

Acknowledgements

None stated.

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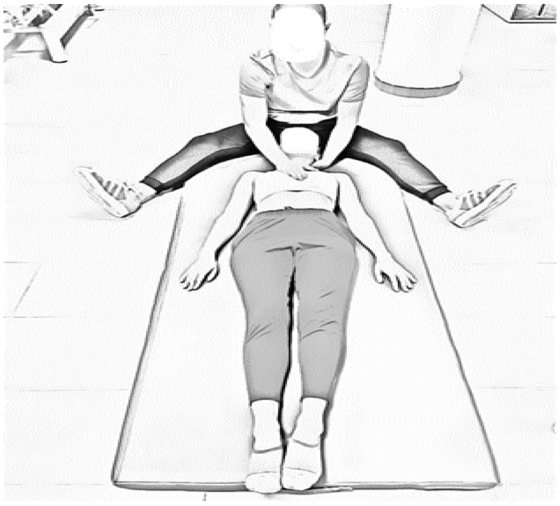
Appendix 1. Intervention Protocol of Experimental Group

(1) First posture with special attention of athlete in supine position accompanied with cervical traction and deep breathing.

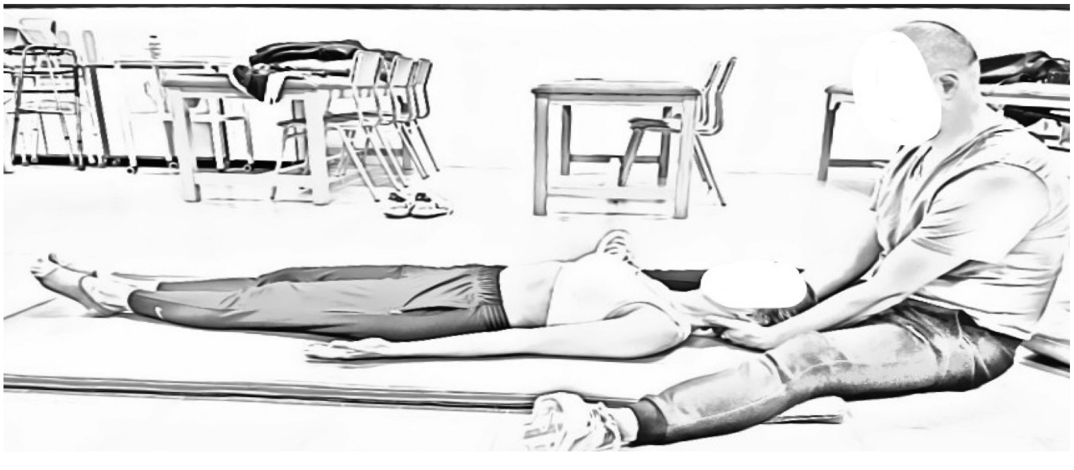
1.1 Patient positioning

1.2. Manual cervical traction

1.3. Therapist hand positioning in occipital bone



1.4. Diaphragmatic breathing reeducation



1.5 First posture treatment combined with cervical treatment and athlete diaphragmatic breathing

(2) Second posture with athlete in supine position

2.2. Athlete supine positioning with hips flexed more than 90°, knees extended and with particular attention to latissimus dorsi and posterior muscular chain

2.1 Athlete positioning with upper limbs abducted to 120°

(3) Third posture with athlete in sitting position

3.1 Lateral sitting position demonstration with performance of an isometric latissimus dorsi contraction in a maximum elongation

3.2 Frontal sitting position demonstration with performance of an isometric latissimus dorsi contraction in a maximum elongation