
UCAM

UNIVERSIDAD CATÓLICA
DE MURCIA

INTERNATIONAL DOCTORAL SCHOOL
Doctoral Program in Health Science

# The Effectiveness of Mézières Therapy in the UCAM's Athletes with Low Back Pain

Author:
Orges Lena

Directors:
Dra. Dña. María Gómez Gallego
Dr. D. José Luis Martínez Gil

Murcia, December 13, 2019

UCAM

UNIVERSIDAD CATÓLICA DE MURCIA

INTERNATIONAL DOCTORAL SCHOOL
Doctoral Program in Health Science

# The Effectiveness of Mézières Therapy in the UCAM's Athletes with Low Back Pain

Author:
Orges Lena

Directors:
Dra. Dña. María Gómez Gallego
Dr. D. José Luis Martínez Gil

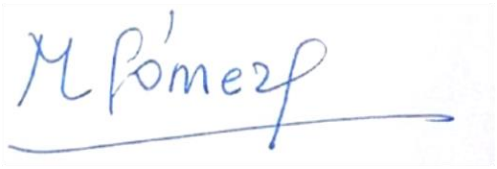
Murcia, December 13, 2019

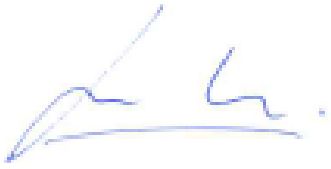
UCAM
UNIVERSIDAD CATÓLICA DE MURCIA

**AUTORIZACIÓN DE LOS DIRECTORES DE LA TESIS PARA SU PRESENTACIÓN**

La Dra. Dña. María Gómez Gallego y el Dr. D. José Luis Martínez Gil como Directores de la Tesis Doctoral titulada "The Effectiveness of Mézières Therapy in the UCAM's Athletes with Low Back Pain" realizada por D. Orges Lena en el Departamento de Ciencias de la Salud, **autorizan su presentación a trámite** dado que reúne las condiciones necesarias para su defensa.

Lo que firman, para dar cumplimiento al Real Decreto 99/2011, 1393/2007, 56/2005 Y 778/98, en Murcia en 18 de septiembre de 2019.





# THE EFFECTIVENES OF MÉZIÈRES THERAPY IN THE UCAM'S ATHLETES WITH LOW BACK PAIN


## ABSTRACT

OBJECTIVE: it pretends to verify the effectiveness of the postural treatment of Mézières Method (MM) on different athletes with mild or moderate LBP.

DESIGN: Randomized, parallel and double blind controlled trial comparing pre and post 24 weeks intervention within 2 groups: experimental and active control.

SETTING: Training Camp.

PARTICIPANTS: In total 139 athletes with LBP participated in the study. Concretely, the sample used was formed by gymnasts of the National rhythmic gymnastics in Murcia; Players in the UCAM Murcia CB / EBA basketball team, and from UCAM Murcia Football Club team.

INTERVENTION: Accordingly, three basic postures are used, those that preferably acted on the posterior chain in a more global way: supine position with the legs at 90 °, in a sitting position and in an upright position with a 90 ° flexion.

OUTCOME MEASURES: Visual Analogue Scale of pain (VAS), Sit and Reach flexibility test, Runtastic Performance Pedometer Android App, Roland-Morris Questionnaire (CRM) which measures physical disability of athletes and Health status questionnaire (SF-12) were used. The SF-12 is composed in tow subscales Mental Health (MCS) formed by 6 parameters and Physical Health (PCS) by other formed by 6 parameters.

RESULTS: By observing Control Group (CG) and Experimental Group (EG), it is evident that the VAS pain assessment scale in pre-post tests (T0-T1), had a significant value ($F = 32.7$; $p<0.05$; $\eta2 = 0.19$) in the between groups analysis. And the between group effect size was high during the 50 sessions of treatment ($d>0.8$).

Also for the Sit and Reach back flexibility test it can be observed a significant change between groups analysis ($F = 27.7$; $p<0.05$; $\eta2 = 0.16$). Furthermore for what concerns the between group effect size it has been confirmed as high during the intervention period ($d>0.8$).

For the Runtastic pedometer performance also in the between groups analysis it is noted a significant effect ($F = 399.1$; $p<0.05$; $\eta2 = 0.74$) and a high effect size throughout the treatment phase ($d>0.8$ as described in table .2)

The disabling status (CRM) was observed in the difference between groups and a significance was noted on the own analysis ($F = 44.2$; $p<0.05$; $\eta2 = 0.24$). Concretely, the effect size was high during the 24 weeks of treatment ($d>0.8$). And furthermore the differences between groups of the health status (SF12) and the effect size analyzed for the two subscales (PCS and MCS) were also significant ($p<0.05$; $d>0.8$).

CONCLUSION: MM can be applied in established conventional protocols to alleviate pain and functionality, by improving the quality of life of the sportsman together with his physical and emotional state.

KEYWORDS: Stretching; Compensation; Manual therapy; Low back pain;

Sportsman; Postures.

# LA EFECTIVIDAD DE LA TERAPIA MÉZIÈRES EN LOS DEPORTISTAS DE LA UCAM CON DOLOR DE ESPALDA


## RESUMEN

OBJETIVO: Se pretende verificar la efectividad del tratamiento postural del Método Mézières (MM) en diferentes atletas con dolor lumbar leve o moderado.

DISEÑO: Ensayo aleatorio controlado, paralelo y doble ciego que comparó la pre y post intervención de 24 semanas en 2 grupos: experimental y control activo.

AJUSTE: Campo de entrenamiento.

PARTICIPANTES: Ciento treinta y nueve atletas en total, con dolor de espalda (LBP) participaron en el estudio. Concretamente, la muestra utilizada estaba formada por gimnastas de la gimnasia rítmica nacional en Murcia; Jugadores del equipo de baloncesto UCAM Murcia CB / EBA, y del equipo UCAM Murcia Futbol Club.

INTERVENCIÓN: En consecuencia, se utilizaron tres posturas básicas, aquellas que actuaron preferiblemente en la cadena posterior de una manera más global: posición supina con las piernas a 90 °, en posición sentada y en posición vertical con una flexión de 90 °.

MEDIDAS DE LOS RESULTADOS: Se utilizaron; la escala analógica visual del dolor (VAS), la prueba de flexibilidad Sit and Reach, la aplicación de Android Runtastic Podómetro, el cuestionario de Roland-Morris (CRM) que mide la discapacidad física de los atletas y el cuestionario de estado de salud (SF-12).

RESULTADOS: Al observar el Grupo de Control (CG) y el Grupo Experimental (EG), se evidenció que la escala de evaluación del dolor VAS en las pruebas previas

(T0-T1) tuvo un valor significativo ($F = 32.7$; $p<0.05$; $\eta2 = 0.19$) en el análisis entre grupos. Y el tamaño del efecto entre los grupos fue alto durante las 50 sesiones de tratamiento ($d>0.8$).

Para la prueba de flexibilidad Sit and Reach se pudo observar un cambio significativo entre el análisis de grupos ($F = 27.7$; $p<0.05$; $\eta2 = 0.16$). Además, por lo que respecta al tamaño del efecto entre grupos, se confirmó que es alto durante el período de intervención ($d>0.8$).

Para el rendimiento del podómetro Runtastic, en el análisis entre grupos, se observó un efecto significativo ($F = 399.1$; $p<0.05$; $\eta2 = 0.74$) y un alto tamaño del efecto durante toda la fase de tratamiento ($d>0.8$).

El estado de incapacitación (CRM) se observó en la diferencia entre grupos y se anotó una significación en el propio análisis ($F = 44.2$; $p<0.05$; $\eta2 = 0.24$). Concretamente, el tamaño del efecto fue alto durante las 24 semanas de tratamiento ($d>0.8$). Y las diferencias entre los grupos del estado de salud (SF12) y el tamaño del efecto analizado para las dos subescalas (PCS y MCS) también fue significativo ($p<0.05$; $d>0.8$).

CONCLUSIÓN: MM puede aplicarse en protocolos convencionales establecidos para aliviar el dolor y la funcionalidad, al mejorar la calidad de vida del deportista junto con su estado físico y emocional.

PALABRAS CLAVE: Estiramiento; Compensación; Terapia manual; Dolor lumbar; Deportista; Posturas.

## ACKNOWLEDGEMENTS

A special thanks goes to Andrés Hernández Rodríguez, Head of the International Doctoral Section, who also has a key role in the realization of this research. Even thanks to him was made possible this research completion. I would take the opportunity to thank him for the smile, support, readiness and assistance given during my permanence in UCAM Catholic University of Murcia.

Contemporaneously I would like to thank all physiotherapists of the teams that enabled my research implementation to the professional sportsmen, in first line the coaches and then, athletes who believed in my professionalism and treatment.

Thank you all!

”If the facts don’t fit the theory, change the facts.”

- Albert Einstein

# CONTENTS

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| A.M.I.K | International Mezquist Association of Kinesitherapy |
| BOCP | Bronco Obstructing Chronic Pneumonia |
| COPD | Chronic Obstructive Pneumonia |
| CRM | Roland-Morris Questionnaire |
| LBP | Low Back Pain |
| MCS | Mental Score |
| MM | Mézières Method |
| RCT | Randomized control trial |
| H | Hypothesis |
| GPR | Global Postural Reeducation |
| PCS | Physical Score |
| SCI | Spinal Cord Injury |
| SF-12 | Health status questionnaire |
| Sit Reach | Sit and Reach flexibility test |
| SPSS | Statistical Package for Social Sciences |
| T0 | Pre-test evaluation |
| T1 | Post-test evaluation |
| UCAM | Catholic University of Murcia |
| VAS | Visual Analogue Scale |
| WHO | World Health Organization |

# INDEX OF FIGURES, TABLES AND ANNEXES

## INDEX OF FIGURES

## INDEX OF TABLES

## INDEX OF ANNEXES

# I – INTRODUCTION

# I - INTRODUCTION

## 1.1 EPIDEMIOLOGY OF LOW BACK PAIN (LBP)

The Low Back Pain (LBP) is characterized as a public health affair by World Health Organization (WHO) because of the presented prevalence and not only, moreover, it affects the physical, emotional, and social aspects of individuals. According to the statistics, 70% of the adult population in the world represents back pain once during lifetime (1), while in the athletes population the frequency ranges from 1 to 30%, varying between some sports and others (2,3,4). Fortunately, only 4% of the population requires surgical interventions due to pain (5)

In fact, the LBP is common in people between adolescence and adulthood who are in the first years of academic training because they spend many hours in classrooms sitting at a desk, decreasing their time and ability to perform physical sports activities, thereby increasing the risk of having loss of sleep, depression, headaches or developing unhealthy habits such as the use of cigarettes or alcohol (6).

Several other factors have been associated with LBP such as sex, age, body mass index, low level of education, physical activity, cigarette consumption, psychological factors including anxiety and depression, maintained postures, etc. (6,7,8,9).

Therefore, LBP tends to influence people's quality of life by inhibiting the freedom of movement, hindering the changes of the posture that the person adopts to carry out their daily activities (such as moving weight, walking, sitting or standing, sexual activity, social life , etc.).

Stating that it can be added that lumbar pain is harvested, thanks to stimulation of specific receptors, distributed throughout the body, such as skin, joint capsules, and mucosal mass. The so-called nociceptors, are responsible for transmitting this signal to the marrow and the nervous system gives rise to a response. The nervous transmission of this pain is influenced by several substances whose action can be inhibitory (encephalins) or facilitative

(prostaglandins) (10). Precisely, the lumbar pain or back pain is concentrated at the level of the lumbosacral vertebral column. The risk of suffering from this pain increases in adolescents due to their participation in sports activities which presuppose a high level of stress in the lumbar spine (11). While the person's feeling is based on pain in the kidneys, back, waist or hip. In some cases, this pain can expand and reach the area of the buttocks or the lower limbs. On the other hand, sciatic pain is the one that is reflected in one or both lower limbs and follows the path of the sciatic nerve. And finally, non-specific backbone is the one where there is an absence of apparent cause (12). Definitively, in this study, I will always refer to the first case, lumbar pain or back pain, always located at the lumbosacral vertebral column.

Correspondingly, it is admitted that the classifications of LBP according to pain suffer, structure, duration and distribution differ. In this merit, lumbar pain, depending on its duration, can be defined in four types (13):

1. *Recurrent lumbago pain:* Several episodes of back pain can occur in the last twelve months;

2. *Chronic lumbago:* causes back pain that lasts more than 6 months uninterruptedly;

3. *Acute lumbar pain:* the pain that is not considered chronic, which happens suddenly and recently;

4. *Transient lumbar pain:* It lasts less than three months and usually does not repeat during a year.

Pérez et al. (2007) follows the same line of Balagué (2012) according to the duration of backbone pain and classifies the acute lumbago, which lasts less than 6 weeks, in subacute between 6 and 12 weeks, and recurrent lumbago, which occurs in subjects who have had previous episodes of low back pain with periods without pain (13, 14).

But in the bibliography it can be find even another LBP classification based on the symptoms of lumbar pain.

With special regard to Seguí and Gervas (2002), primary LBP is usually defined with a mechanical symptomy, where in 5% of cases there may be several structural alterations of the disk, joints or alterations of the biomechanics of the lumbar vertebral column. Meanwhile in a higher percentage, around 60-80%, primary backbone has no apparent cause. These same authors classify secondary

LBPs, which are related to various inflammatory processes, tumors, infections or metabolic pathologies (12).

## 1.2 SPORTS INJURIES AND LBP

In the way that LBP affects the general population, it is very common to see athletes from a multitude of sports such as soccer, tennis, volleyball, basketball, gymnastics, diving, weight lifting, golf and rowing with LBP (15,16,17). The incidence of backbone in young athletes has been heavily studied in the literature, determining the percentage of incidence in this population between 1-30% (2, 4). In addition, the literature states that in all sports injuries the backache represents 10-15% of total cases (18, 19).

Intuitively, it is not by chance that this study focuses on the treatment of sportsmen LBP such as rhythmic gymnastics, basketball and football.

As for the deported lesions mentioned earlier, the most traumatic is the one that affects the spinal cord injury (SCI), being one of the most feared influences. Although it may seem impossible in sports, 11,000 cases in the United States in one year were identified, 9% was related to sports, being the fourth most common cause of spinal cord injury (20).

In sports, not only is it possible to see spinal cord injury, but also death from this same cause. Exactly in football, 116 deaths were detected due to cervical spine injuries between 1945 and 1994 period (21).

In this context, Eddy et al., (2005), presents lesions of the herniated disc. And LBP is one of the most common affinities in the affected population, causing 80% of it, while having some lumbar pain episode during lifetime (22, 23, 24). However, the disk hernia is less common, with only a prevalence of 2-5% (25). As the pulp nucleus is generally ejected between the two vertebral bodies due to the weakness of the back ligament (26). Also is known that 95% of horned disks occur in L4-L5 and L5-S1, and the latter is the most common. The symptoms that can be found in this pathology are back and also leg pain.

Another damage that affects the spine is spinal stenosis, which involves a narrowing of the spinal canal. The origin of this can be congenital or acquired. When this affect is acquired, it is assumed that the enlargement of the joints,

ligaments and invasion of the vertebral disc occurs. Effects symptoms suggest weakness and cases of paresthesias that may last for a few seconds, and in very rare cases a permanent pain and paralysis can be verified (27).

The literature determines that radiography serves as the primary method of diagnosis (28), however, many authors recommend studying the entire spinal cord and not just the affected part (29). In those cases in which the affectation ceases and there is no symptomatology, the authors do not prevent the return to sports practice (30), even on the contrary, there are other authors, who in situations with root canal stenosis, totally ignore the sport practice (29).

## 1.3 THE INCIDENCE OF BACK PAIN IN SPORTS

Among the percentages that can be found in the literature, as regards the incidence of back pain in various sports, gymnastics stands out with 11% (31) and football with 50% (32).

According to Sward et al., (1991), low back pain in elite gymnasts was higher than in the control group, with 79% and 38%, respectively.

If we compare different groups of athletes in different modalities, with control population of the same age and sex, but not professionals of that specialty, we would find that according to Granhed and Morreli (1988) the prevalence of low back pain in wrestlers was significantly higher than that found in the population of the same age, respectively of 59% and 31% (2).

This incidence of LBP in sports is explained by several authors because of the existence of low abdominal muscle strength, muscular imbalances and poor flexibility of the lower limbs (16).

In addition to the abdominal muscles, the hip muscles play a very important role in the transfer of forces from the lower limbs to the vertebral column, during both activities and in an upright position (33, 34).

Comparatively, there is evidenced that poor resistance in the hip extensors, such as the gluteus maximus and the gluteus medius, is related to LBP (16).

As a result of this lack of muscular work, the literature recommends the work of the upper body, with improvements in isometric strength in the

abdominal muscles, as well as the work of flexibility in the back muscles of the thigh, in order to give stability and protection of the lumbar spine (35,36,37).

Concerning to the sport, although most athletes have developed this kind of work, it is very common to find backbone as a high incidence pathology, as has been shown in the previous lines (38, 39).

There is a real interest in knowing why LBP becomes a very common disease in this type of population, given that it is assumed that people are in good physical condition. One of the main causes cited in the literature about the reason why even athletes with a high physical condition suffer from this disease is because they often develop sports that involve disk compression movements during flexion, lifting loads or torsion movement (38).

Leading to the understanding, even the athlete has a proper muscular development of the trunk, sport and the specific technique of this, we suppose situations of great stress for this vertebral area. The mechanism that occurs in these situations of great physical stress, is that the soft tissues, such as the muscles, the cartilage of the facets, the ligaments and the intervertebral discs, can not withstand the cutting movements, as well as the compression or movements of twist. Properly this, begins to produce imbalances that directly influence the mechanics and biomechanics of the vertebral column (40). Therefore, we can say that athletes, like the general population, can undergo biomechanical adaptations in the lumbar spine tissues (41).

In this context, the literature mainly indicates three main mechanical causes of LBP in this type of population: muscle and ligament disorders, disk degeneration and spondylolisthesis (42,43,44). In contrast, the less pronounced causes in this population are stress fractures in the joints and faces of the sacrum (45).

Especially the spondylolisthesis is closely related to the repeated hyperextension movements that occur in sports such as gymnastics, figure skating, diving and soccer, as well as hyperlordosis, which is also considered the second leading cause of back pain in adolescents (46). Referring to the latter, this injury occurs during the growth of the axial skeleton, because it grows faster than the surrounding soft tissues, producing muscle pain (47).

In this circumstances is affirmed that not only LBP is one of the most common conditions in the general population, but it is present also in younger

athletes. In this population has a prevalence between 10-15% (32). This pain in most cases is related to spondylolysis situations (48). Micheli and Woods (1995), in their retrospective study of 100 cases, found that almost half of those cases with back pain were due to spondylolysis (46). This affectation presupposes a defect in the inter-articular part of the vertebrae. It is estimated that about 5-6% of the population has spondylolysis (49) while in athletes it has a much higher prevalence, where about 43%-90% (50, 51) of spondylolysis occurs in L5 (52, 53).

This affectation is defined as a stress fracture in one of the vertebrae of the vertebral column, which evolves progressing into a sliding of the vertebrae and giving rise to spondylolisthesis. Spondylolisthesis instead is a displacement of some vertebrae after bilateral spondylolysis has occurred. It is a more frequent affectivity in adolescents, due to incomplete maturation of the inter-articular portion, which makes it more susceptible to injury.

The symptoms are focused on LBP, which is exacerbated by the extension of the spine. The sports in which you can see more cases of spondylolysis are gymnastics (11%), diving (43%), weightlifting (23%) and fight (30%) (32, 50.51).

## 1.4 MANUAL THERAPY AND LBP

Spinal manipulation is defined as a high velocity and low amplitude mobilization technique, beyond its limitation of joint movement. Spinal mobilization instead involves low speed passive movements within the limit of the common movement range (54, 55).

Most studies do not make a clear distinction between manipulation and mobilization, because in clinical practice they are part of a "spinal manipulation package", which is often referred as manual therapy (56).

Twelve studies were found focused on the effectiveness of manipulation and / or spinal mobilization (considered the same) compared to other procedures, some of which were considered placebo (54,55, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66), while two are separate manipulations and spinal mobilizations (67, 68). Table. 1

In this respect, the studies of Hemmila et al., (1997), Koes et al., (1992), Postacchini et al., (1988), Skargren et al., (1997), revealed that spinal manipulation showed no significant differences in physiotherapy and physical exercise,

compared to short or long-term pain as well as on the degree of physical disability (69, 70, 71, 72) (Table. 1).

The clinical trial of Aure et al., (2003) instead, found significant differences in the return of work of manual therapy compared to exercise, with significant differences for both groups in terms of pain, disability and mobility after the intervention of 8 weeks lasted for 12 months (73) ( Table. 1)

Whereas the study by Childs et al., (2004), concludes that the predictive clinical role of spinal manipulation should be considered for decision-making on interventions in non-specific mechanical low back pain. This predictive role is based on the duration and position of symptoms, on lumbar and hip mobility and on unsafe movements (74) (Table. 1).

Many studies other have grouped vertebral pains of different length and position, not being able to differentiate the subgroups of chronic low back pain.

From the other side, most of the manipulation/ mobilization treatments were administered by personnel who were considered "qualified" within their own medical specialty (osteopathy, chiropractic, manual medicine, physiotherapy), although the qualification requirements are different among professions. Furthermore, the techniques used in the tests were more commonly administered twice a week (1-7 times a week) and more commonly for a period of 2-3 weeks (2-9 weeks). Anyway, it was concluded that there is no evidence to suggest that long-term manipulative treatment contributes to any additional benefit (75) (Table. 1).

The most systematic reviews of the effectiveness of manual therapy included evidence in spinal manipulation and spinal mobilization, both of which were considered to be the same treatment. As such, it was impossible to determine the relative efficacy of spinal manipulation or mobilization (56).

**Table 1. Studies on the effectiveness of manual therapy in LBP**

| First Author's Name | Research topic | Journal's Name | Year | References |
|---|---|---|---|---|
| Brox et al. | Exercise therapy and manipulation in LBP | Tidsskrift for Den norske legeforening | 1999 | 54 |
| Koes et al. | Systematic Review/Spinal manipulation for LBP | Spine | 1996 | 55 |
| Harvey et al. | Spinal manipulation for LBP | Manual Therapy | 2003 | 56 |
| Abenhaim et al. | 20 Years of RCT of manipulative therapy for back pain | Clinical and Investigative Medicine | 1992 | 57 |
| Assendelft et al. | Efficacy of chiropractic manipulation for back pain/ Blinded review RCTs | Journal of Manipulative and Physiological Therapeutics | 1992 | 58 |
| Assendelft et al. | effectiveness of chiropractic for treatment of LBP | Journal of Manipulative and Physiological Therapeutics | 1996 | 59 |
| Assendelft et al. | Effectiveness of manipulative therapy in LBP/Systematic review | Nederlands Tijdschrift voor Geneeskunde | 1998 | 60 |
| Assendelft et al. | Spinal manipulative therapy for LBP/ A meta-analysis | Annals of Internal Medicine | 2003 | 61 |
| Cherkin et al. | A review of the evidence for the effectiveness, massage therapy, and spinal manipulation for back pain | Annals of Internal Medicine | 2003 | 62 |
| Ferrerira at al. | Specific stabilization exercise for spinal and pelvic pain/A systematic review | Australian Journal of Physiotherapy | 2006 | 63 |
| Koes et al. | Physiotherapy exercises and back pain/ A blinded review | British Medical Journal | 1991 | 64 |

**Table 1. Studies on the effectiveness of manual therapy in LBP (continued).**

| First Author's Name | Research topic | Journal's Name | Year | References |
|---|---|---|---|---|
| Ottenbacher et al. | Efficacy of spinal manipulation/mobilization therapy/A meta-analysis | Spine | 1985 | 65 |
| Shekelle et al. | Chiropractic spinal manipulation for LBP | Annals of Internal Medicine | 1998 | 66 |
| Andersonet al. | A meta-analysis of clinical trials of spinal manipulation | Journal of Manipulative and Physiological Therapeutics | 1992 | 67 |
| Ernst et al. | Spinal manipulation/A systematic review of sham controlled, double-blind, RCT | Journal of Pain and Symptom Management | 2001 | 68 |
| Hemmila et al. | RCT on patients with prolonged back pain | Archives of Physical Medicine and Rehabilitation | 1997 | 69 |
| Koes et al. | Effectiveness of manual therapy, physiotherapy for nonspecific back and neck complaints/RCT | Spine | 1992 | 70 |
| Postacchini et al. | Efficacy of various forms of conservative treatment in LBP/A comparative study | Neurology and orthopedics | 1988 | 71 |
| Skargren et al. | Chiropractic and physiotherapy treatment for low back and neck pain | Spine | 1997 | 72 |
| Aure at al. | Manual therapy and exercise therapy in patients with chronic LBP/RCT | Spine | 2003 | 73 |
| Childs at al. | LBP most likely to benefit from spinal manipulation/A validation study | Annals of Medicine Internal | 2004 | 74 |
| Licciardone at al. | Osteopathic manipulative treatment for chronic LBP/ A RCT | Spine | 2003 | 75 |

## 1.5 THE ROLE OF MUSCLE STRENGTHENING IN LBP

Muscle strengthening is part of the therapeutic physical exercise which includes any rehabilitative program in which, during the sessions, the participants are required to perform dynamic or static movements and where the exercises are intended to be supervised and / or prescribed (76).

Following the above mentioned argumentation line, the clinical studies of Bronfort et al., (1996), Hansen et al., (1993), Johannsen et al., (1995), and Manniche et al., (1991) compared a certain type of muscular stabilization and motor control of the local lumbar stabilization system with other types of exercises (77,78,79,80).

Advancing with the bibliographic research, two studies have shown better results than pain and the degree of physical disability, for an intensive program, rather than a slight exercise (80,81); two others found no significant differences between stabilization exercises and general physiotherapy exercises (78) or stretching exercises (77) and finally another study found no significant differences between stabilization exercises and general coordination training, in terms of improving pain and the degree of physical incapacity (79).

Comparatively another study deduces that there are no significant differences between muscle strengthening exercises and aerobic exercise (82), compared to pain improvements up to one year after treatment. Another quality test showed that muscle-strengthening exercises gave similar results to McKenzie's exercises in terms of improving pain and the degree of disability (83).

As for aerobic exercise, there has been limited evidence that there is no difference between aerobic and strengthening exercises compared to pain improvements up to 1 year after treatment. The degree of physical disability was considerably reduced after 6 months in the aerobic group, compared to the muscle strengthening group, but the difference disappeared in 12 months (82).

A further clinical study presented limited evidence in an aerobic exercise program combined with education, being more effective than flexion and lower back pain training, in terms of pain immediately after the program (84).

Mannion et al., (2001), with an intervention based on aerobic group exercises (10-12 per group) against a small group (2-3 participants) of individual

physiotherapy exercises, states that no clinically relevant improvements of pain and physical disability were found (85).

Obviously these research results bring to the attention the fact that further steps should be done in this aspect, aiming to better understand and capture the effects of muscle strengthening in LBP.

## 1.6. MÉZIÈRES METHOD (MM)

The Mézières Method (MM) was implemented in 1947 by Françoise Mézières, a French physiotherapist who carried out his research on posture and muscle chains. The results of the research were published in 1984, in which the principles of his new method are defined through observation and experience as a professor of anatomy and physiology at the French School of Orthopedics and Massage. Mézières died in 1991 at the age of 82, she founded the association that bears her name "International Mezquist Association of Kinesitherapy (A.M.I.K)" (86).

Inspired by his first studies and original observations in 1947, invalidating numerous classical principles, the Mézières gymnastic method can be considered as an analysis of the disorders of the statics and their pathological consequences, leading to a treatment of global posture type. According to the therapist, "damage is never where it manifests itself" (87).

The therapeutic principle of this technique is based on working in a correct position through the lengthening of the muscle chains, progressively balancing the muscular work without making any compensation (88).

According to Mézières, "any shortening of the posterior musculature causes a retraction of the entire chain". Meanwhile any attempt to reduce cervical lordosis will cause an increase in lumbar lordosis, as noted in the observation of the principle. Thus, the solution will never be to reduce its lordosis, which is primary according to it (89).

Through this technique, the shortened muscles are never tense because of tonic imbalances, but the patient is induced to perform voluntary muscular contractions located in distant points of the imbalance found, so that when these contractions are made, the relaxation effect of the contraction causes the initial

tonic imbalance and consequently a morphological correction is obtained. In other words, the technique does not try to teach the erected station to the individual, but to help him achieve his correct postural balance (89).

MM looks at the patient globally and analyzes the physiological rhythms of each patient, adapting treatment techniques to individual reality. In addition, it works in conjunction with breathing exercises, manual techniques and active stretching exercises that rebalance the muscle chains and allow maximum functioning (90).

Each treatment is individual, but the difficulty lies in the fact that the development of a session will be a set of answers derived from the examination of the subject and his/her behavior during all the postural phases. There are no lines of treatment, they are a series of personalized postures that tension the muscle groups responsible for lordosis, internal rotations and the chest block in inspiration (91).

The physiotherapist who uses the postural treatment Mézières assists the patient continously in such a way as to better perceive his/her body together with breathing. Therapeutic progression will be the main key in order to achieve treatment success.

Being in the theme of breathing (fundamental for treatment) this method could favor the relaxation of accessory-inspired muscles (which are hypertonic) in the Bronco Obstructing Chronic Pneumonia (BOCP) to reduce the dependence of breathing with the upper portion of the thorax and reduce muscle tension associated with dyspnoea, improving the patient's breathing pattern and ventilation, emphasizing diaphragmatic breathing and relaxed breathing, i.e: reduction of respiratory work, respiratory rate and use of accessory muscles, projecting controlled breathing into functional activities ( 92).

According to Mézières, the diaphragm is the main motor muscle of respiration and also one of the most important for static electricity. Associated with the psoas and the iliac, it helps to form the anterior-internal chain which can determine the maintenance of lumbar lordosis in conjunction with the muscles of the posterior chain. Mézières claimed that the diaphragm muscle was frequently blocked in inspiration, increasing the lumbar lordosis and positioning the thorax in a high position (86, 91).

The ideal work to restore its elasticity and to drop "the lordosis" will be an expiratory work, and only by moving away the frenetic center (non-contractile part of the diaphragm constituted by the juxtaposition of the central tendons of the digastricos muscles) of the peripheral insertions, it will be possible to recover optimal extensibility of the contractile part and secondly loosening of the loins (94).

Mézières also explains the fact that the tendency in physiotherapy is to strengthen the muscles, but the deformations do not necessarily derive from the weaknesses. The problem may be the hypertonia of inspiratory muscles that are static (eg in BOCP, hypertony of accessory muscles due to overuse). The problem of deformations would be a problem of elasticity of the muscles. For this reason, it proposes a work of eccentric contraction (the muscle is composed of contractile and elastic elements, if they contract the muscle that stretches it, they lengthens and retains its strength), to return to elasticity (95).

A dynamic muscle tone can serve as an indication, but doing it with a static muscle only aggravates the pathology, because it will increase its shortness and rigidity, it will end up causing greater deformity. Philippe Souchard, a student and assistant to Françoise Mézières, considers the toning of static muscles to be a typical mistake; for him it is necessary to restore the lost elasticity. Static patients have become rigid and hinder joint mobility. If they are passively stretched, they will not increase their muscle mass. But is admitted that if we rub to them, the degree of rigidity will increase (94).

In this way, and based on the acquired muscular flexibility, pain aches and / or slow modification of the static is achieved towards the desired harmonization. After the healthy recovery, there is a marked increase in body awareness, a new attraction for aphrodisiac of forgotten life (better quality of life), general relief and a slow rebalancing of neurovegetative functions (96).

### 1.6.1 Mézières Method psychology

According to Mézières, mind and body are in an intimate relationship. Therefore re-education must take into account the personal history of the patient in his/her physical and psychic globality, that is, treat the human being from a functional, physical and psychological point of view. Considering that the body or its deformities create anxiety (88, 95). The body is not something material but an entity that must be understood and conceived as a whole somatic and psychic, with its fragility, its strengths, its individual peculiarities and its history (97).

The feeling of lack of air creates a certain anxiety and decrease of activities, the physical deterioration results in a low self-esteem that can further cause a depression. The prevalence of depression in patients with Chronic Obstructive Pneumonia (COPD) is estimated between 6%-50% and is a predictor of mortality. The Van Manen study concluded that the risk of depression in the patient with COPD is 2.5 times higher than in the general population (98). Furthermore, they have restlessness, lack of spontaneity and security (99). It is because, as we saw earlier, psychological support plays an important role in the RR of patients with COPD (100).

The treatment of patients with BPC, anxiety and depression is totally pharmaceutical. And unfortunately, very few studies have investigated the efficacy of anxiolytics in COPD (101).

In this logic, the Mézières method (MM) could be a therapeutic alternative to acting on a psychological level, reducing the vicious circle of deconditioning produced by anxiety and depression. As the treatment includes body awareness techniques and exercises, stimulating the proprioceptive mechanisms located in muscles and joints.

By this way, through MM the person will know better the different parts of his/her body and will feel a new body schema, thanks to the interconnections that occur between these proprioceptive receptors and the brain, especially there will be an improvement in harmony between body and mind (102).

### 1.6.2 Scientific bases and technical aspects of the MM

#### 1.6.2.1 The fundamental laws of the MM

With the "laws" of his technique, Mézières tried to summarize the conclusions extracted from own observation on the main treatments and the results that follow constitute a sort of catalogue of the method.

• First law: the back muscles behave like one muscle.

From this myofascial unit was born the concept of "muscular chain", annalized continuously.

Second law: the back muscles are too strong and too much courts.

Both characteristics make them acquire a natural tendency towards hypertonia and retraction. The shortening would be responsible for our deformations and not for muscle weakness, as postulated by the classical theories of physiotherapy.

• Third law: any localized action, both prolongation and shortening, instantly provokes the shortening of the whole system.

This particularity would force to work globally as a whole and not to limit the therapeutic approach to a single muscular region.

• Fourth law: any opposition to this shortening immediately causes lateroflexions and rotations of the vertebral column and limbs.

In this law, Mézières has done nothing but emphasizes the biomechanical behavior of muscles able to develop actions in different planes thanks to its helical position in the body. Therefore, when we stretch a muscle in one of its functional planes, it will tend to express its shortening in others.

• Fifth law: the rotation of the limbs due to the shortening of the chains always takes place inside.

This law was one of its main empirical findings. The rotational phenomenon is due to the relief that the back muscles of the vertebral column do with the internal rotatory muscles of the limbs, such as the great dorsal or the hamstrings.

### 1.6.3 The Mézières Concept of the muscle chains

Françoise Mézières defines muscle chains (87) as sets of interlocking polyarticular muscles (that is, superimposed like tiles on a roof). This interweaving is of great importance as it gives to the chains their power, their vocation to shortening and, above all, the mobility of compensations.

#### 1.6.3.1 Rear chain

The first muscle chain defined was the posterior chain, responsible for changing the evolution of the patient in an upright position. This classic concept of muscle chains was further developed and adopted by three disciples: Philippe Souchard, Leopold Busquet and Godelieve Denys-Struyf; although they later developed their own methods, by incorporating these concepts as already described by Kabat (103). The posterior chain extends from the back of the skull to the ends of the toes in the back, passing in front of the leg after passing through the back and ending in the tuberosity of the tibia (Fig. 1).

#### 1.6.3.2 The front-internal chain

This chain meets inside of the belly and is constituted from diaphragm and iliopsoas (Fig.2)

#### 1.6.3.3 Brachial chain

It is located in the front side of the shoulder till to the fingertips. They integrate the coracobranaciale; brachial biceps; epitrochlear: round pronator, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, flexor digitorum superficialis; flexor of deep fingers; flexor longus of the thumb; square pronoun; lumbricales; interosseous handheld; tenaris muscles and muscles of hypotension (Fig.3)

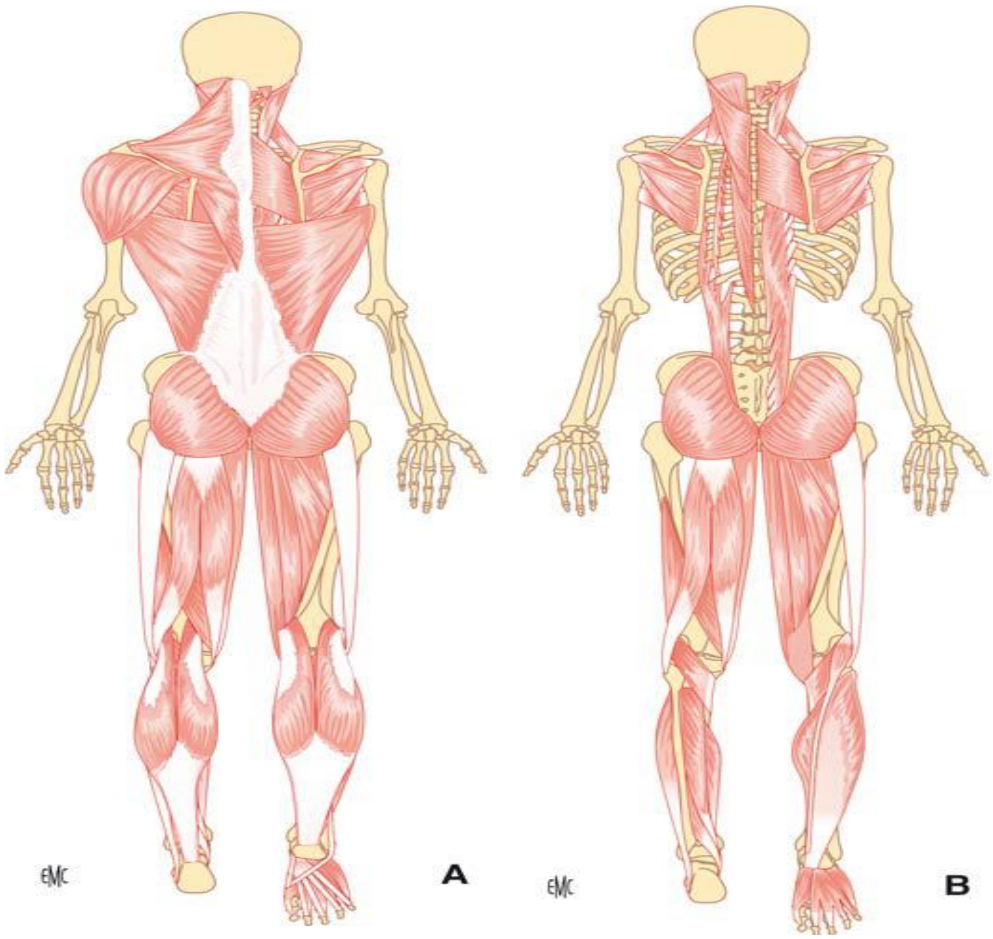



**Figure 1. Rear chains of MM (NISAND, 2010)**

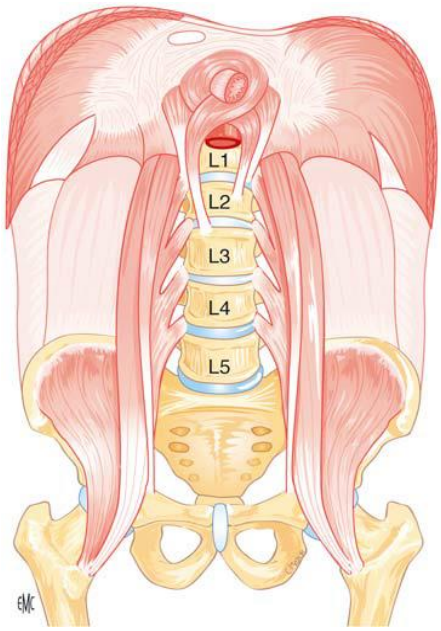



**Figure 2. Antero-interior chain of MM (NISAND, 2010)**

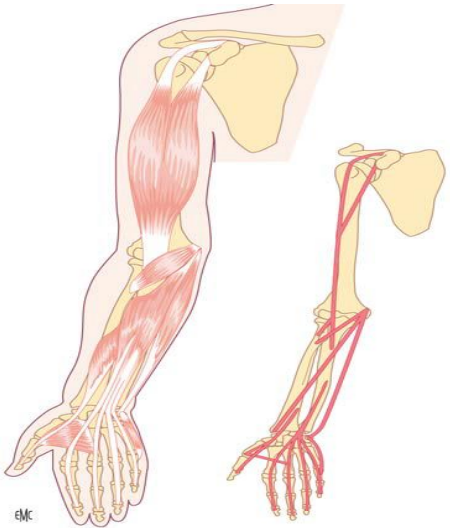


**Figure 3. Brachial chain of MM (NISAND, 2010)**

#### 1.6.3.4 Anterior neck chain

This chain is constructed from 4 muscles in the anterior part of the cervical vertebrae as: the anterior rectum, the major and minor of the head; the very long of the head and neck (Fig.4). This chain was described in 1981 by Michaël Nisand and incorporated in 1984 by Françoise Mézières in her work entitled "Originalité de la méthode Mézières" (89).

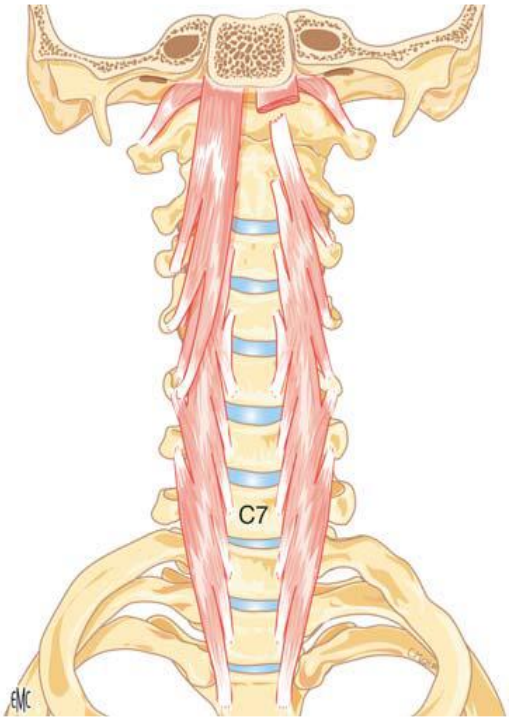



**Figure 4. Front chain of neck (NISAND, 2010)**

According to Mézières, these chains, with their tendency to retraction, curve our body in the same way that an arch bends when the string is tightened. Moreover, by virtue of the different working directions of the muscles of the chains, deformations could appear in the three floors of the space which, if aggravated, would cause pain and dysfunction (89).

## 1.7 PRINCIPLES OF MM

This technique is based on seven fundamental principles (90).

First principle: "**Everything derives from the stiffness of the posterior muscles**"

This principle explains that in the standing position, a noticeable muscular activation by the spinal muscles is not necessary, on the contrary, its flexibility is of great importance. From the other hand, several alterations of the spine can be resolved with muscle flexibilization, considering that the weakness of the extensor muscles should not be combated, but rather their rigidity (104).

Interpreting the first principle, in a normal position the balance is stable and does not require any muscular contraction. And the strength of the spinal cord must not intervene in the normal position, on the contrary, its flexibility is indispensable because its static contraction is eccentric. In this way the physiological lordosis is accentuated with the upright position and with the movements of the limbs. The upright position increases the vertebral curves and shortens the spinal points that support the arches. The different deviations in the anteroposterior direction are resolved with the flexibilization of these muscles (105).

Second principle "**There is only lordosis, lordosis is responsible for kyphosis, it is a lordotic compensation**"

Lordosis is the origin of all deformations and only treatment of lordosis should be considered, regardless of severity. Despite its curves, the rachis has two posterior concavities: dorso-lumbar and cervico-dorsal.

There are two physiological lordosis oriented differently. The apparently domed region is the point of union of the two concavities. It is located in the area of the shoulder blades (89).

According to Mézières, lordosis is the origin of kyphosis and lordosis must be reduced to correct kyphosis. The theory is identical for scoliosis: the spinal, which produce lordosis, are also rotators and lateral flexors. The shortening of the posterior muscles causes flexions and rotations in cases or postures (or movements) that are not strictly symmetrical. Spinal cord can therefore cause scoliosis. By lengthening them, the lordosis can be reduced and the rotations and lateral folds can be corrected. So the conclusion is: "there is only lordosis", and the need to correct lordosis is to erase scoliosis.

Third principle: "**Solidarity of the trunk and the limbs. The influence of the internal rotation of the limbs**"

The limbs are integral with the trunk and the popliteal cavity constitutes a third posterior concavity. The lengthening of the popliteal fossa causes more lumbar or cervical lordosis, and inversely the rectification of spinal lordosis implies the flexion of the knees. The lordosis is always accompanied by the internal rotation of the limbs. This compensation produces:

In the upper limbs, the curl of the shoulders forward and the pronation of the hands. The lengthening of the internal rotators is immediately compensated by a high lordosis and the raising of the shoulder, which, going backwards, still increases the lordosis . Hence the need to simultaneously correct all lordosis and internal rotation.

In the lower limbs, in any case, the femur is always in internal rotation. Lordosis and internal rotation are the only responsible for the curved knee. When an external rotation of the thighs is performed, completely correcting the lordosis, the recurvatum disappears and the knee can barely lengthen normally as in Figure 5 (89).

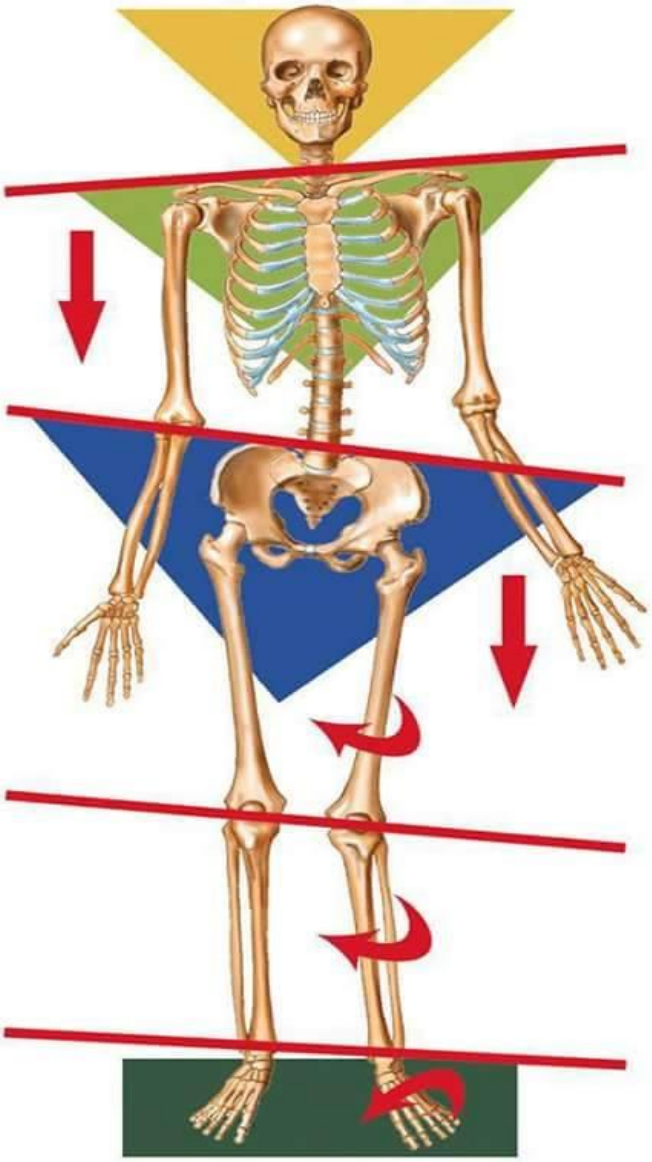


**Figure 5. Third principle of MM: Influence of internal rotation of the limbs**

Fourth principle: "**Influence of the diaphragmatic block**"

The lordosis is closely related to the diaphragmatic block and respiratory problems, because the diaphragm has the tendency to lordodizare and extend the first three lumbar vertebrae, since the epispinoid tends to encode the first three lumbar vertebrae and insert them in the anterior flexion, and then keep static (Busquet, 2008, p.28).

Fifth principle: "**Without quadriceps there is no good support**"

The importance of the muscle tone of the quadriceps in the body statics is fundamental. It has been observed that its contraction is very intense when the lordosis and internal rotation of the femur are maintained, which puts the whole body taut (104).

Sixth principle: "**The abdominals**"

The classic abdominal exercises have no effect on the chest, since the technique forgets to perform them with a total lengthening of the vertebral column, which requires that the pre-cervical muscles are simultaneously in contraction. Dictating a rule "when a partial lengthening of the posterior musculature is not possible, the partial contraction of the anterior musculature is inoperative". Consequently, it is essential to act simultaneously from one end of the spine to the other in the anterior and posterior planes to obtain one elongation in one and one shortening in the other (89).

Seventh principle: "**Effects of head positions**"

The occipital elevation in the plane of the bachelor and the sacred. This movement, which recruits the pre-cervical muscles, involves the elevation of the entire anterior thoracic wall and cancels the cervical lordosis. With compensation increases the lumbar lordosis that extends to the dorsal region. This inversion of the dorsal curve must be correct.

The lateral flexion of the head produces an expansion of the lateral contour of the head and involves an elevation of the pelvis on the same side and an apparent shortening of the ipsilateral lower limb occurs.

The rotation of the head produces an elevation of the anterior half of the opposite side, as well as the anterior projection of the opposite shoulder, which must be avoided (104).

The rotation of the head produces an elevation of the anterior half of the opposite side, as well as the anterior projection of the opposite shoulder, which must be avoided (104).

This principle asserts that it is only possible to increase the anterior and lateral thoracic volumes through the cervical muscles and the static scoliosis can be explained with the shortened leg. The lordotic compensation established by these exercises and their disastrous effect can only be prevented by the abdominal musculature (89).

# II – JUSTIFICATION

# II - JUSTIFICATION

The scope of this thesis is to analyse the Mézières treatment method (MM) effects on Low Back Pain (LBP) in athletes of Catholic University of Murcia (UCAM) in Murcia, Spain.

Intuitively, the planning and development of this study did not happen by accident. Thus, the treatment of athletes is based on the certification and professionalism of the MM explored by the author in this thesis while exploring for further improvements. Given that UCAM holds a broad range of sportsmen and sport teams, it was thought that it was the best way to promote Mézières's technique, almost when scientific research on this treatment is lacking and in recent years there has been a rise in global treatments such as: Postural Reeducation (GPR) technique, which is a deviation or an end to the technique of Mézières without preserving its originality. Comparatively considering that today's courses of perfection of this technique have been certified all over the world by the disciples of Mézières, as the author of this work did, it was payed a particular reference to LBP, and it was thought to implement this treatment in UCAM athletes such as UCAM Murcia CF, UCAM Murcia CB / EBA and NATIONAL RHYTHMIC GYMNASTICS TEAM OF MURCIA.

Indeed, the treatment of sportsmen with LBP is very important issue together with finding of more pleasant and effective alternatives to control pain and alleviate its symptoms without medication would be interesting.

Moreover, in this context it must be admitted that due to the action of several factors, alterations in the body's physiological functions (such as alteration of breathing) can occur, which produce postural alterations, i.e deviations from the correct posture. And precisely, these are compensations adopted by the body (88).

In this regard, the purpose of this study would be to provide a complementary alternative to sports treatments that should always be used. By

considering that this technique allows to act directly on a factor involved in the worsening of the patient's condition: the postural alteration, which the patient can carry within a vicious circle. Furthermore, it allows us to see the human body in a different way, "the body as a whole" (102), thus, the acceptance of the basic concepts of the technique allows the physiotherapist to make a real introspection and a questioning of knowledge.

Scientifically speaking, the starting point of the research is to consider that sports modalities, such as rhythmic gymnastics, football and basketball, have a common form of elements that imply a high number of impacts on the ground, which can affect the musculoskeletal structures of the body, vertebral axis, in addition to incorporating the hyperextension movements of the spine.

For this reason, is intended to quantify with this research the influence on the capacity of force, evaluating its effects through isometric tests, isokinetic tests and pain. Likewise, the literature highlights the three most common disorders in back pain of basketball players, knee pain and shoulder pain (106).

In this merit, observing the technique of sports, on the one hand rhythmic gymnastics, is based in its overwhelming majority in the hyperextensions of the lumbar spine, becoming the pain of the lower back in one of the most common injuries in these athletes (107).

Inspired by these data, the need arises to apply a rehabilitative treatment protocol to strengthen the stabilizing musculature and to discuss, as has been done in other sports modalities (108), while evaluating if the MM is useful for reducing lumbar pain in rhythmic gymnastics, basketball and soccer.

By combining the epidemiological data on the LBP in athletes, the frequency is 1 to 30% (109, 110), and the data that varies depending on the sport, being more common in gymnastics, among others. In the lower back pain also other factors impact such as sex, intensity and frequency of training, as well as sports technique. Other authors show that back pain is a common symptom in adolescent athletes (111).

However, the most epidemiological studies are contradictory. Thus, Videman (1995) observed that among the athletes the appearance of low back pain showed a lower frequency (29.3%) to groups of non-athletes (44%). The study of Kujala (1999) instead found that the frequency of back pain among

athletes was 46%, while ccccamong non-athletes the frequency was only 18% (112,113).

Meanwhile the rhythmic gymnastics is characterized by the use of the gymnast's body in articulated ranges outside the physiological limits, adopting hygienically inadequate postures that can cause a large external load during the exercises of great torsion, performed even at high speed.

But the movements most commonly encountered in a rhythmic gymnastics exercise are hyperextensions of the lumbar spine, causing collisions between the facet joints of the spinous and transverse processes, as well as the bone contacts of the spinous processes of the vertebrae, which in some cases may facilitate the appearance of arthritis, faceted syndromes and arthritis in the joints of the posterior aspect of the spine (114).

It is therefore considered that this fact may be the main reason why low back pain has become one of the most common injuries in rhythmic gymnastics, generating a loss of training days (115). Therefore, it is considered the need to find a specific workout that reduces or prevents pain in the lower back of the gymnasts.

By this way, referring to the bibliography mentioned above, which guarantees the benefits of manual therapy on low back pain, analyzing the impact that the practice of rhythmic gymnastics has on the osteoarticular level and the similarities with other sports, it is proposed to apply a postural treatment protocol as MM, progressive and adapted, for strengthening the abdominal and stabilizing band, which improves the values of strength, endurance and muscular activity and, at the same time, reduces or avoids muscle pain of athletes in the lower back.

# III – OBJECTIVES AND HYPOTHESIS

# III – OBJETIVES AND HYPOTHESIS

## 3.1 OBJECTIVES

**General objectives**

This research study attempts the re-harmonization of the kinetic chains and posture, based on spinal muscular atrophy through global stretching which tries to test the effectiveness of Mézières treatment method (MM) on sports subjects. Its main objectives consist in:

- Performing a descriptive analysis of the study sample as a function of interventions, gender and age;

- Observing the incidence and severity of LBP on the sportsmen studied;

- Analyzing the effect of MM rehabilitative treatment for 24 weeks on LBP in rhythmic gymnastics, basketball and football athletes;

- Comparing the flexibility of the vertebral column obtained in the initial test among the basketball, rhythmic gymnastics and football athletes that have applied the MM with the others who have benefited from the conventional treatment of sports rehabilitation;

- - Evaluating the benefits of MM added to the conventional sports treatment program with LBP.

**Specific objectives**

1. Analyzing the effectiveness of MM between groups in the LPB intensity of athletes through the Visual Analogue Scale (VAS).

2. Measuring the flexibility of the back musculature of athletes with LBP through sit and reach flexibility test before and after the implementation of MM.

3. Calculating the performance of the athletes with LBP throw the Runtastic pedometer performance application at the baseline and after 24 weeks of treatment.

4. Surveying the physical disability of the athletes with LBP by using the validated Roland-Morris questionnaire (CMR) in the 24 week of the treatment.

5. Evaluating the general health conditions of study sample before and after the implementation of MM in the experimental group by using the validated Health status questionnaire (SF-12).

## 3.2 HYPOTHESIS

The study hypotheses raised in this survey are:

- The application of MM can have a positive effect on the outcomes as VAS, Sit and Reach flexibility test, Runtastic pedometer performance, CRM and SF 12 in athletes with nonspecific back pain.
- MM can improve the physical and the mental health of athletes through the evaluation of MCS and PCS subscales in accordance with the Health status questionnaire.
- MM in athletes can improve the flexibility of back and reduces the LBP.
- MM can increase the performance of the athletes with LBP evaluating with the Runtastic pedometer performance application.

# IV - METHODOLOGY

# IV – METHODOLOGY

## 4.1. PARTICIPANTS

In total 139 athletes with LBP participated in the study undertaken during December 2016 - May 2018 period, where 70 belong to the control group. Concretely, the sample used was formed by gymnasts of the National rhythmic gymnastics in Murcia; Players in the UCAM Murcia CB / EBA basketball team, and from UCAM Murcia Football Club team.

The three groups of professional athletes between 15-39 years with LBP have been characterized by a high level of training. All the participants, including minors, who also presented a paternal authorization document, presented the informed, complete consent, after having read and accepted the conditions of participation and the characteristics that were collected in a previous informative letter.

The evaluation field of the athletes has been their preparation center such as:

- For the National Rhythmic Gymnastics - the sports hall of "Puente Tocinos", Murcia, Spain;
- For the football club Club de Futbol UCAM Murcia CF - the "Mayayo" sports ground and the "Condomina" stadium, Murcia, Spain;
- For the basketball group UCAM Murcia CB / EBA - "Atalayas" sports hall, Murcia Spain.

The permission to make possible this investigation in these settings was given by the medical and physical team and the coaches.

Whereas in order to ensure the homogeneity of the sample, several inclusion criteria were established for each of the two modalities.

In parallel, to ensure that the sample was as homogeneous as possible, in terms of sports practice, it was determined that all athletes had the same level of training. In this sense, the number of training hours per week was not considered

an indicator of the same, because for each sport studied, this is a very different variable, correspondingly the inclusion/ exclusion criteria were as follows:

**Inclusion criteria:** older than 15 years, both male and female who practice sports at a competitive level and with a healthy and sporty lifestyle with symptoms and clinical diagnosis of chronic non-specific low back pain and other vertebral pains lasting more than 1 month, diagnosed by the attending physician or specialist, presence of kyphosis or scoliosis, training time at least 9 hours a week, sport practice for a minimum of 2 years;

**Exclusion criteria:** have undergone back surgery in the last 6 months, presence of tumors or spinal metastases, vertebral fractures, severe osteoporosis, infection or inflammation in acute diseases with involvement of the central nervous system, autoimmune disease in early phase, rheumatic diseases in acute stage, herniated discs and lumbar or cervical expelled, pregnant women, people with scoliosis structured with more than 30 ° Cobb, insurgent pain lasting for less than 3 months.

The inclusion and exclusion criteria were maintained the same during the therapeutic intervention of the study.

## 4.2 RANDOMIZATION

The stratified randomization of the research groups was performed, in relation to the dependent and non-dependent variables, the age of the subjects, responding to a pre-post random group, thus ensuring that both groups were equivalent in features, before application of the treatment. Furthermore, to avoid a possible positive transfer of the effects of the test, a knowledge of all the evaluations that would have been made in the initial and final evaluation were examined.

The treatment procedure was explained verbally and then it was referred to the author of this work who applied the MM on the experimental group assigned through the uniform distribution (1.1) of the Excel 2016 plataforma compared to the control one that did not receive this type of treatment, following the rehabilitation diary protocol. The participation and extraction of participants is detailed in Figure 6.

As already mentioned, the previous participants were assigned prospectively to the intervention of MM in order to evaluate its effect in conjunction with the other types of treatments related to the rehabilitation of LBP (Table 2).

**Table 2. Arms and Interventions**

| Arms | Assigned Interventions |
|---|---|
| **Experimental: Mézières method** | Mézières Therapy for LBP |
| **Active Comparator: Control Group** | Other rehabilitation treatment protocol |

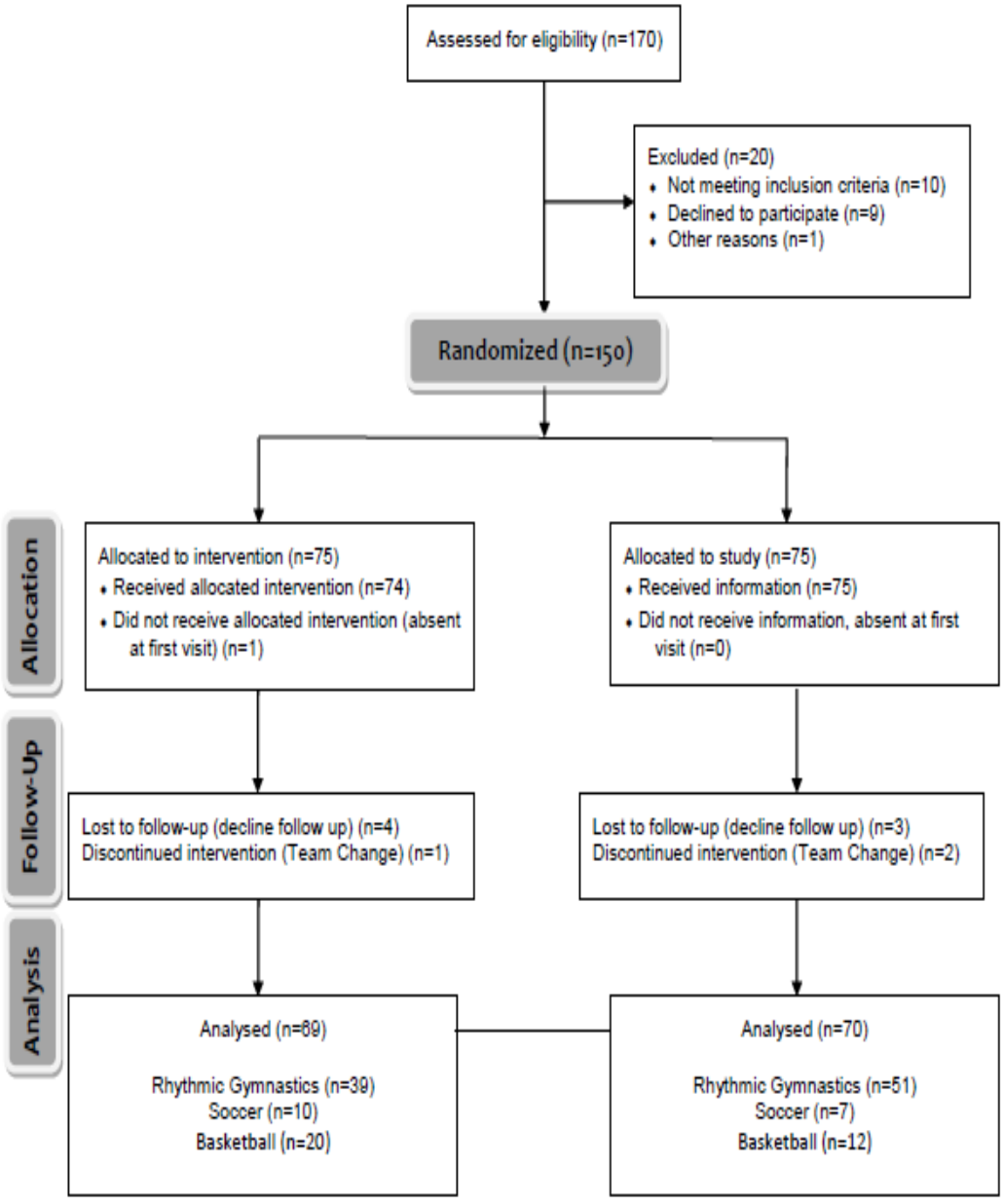



**Figure 6. Flow chart of participants**

## 4.3 STUDY DESIGN

This study was developed referring to a randomized controlled experimental design, with two parallel groups, double blind, registered in the international protocol of U.S. National Library of Medicine / U.S. National Institutes of Health / U.S. Department of Health & Human Services with registry number of Clinicaltrial.gov. ID: NCT03849053 (see Table.3).

In accordance with the Helsinki Declaration, the study was approved by the Ethics Committee of the Catholic University of Murcia "San Antonio" with protocol No. 6572 (Annex 1). In this study the analysis took place in 2 different periods (Baseline / T0 and After 6 months / T1), it insinuates (pretends) to verify the effectiveness of the postural treatment of Mézières Method on different athletes with mild or moderate LBP. The sequence of the study is longitudinal, since the variables are collected at different times.

**Table 3. The study design**

| **Study Type:** | **Interventional** |
|---:|---|
| **Primary Purpose:** | Treatment |
| **Study Phase:** | 2 |
| **Interventional Study Model:** | Parallel Assignment |
| **Number of Arms:** | 2 |
| **Masking:** | Double (Care Provider, Outcomes Assessor) |
| **Allocation:** | Randomized |
| **Enrollment:** | 139 |

## 4.4 INTERVENTION

Theoretically based, the treatment is very simple by consisting in any case, in lengthening the spine to eliminate all the curves. It is simultaneously directed even in the opposite direction to the anterior and posterior planes of the transverse axis of the vertebral column. In the anterior plane, it is advisable to shorten the trunk vertically (convexity of the curves) and to extend it transversely in the scapular region. In the posterior plane instead, it tends to lengthen the trunk vertically (concavity of the curves) and shorten transversely in the scapular region (87). As a result, the muscles that need to be relaxed are the upper dossiers of the trapezoids, the hamstrings, the large pectorals, the internal rotators of the arm and the adductors. Its elongation, passive at the beginning, will be the basis of the acts that constitute the first part of the treatment. The elongation will be active in the second part of the treatment, will involve the training and shortening of the muscles able to stretch the above, that is: the pre-cervical muscles, above and below the hyoid, sternocleidomastoid, abdominals, quadriceps, flexors of the foot, inferior fascicles of the trapezoid muscles, external rotators of the arm, and the gluteus maximus ".

The intention of the treatment was to direct against the stiffness of the muscles (spinal). In accordance with the technique, only lordosis was considered, so that the total lengthening of the vertebral column was the only curative method of LBP; because the attitude of the lower limbs and the pelvis is considered influential in the spine.

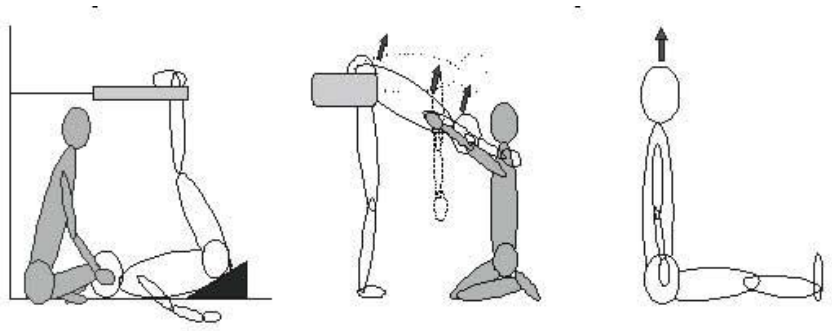
### 4.4.1 Postures of treatment

During the first week, it was necessary to perform a general physical examination, from head to toe, through breathing. The aim was to know the state in which muscle chains are found, also studying the asymmetric imbalances of posture and the curves of the back, looking for a global and individualized analysis of each person, since it is a personalized therapy with a maximum duration of 60 minutes.

In practice, multiple treatment techniques have been used and applied according to the needs of each patient.

Therefore, due to the importance of the diaphragm muscle in the vertebral static, it was important to restore the mobility to the chest of the sportsman, relieving the respiratory block of breathing, releasing with a precise touch, the tensions due to the excessive use of the accessory muscles.

Accordingly, three basic postures are used, those that preferably acted on the posterior chain in a more global way: supine position with the legs at 90 °, in a sitting position and in an upright position with a 90 ° flexion. The key point remains in not allowing losses or compensation (Figure 7).



1-passive posture; 2- active/passive posture; 3-active posture

**Figure 7. Basic postures of MM**

Taking clue of the postures, the basic exercise was the positioning of a posture: dorsal decubitus, flat back to the floor, lower limbs extended vertically to 90º, feet in talus, upper limbs along the body in external rotation. This position is explained by the above mentioned reasons: all the posterior longitudinal musculature (from the fingers to the occiput) represent a unique and inseparable chain that must be lengthened (Figure 8).

**Figure 8. First posture of treatment (NISAND, 2010)**

In the postural treatment model, three important parameters were taken into consideration: 1) the time of tension, 2) the angle used and 3) the phases of the progression:

- The duration of the overall tension during the first treatment was about ten minutes, then gradually and progressively increased during the other sessions, until one hour was reached. It started with only one treatment per week, except in the evolutionary scoliosis in which several sessions are performed. Tension time has been adapted to the possibilities of each patient, to their discomfort, to the physical and mental conditions and to the elasticity of the tissue.

It must be remembered that postural treatment has repercussions throughout the musculoskeletal system and in the vegetative system, so working more than once a week can cause muscle pain and excessive neurovegetative reactions. The body needs time to rebalance itself in the new positions acquired (96).

- The tensioning has been carried out, as it was said, by means of three postures of global correction: a first square in a supine position with the legs raised at 90 °; a second team in a sitting position with the trunk at 90 ° with respect to the legs; and a third square in which the feet rest on the ground and the trunk flexes 90 ° (Figure 9).
-
- To maintain these positions, a lot of effort is required and often during the session there is an uneasiness, so it must be very careful that the dynamic muscles do not work excessively in their enthusiasm to avoid compensations and overcome the shortening of the retracted muscles.

The method is characterized by the implementation of a slow and fluid progression, which is accompanied by a considerable manual therapy that allows the awareness of tensions and blockages, thus, limiting the possibility that the treatment is experienced as "too hard".

To properly maintain muscle tension and make it pleasant and efficient, cushions have been used and removed gradually, as well as rigid or elastic straps,

depending on the possibilities and conditions of the patient, to support the lower limbs or the trunk.

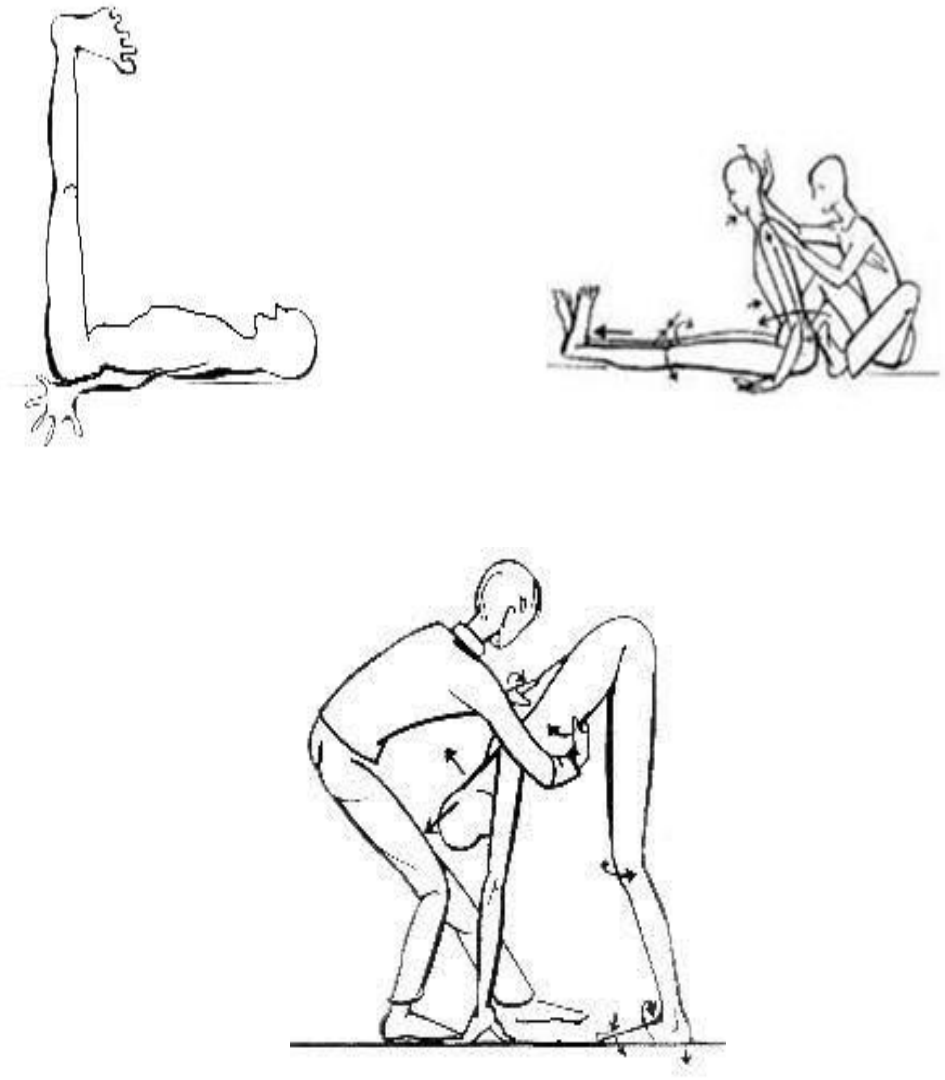


**Figure 9. Postural treatment**
**(NISAND, 2010)**

### 4.4.2 Important outline of the treatment

• When the cause of the pain was in the symptomatic region, the treatment started at the same point. The patient presented an "inconsistent postural chain", i.e an analgesic attitude that unbalanced normal posture, taking the body's center of gravity out of the supporting polygon.

• The goal of therapy in that phase was to bring the individual back to his normal postural alignment by eliminating the pain, which was the cause of the imbalance. If the cause of the pain was far from the symptomatic area, where it was worked remotely, in the region where the primary stiffness was located. In these cases, it was normal to find a "coherent postural chain", i.e well adapted by primary equilibrium mechanisms and respecting the basic alignment. Pain manifested itself in the segments that did not have the possibility to continue to compensate.

• In postural treatment, all the body segments had to be positioned correctly. The mobilization has served only to overcome tensions and muscle stiffness; therefore the posture has kept the time necessary to reach the fluidity. The patient had to endure muscular tensions that are often painful and had to participate at all times.

• All the corrections at a time had to be emphasized: references and positioning of the toes, heels, ankles, knees, back and occipital always avoiding to stop breathing: to harmonize the posture.

• Thus, intervening throughout the patient's body simultaneously and stimulating their active participation in treatment, it will be possible to alleviate pain and improve posture.

4.5 STUDY VARIABLES

This study is developed through an experimental work based on the relationship between:

Independent variables – meaning the variables that did not have a relationship between them. Particularly the table 4 presents the independent variables of this study.

**Table 4. Independent variables of the study**

| Independent Variable | Type | Value |
|---|---|---|
| Categorized Age | Scale | 15-39 |
| Phase | Ordinal | Baseline -6 months |
| Intervention Type | Nominal | Postural treatment-other |
| Gender | Ordinal | Man-Woman |
| High | Scale | cm |
| Sport type | Nominal | Football, Basketball, Rhythmic Gymnastics |
| Treatment frequency | Ordinal | 1-3 times week |
| Treatment time | Ordinal | 30-60 min |

Dependent variables – are part of those variables that influence another variable or relate to the other, better called the one that undergoes the effects of the changes on the independent variable presented in the following Table 5.

**Table 5. Dependent variables of the study**

| Dependent variable | Type | Values |
|---|---|---|
| Back Elasticity | Ordinal | 0-160 ° |
| Jumping | Quantitative | cm |
| Flexion- Extension Column Amplitude | Quantitative | cm |
| Average Step/ frequency | Quantitative | st/min |
| Distance | Quantitative | km |
| Average Speed | Quantitative | kph |
| Calories | Quantitative | no |
| Average pace | Quantitative | min/km |

## 4.6 OUTCOME MEASURES

All athletes were evaluated at baseline and after 6 months (24 weeks) of the treatment.

The outcome measures which were implemented concerning the above mentioned assessment are:

### 4.6.1 Primary outcomes

- VAS (Visual Analogue Scale) (116); The pain intensity can still be measured by the use of a descriptive rating scale, numerical or analog visual. It was therefore decided to use the VAS (Visual Analogue Scale) to quantify precisely this pain at the beginning and end of the treatment and then assess whether or not there have been improvements. It consists in identifying the patient, on a 10 cm line, referring to the point that best represents his pain, where 0 means no pain and 10 = worst possible pain. The distance between the mark left by the patient and the 0 (no pain) is measured in centimeters and becomes a recordable value and comparable during the sessions. If the scale has the opportunity to be used properly, it demonstrates effectiveness and accurately reports the measure of the patient's pain according to his experience.

-Sit and Reach flexibility test (117) - This test is designed to test the flexibility of lower back and hamstring muscles and is important as a result of lumbar lordosis, forward pelvic tilt and lower back pain. It was first described by Wells and Dillon (1952) and is now widely used as a general flexibility test (118). There are some variations of the test.

Many of the variations of this test involve differences in the value of the level of the feet. The most logical measure is to use the level of the feet as a registration zero seen in athletes (118), so that any measurement that does not reach the toes is negative and any flow beyond the toes is positive.

The score is recorded to the nearest inch/cm or inch/cm as the distance reached by the hand. According to the typology evaluated with SIT AND REACH test the co-responding answers to the measurements in cm are: Very Poor, Poor, Fair Average, Good, Excellent, Super. For women, the lowest value is < -15 cm and the highest is > +30 cm. For men instead, the lowest value is < -20 cm and the highest is >+27 cm.

-Runtastic Performance Pedometer (119) - Runtastic PRO is an app aimed at recording fitness in many activities and sports. It captures all basic data: distance, average speed, speed between mile markers, altitude, pace, step between mile markers, duration, calories burned and route plotted on a map using Global Positioning System (120). The final result shows how many steps are made in the arc of the minute (st / 60sec).

**4.6.2 Secondary outcomes**

In this subcategory no less important questionnaires are applied in comparison with the first part of research concerning the athlete's quality and disability since the first outcome measures are specific in the athletes.

-Roland-Morris Questionnaire (CRM) (121)- Physical disability of athletes was measured by using the validated Roland-Morris questionnaire explored during 1983, in accordance with its spanish version validated by Kovacks et al., (2002) study with high reliability (ICC 0.87). The questionnaire composed of 24 points of functional capacity of the back is a self-administered questionnaire with a timeframe of 5 minutes. The sense of progression is : the more serious the worse is the performance (122).

-Health status questionnaire (SF-12) (123) - The general health conditions were measured by using the abbreviated questionnaire, SF-12, validated in lumbar pain by Luo et al., (2003) and adapted from an extended version SF-36 (124). Concretely here the physical component (Physical Score-PCS) and the mental component (Mental Score-MCS) were evaluated. The questionnaire consists in 12 items of the 8 dimensions of the SF-36 such as: physical function (2), social function (1), physical role (2), emotional role (2), mental health (2), vitality

(1) , body pain (1), general health (1). Meanwhile response options form Likert-type scales that evaluate intensity or frequency are achieved (125). While the two summary scores are: the summary of physical and mental measurement. MCS subscale is composed by 6 respective items and PCS subscale is formed by the 6 other respective items.

Aiming to facilitate the interpretation, these scores are standardized with the values of population norms, so that 50 (standard deviation of 10) is the average of the general population. Values greater or less than 50 should be interpreted as best or worst cases, respectively, in the reference of population (126).

For each of the 8 dimensions, the elements are coded, aggregated and transformed into a scale that has a distance from 0 (the worst health status for that dimension) to 100 (the best state of health). The measurements were evaluated by using the online application of SF-12 scale.

## 4.7 STATISTICAL PROCEDURE

The statistical analysis was performed by using the Statistical Package for Social Sciences --- SPSS 21 Windows Version. Baseline outcome characteristics and measures were calculated. Meanwhile the continuous variables were expressed as mean the categorical variables were expressed as absolute frequencies and percentages.

The sample calculation instead was studied by using the G * Power 3.1.9.2 program to determine the effect size before the initial collection as well as in the post hoc analysis by determining the power of the study based on the sample size used and the effect size calculated. The factors influencing statistical power are $\alpha$ (statistical significance criterion used in the test) and Cohen's d (magnitude of the effect of interest in population). More power means less chance of committing a

Type 2 error (less chance of not finding a difference or relationship that actually exists) (127).

In order to evaluate the homogeneity of reference of the 2 groups, Student's t tests were performed for the continuous variables and chi-square tests for categorical ones.

From the other hand, Anova Repeated Measures analysis was used to determine the effect of treatment on the results of each measurement. The statistical analysis of Ancova instead was used for mixed models with repeated measures that considered the outcome scores at different times as the dependent variable, and time as an internal factor while group as a factor between subjects.

The base score was included in the calculations in order to check for its potential comparison factor in confront to the treatment effect.

The differences between the groups were the mean differences in scores (with 95% confidence interval) in the two different measurement times between the two groups (baseline / T0 - after 6 months / T1). The size of the effect between the groups was calculated using the Cohen- d factor analysis. In this context, the effect size greater than 0.8 was considered large, about 0.5 was considered moderate and less than 0.2 was considered small.

## 4.8. CONFLICTS OF INTEREST

In full responsibility the researcher declares that he has no conflicts of interest with the study undertaken.

# V - RESULTS

# V – RESULTS

The results of this research are grouped according to the data obtained in the various evaluations. Here are the variables analyzed in the previous sections divided into the demographic and outcome measures that preclude: height, gender, type of sport, back pain in the lumbar area, podometric performance test, health status, flexibility of the back, physical disability etc.

Beyond this, the outcome measures are divided according to the type of assessment (physical or psychological) in primary and secondary. And each group of results is shown in two different ways: on the one hand the comparison of the different moments of pre-test evaluation (T0) and post-test (T1) and on the other one the inferential analysis of the differences between the study groups (T1-T0 in function of EG / CG), in the pre-post test moments, respectively with the intragroup or intergroup differences.

## 5.1 G POWER TEST- A PRIORI POST HOC ANALYSIS

As previously mentioned in the data analysis section as the starting point of the study was the calculation of the sample to evaluate for a significant clinical effect through the design of effect size to expect (127).

The objective was to achieve a statistical power greater than 80, with a significance level of 0.05, and before without the theoretical justification the dimensional effect was estimated as a median value of 0.5 in the quality of a minimal significant approximate difference. Accordingly, it is used a total sample that reached 139 athletes, 70 pertaining to the control group and 69 to the experimental one. Particularly, the figure 10 shows those calculations of the G * Power 3.1.9.2. Program, where a statistical power of 83 is obtained.

.

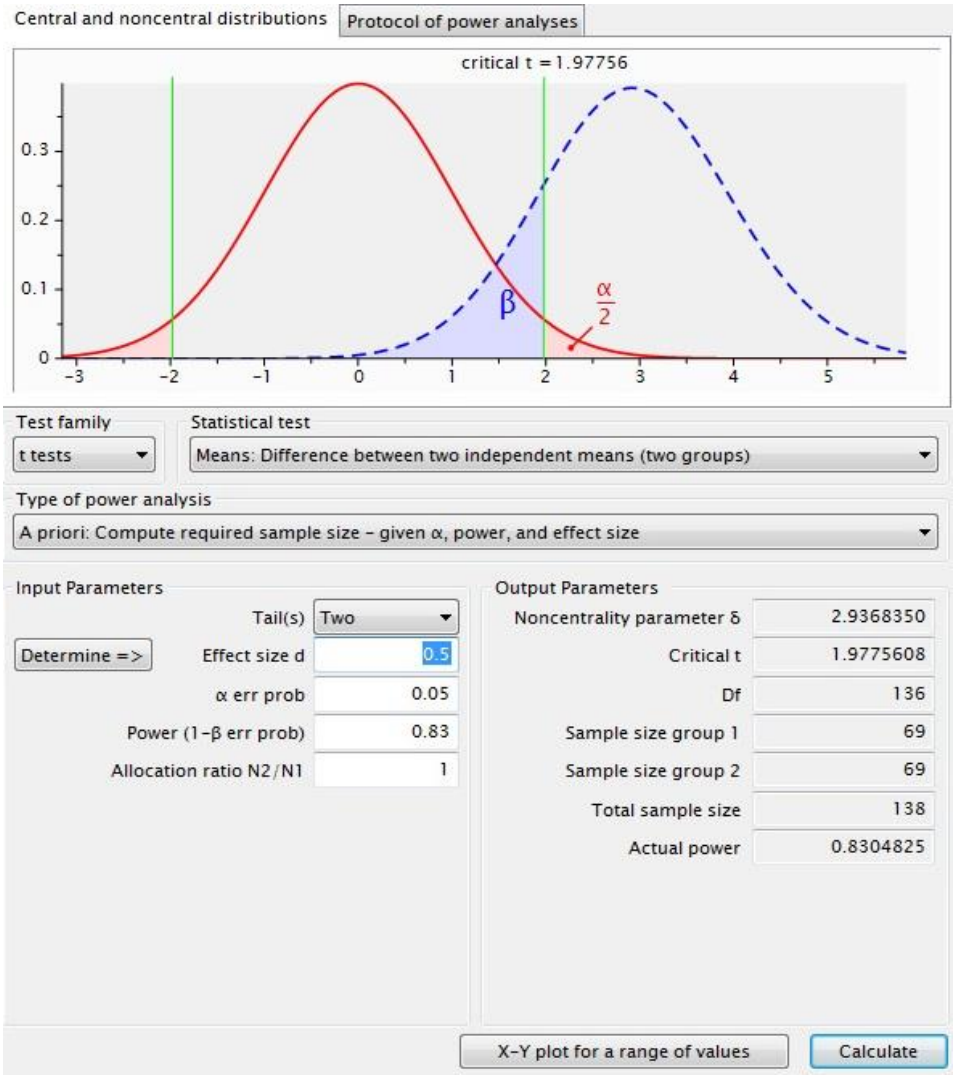



**Figure 10. The power analysis of sample measured with G Power 3.1.9.2 program**

## 5.2 SAMPLE DESCIPTIVE ANALYSIS

Referring to the evaluation period from December 2016 to May 2018, 170 individuals were qualified as eligible for the study from which they were randomized 150, following the selection of inclusion-exclusion criteria from where 1 individual missed the first visit, 7 refused to continue the treatment and 3 athletes changed the team ( refer to Figure 6).

By this way, the outcome measures were evaluated in 139 athletes from whom 64% consisted in women (n woman = 89; n man = 50). Specifically, the sample consists in two experimental groups composed of 69 participants, of whom 27.3% are women (n women = 38; n man = 31) and where the control one has a 13.7% male ratio (n woman = 51; n man = 19, according to Figure 11).

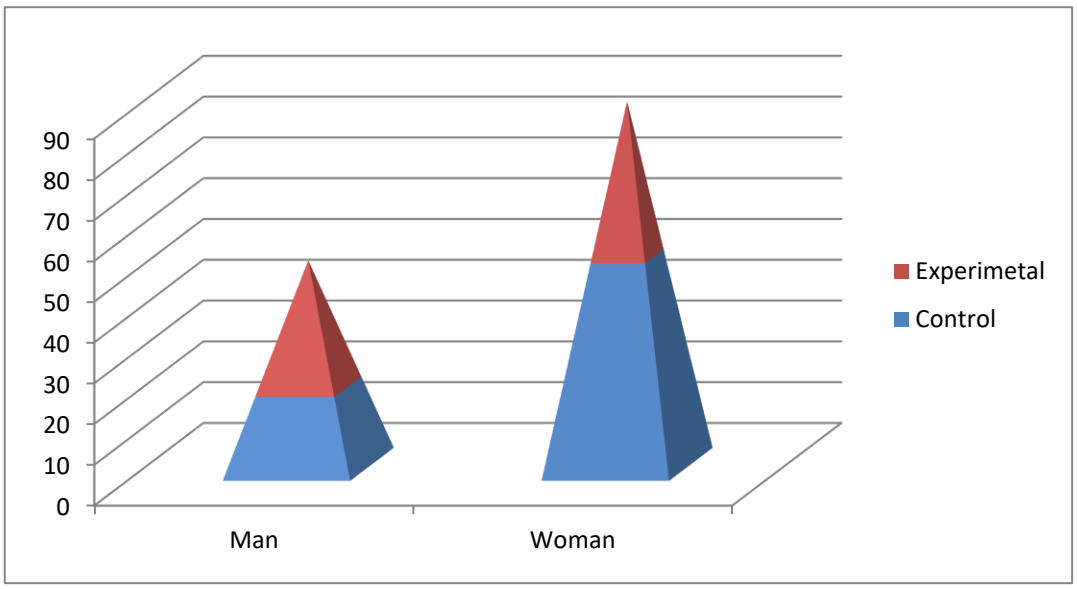



**Figure 11. Sample descriptive data distribution versus gender**

Regarding the age of the study, the sample is characterized by sportsmen aged 15-38 years old (M age = 21.42; SD = 4.56) with a height of 153 cm-210 cm (M height = 171.22; SD = 11.6). Anyway, figure 12 gives a clear picture of age and height distribution in the two study groups from which its homogeneity is verified.

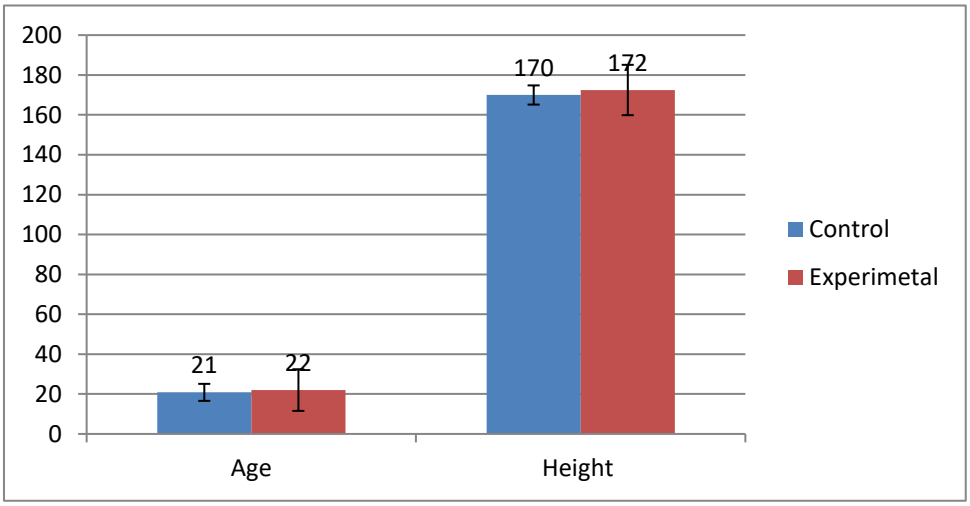



**Figure 12. Demographic sample data (Mean; SD)**

Moreover through the histogram of Skewness it was verified the direction of the average and median of the sample modes related to the length variable from which a positively skewed distribution was observed (see Figure 13).

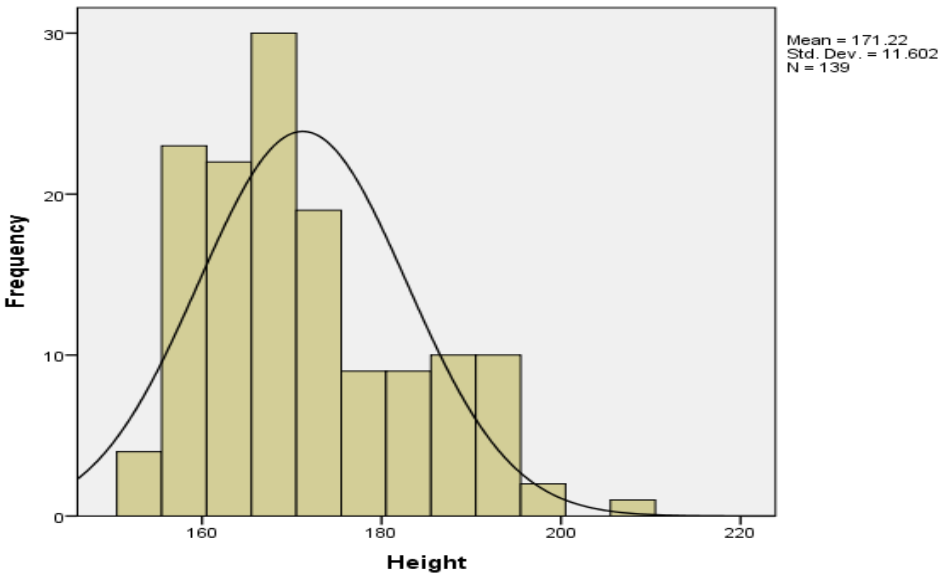



**Figure 13. The height variable positively skewed**

In the evidence of Skewness related to the age of the study, a normalization of the curve was observed otherwise, it is called a perfectly symmetrical distribution (see Figure 14).

Thus, it should be highlighted that the basic characteristics were similar in both study groups. But comparatively it should be added that no adverse effects were observed during the application of GPR treatment and none of the patients modified the therapeutic plan during this study.

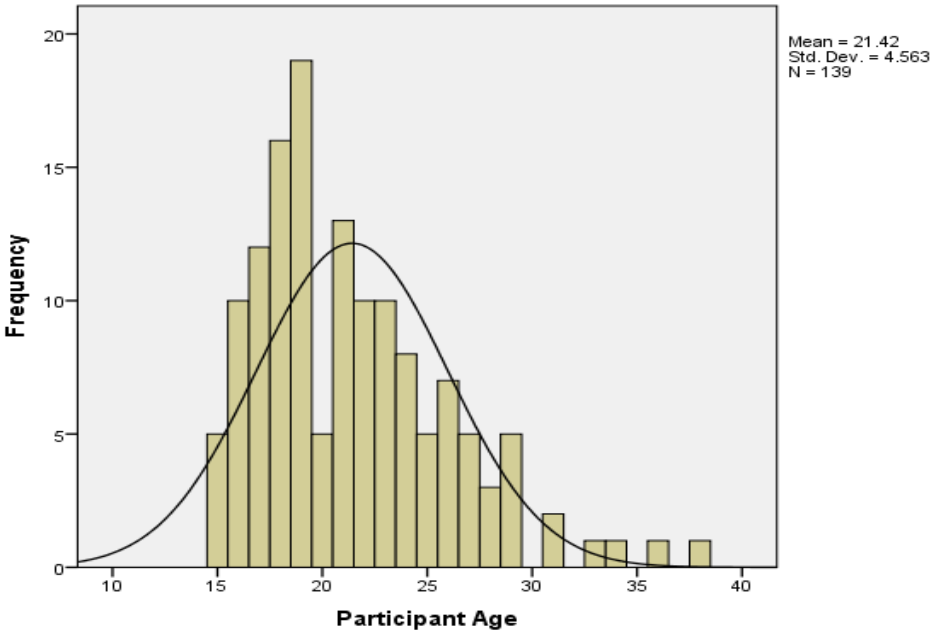



**Figure 14. The participant's age distribution curve**

### 5.2.1. SPLIT SPORTS DESCRIPTIVE ANALYSIS

#### 5.2.1.1. **Rhythmic Gymnastics athletes sample description**

In this study 90 gymnastics rhythmic met the inclusion-exclusion criteria. During the study period, 39 participants were assigned in the experimental group and 51 were assigned in the control group.
Specifically, the sample consists in two groups composed of 90 participants (EG n=39, CG n=51), of whom 98.9% are women (n women = 89; n man = 1).
Regarding the age of the study, the sample is characterized by athletes aged 15-38 years old (M age = 20.89; SD = 4.63) with a height of 153 cm - 173 cm (M height = 164.1; SD = 5.4) Figure 15 shows a clear rhythmic gymnastics athletes sample description.

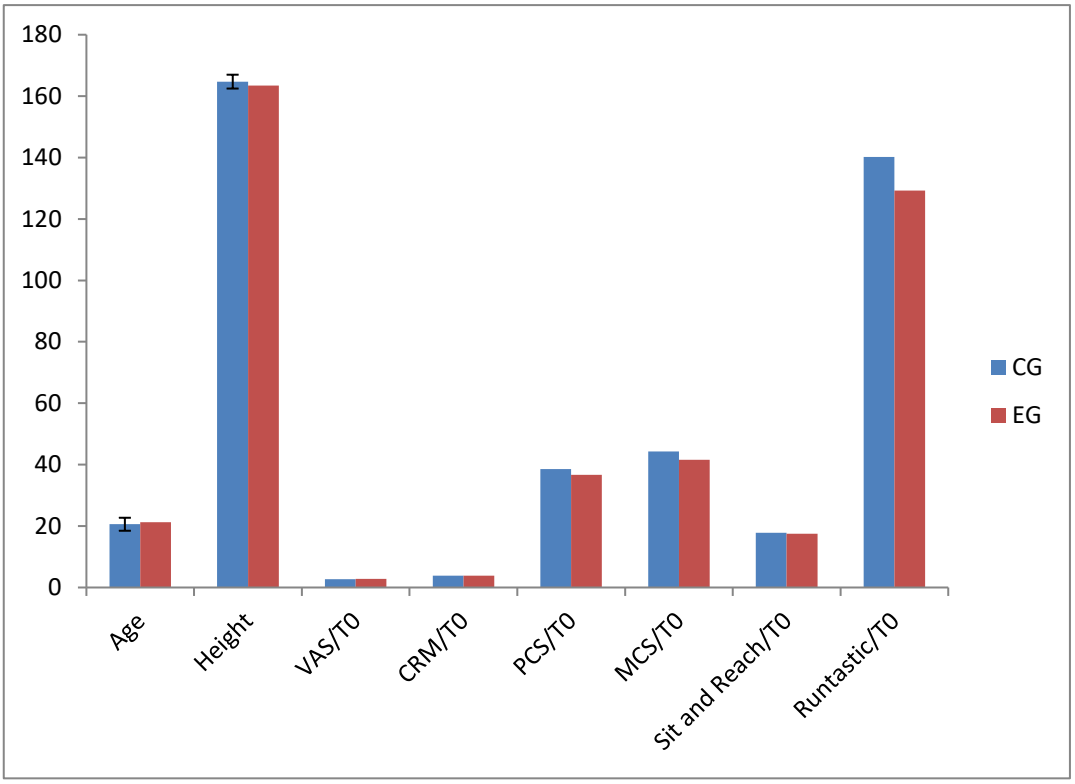



**Figure 15. Descriptive data of gymnastics rhythmic participants at baseline**

### 5.2.1.2. Soccer athletes sample description

Regarding the soccer athletes, in total 17 male participants were analyzed in this study where 10 participants were assigned in EG and 7 pertains at CG. Regarding the age of the soccer it was between 19-33 years old (M age= 25.06; SD=3.61) with a height between 168cm – 183 cm (M height =176.12; SD=4.48). These data and the other assessment of the study are presented in Figure 16.

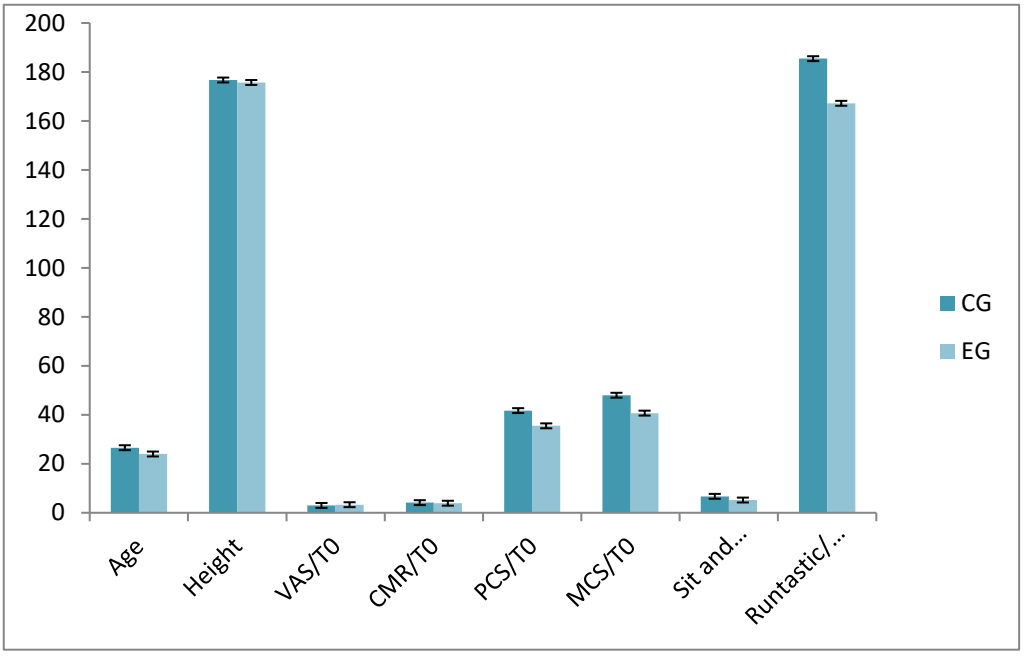



**Figure 16. Descriptive data of soccer participants at baseline**

### 5.2.1.3. Basketball athletes sample description

In total 32 male pertaining to basketball athletes were analyzed in these subgroup where 20 athletes were assigned in EG and 12 were assigned at CG. The age of basket athletes was between 15-31 years old (M age=20.97; SD= 4.01) and with the height of 177 cm -210 cm (M height=188.38, SD=6.67). (Figure 17)

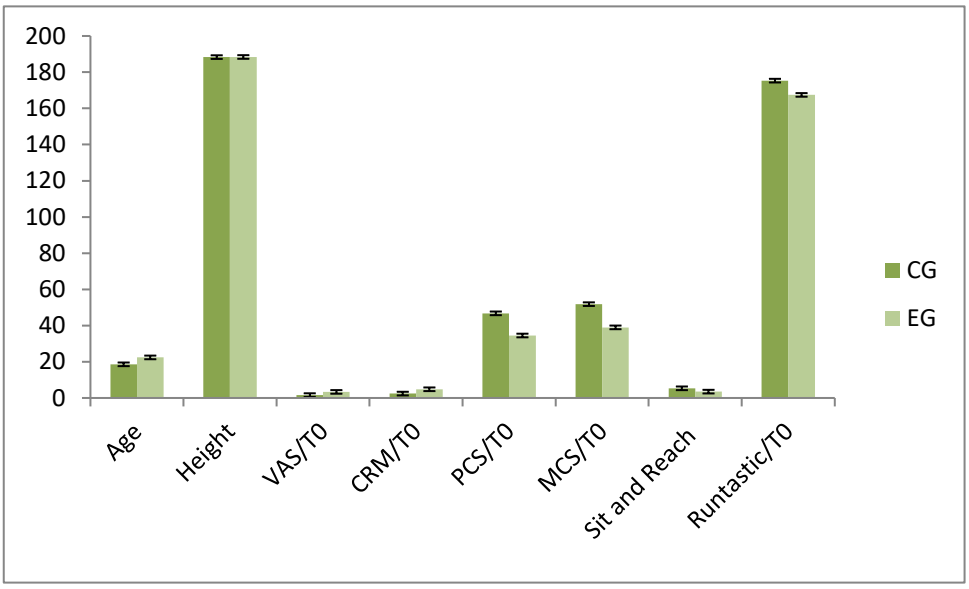



**Figure 17. Descriptive data of basketball participants at baseline**

### 5.2.1.4. Descriptive analysis of Outcome Measures of study sample

At baseline, there wasn't any between-groups difference for the primary study variables such as: VAS ($p = 0.05$), Sit and Reach Test ($p = 0.08$) and Runtastic ($p = 0.08$).

Even in the secondary variables there wasn't any between-groups difference for CMR ($p = 0.05$), with the exception of the health scale (SF12) with the sub-scales of the participants analyzed separately (PCS, MCS) ($p<0.05$) (as per Table 6 data).

**Table 6. Mean and standard deviation of study outcomes**

| Domains | Outcomes | Groups | Means | SD | p |
|---|---|---|---|---|---|
| Visual pain | VAS | EG | 3.04 | 1.18 | 0.05 |
| | | CG | 2.54 | 1.05 | |
| Back Flexibility | Sit and Reach | EG | 11.67 | 6.9 | 0.08 |
| | | CG | 14.6 | 5.7 | |
| Pedometer performance | Runtastic | EG | 145.81 | 21.5 | 0.08 |
| | | CG | 150.74 | 19.7 | |
| Physical disability | CRM | EG | 4.1 | 1.49 | 0.05 |
| | | CG | 3.61 | 1.35 | |
| Physical Score /General Health- SF12 | PCS | EG | 35.87 | 5.02 | 0.00 |
| | | CG | 40.29 | 5.69 | |
| Mental Score /General Health- SF12 | MCS | EG | 40.72 | 4.80 | 0.00 |
| | | CG | 45.94 | 5.85 | |

## 5.3. SPLIT SAMPLE RESEARCH ANALYSIS RESULTS

### 5.3.1. RHYTHMIC GYMNASTICS ATHLETES ANALYSIS RESULTS

By observing the rhythmic gymnastics CG and EG, it is evident that the VAS pain assessment scale in pre-post tests (T0-T1), had a significant value ($p<0.05$, $\eta 2 = 0.625$) in the between groups analysis and the between groups effect size was large during the 24 sessions of treatment.

Effect sizes are reported as partial η2, with cutoff values of 0.01, 0.06, and 0.14, respectively, for small, medium, and large effects.

Also for CRM ($p<0.05$, η2 $p=0.802$), PCS ($p<0.05$, η2 $p=0.613$), MCS ($p<0.05$, η2 $p=0.736$), Sit and Reach flexibility test($p<0.05$, η2 $p=0.666$) and Runtastic performance($p<0.05$, η2 $p=0.790$) between groups effect size was high during the 24 sessions of treatment (as described in Table 7).

**Table 7. Comparison of outcomes between the rhythmic gymnastics groups**

| | Rhythmic Gymnastics Sample | | | | | |
|---|---|---|---|---|---|---|
| | Control Group (n = 39) | | Experimental Group (n = 51) | | | |
| | T0 | T1 | T0 | T1 | P | η2 |
| ***Outcomes*** | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | | |
| ***VAS*** | 2.7(1.04) | 3.5(1.1) | 2.8 (1.07) | 1.1(1.12) | 0.000 | 0.625 |
| ***Sit -Reach*** | 17.8(2.11) | 16.4(2.23) | 17.5(2.25) | 21.7(3.6) | 0.000 | 0.666 |
| ***Runtastic*** | 140.2(10.27) | 131.6(10.71) | 129.2(11.52) | 140.4(9.55) | 0.000 | 0.790 |
| ***CRM*** | 3.8(1.39) | 5.1(1.01) | 3.7(1.39) | 1.5(1.25) | 0.000 | 0.802 |
| ***PCS*** | 38.5(5.16) | 33.8(5.26) | 36.6(4.85) | 43.4(5.48) | 0.000 | 0.613 |
| ***MCS*** | 44.2(5.28) | 37.4(5.03) | 41.6(4.72) | 50.5(5.52) | 0.000 | 0.736 |

### 5.3.2. SOCCER ATHLETES ANALYSIS RESULTS

Analyzing the soccer athletes groups, it can be observed that VAS scale in pre-post tests (T0-T1), had a significant value ($p<0.05$, $\eta2 = 0.240$) in the between groups analysis and the between groups effect size was high during the 24 sessions of treatment. Also for the CRM assessment in T0-T1, the difference between groups analysis had a significance ($p<0.05$, $\eta2 =0.571$) with a large effect size during the 24 sessions of treatment.

Regarding the sit and Reach flexibility test, Runtastic pedometer performance , PCS and MCS the results didn't show a significance between groups effect size during the 24 sessions of treatment (Table 8).

**Table 8.Comparison of outcomes between the soccer groups**

| | Soccer Sample | | | | | |
|---|---|---|---|---|---|---|
| | Control Group (n = 7) | | Experimental Group (n = 10) | | | |
| | T0 | T1 | T0 | T1 | P | η2 |
| ***Outcomes*** | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | | |
| ***VAS*** | 3(0.81) | 3.71(1.49) | 3.3(1.16) | 1.20(1.35) | 0.046 | 0.240 |
| ***Sit -Reach*** | 6.71(1.11) | 5.86(1.21) | 5.2(1.03) | 7.9(1.96) | 0.682 | 0.012 |
| ***Runtastic*** | 185.4(3.69) | 175.4(6.9) | 167.2(10.7) | 182.9(5.3) | 0.113 | 0.159 |
| ***CRM*** | 4.14(0.69) | 5(1.41) | 3.90(1.19) | 1(0.94) | 0.000 | 0.571 |
| ***PCS*** | 41.7(3.81) | 33.5(5.28) | 35.5(5.6) | 46.4(6.47) | 0.227 | 0.096 |
| ***MCS*** | 48 (5.44) | 37.2(7.82) | 40.7(4.96) | 51.9(5.72) | 0.209 | 0.103 |

### 5.3.3. BASKETBALL ATHLETES ANALYSIS RESULTS

By observing the basketball athletes groups CG and EG, VAS pain assessment scale in pre-post tests (T0-T1), had a significant value ($p<0.05$, $\eta 2 = 0.787$) in the between groups analysis and the between groups effect size was high during the 24 sessions of treatment.

Also for Sit and Reach flexibility test($p<0.05$, $\eta 2$ $p=0.395$), Runtastic performance($p<0.05$, $\eta 2$ $p=0.617$), CRM ($p<0.05$, $\eta 2$ $p=0.666$), PCS ($p<0.05$, $\eta 2$ $p=0.329$), MCS ($p<0.05$, $\eta 2$ $p=0.244$), between groups effect size was high during the 24 sessions of treatment (as described in Table 9).

**Table 9. Comparison of outcomes between the soccer groups**

| | Sample | | | | | |
|---|---|---|---|---|---|---|
| | Control Group (n = 12) | | Experimental Group (n = 20) | | | |
| | T0 | T1 | T0 | T1 | P | η2 |
| *Outcomes* | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | | |
| ***VAS*** | 1.58(0.66) | 3.33(0.77) | 3.35(1.34) | 1.25(0.96) | 0.000 | 0.787 |
| ***Sit-Reach*** | 5.33(1.23) | 4.42(0.51) | 3.50(1.43) | 4.60(1.66) | 0.000 | 0.395 |
| ***Runtastic*** | 175.3(4.55) | 168.33(3.57) | 167.45(6.05) | 172.8(5.34) | 0.000 | 0.617 |
| ***CRM*** | 2.42(0.66) | 4.25(0.96) | 4.80(1.64) | 2.75(1.11) | 0.000 | 0.666 |
| ***PCS*** | 46.75(3.72) | 38.75(3.88) | 34.5(5) | 40.80(4.13) | 0.001 | 0.329 |
| ***MCS*** | 51.83(4.26) | 42.42(3.77) | 39(4.65) | 46.35(4.53) | 0.004 | 0.244 |

## 5.4. CROSS GROUPS RESULTS

### 5.4.1. Rhythmic Gymnastics and Basketball team cross groups results

Referring the type of sport analysis and the between groups results, an Ancova statistics were performed with the 95% confidence interval (CI). Covariates appearing in these results are evaluated in function of this study section sample as: Rhythmic Gymnastics no = 90 (EG= 39; CG=51) and Basketball team no=32 (EG=20; CG=12). In total 122 participants were analyzed.

Comparing the difference between groups of VAS outcome at the baseline, a significance in the Rhythmic Gymnastics and Basketball team was shown ($p = 0.002$, $\eta 2 = 0.052$) with a medium effect size. By observing the VAS outcome at 24 weeks of treatment it can be said that a difference between groups with large effect size significance was shown ($p = 0.000$, $\eta 2 = 0.546$).

Analyzing the between group difference at baseline a significance with a medium- large effect size was observed as per Runtastic ($p = 0.000$, $\eta 2 = 0.24$); CRM ($p=0.034$, $\eta 2 = 0.037$); PCS ($p = 0.000$, $\eta 2 = 0.149$) and MCS ($p = 0.000$, $\eta 2 = 0.191$) outcomes.

Only the Sit and Reach outcome didn't shown a significant difference between groups at baseline ($p>0.05$).

Referring the between groups effect size at the 24 weeks of treatment it can be observed a significance with a large effect size in all the study outcomes as Sit and Reach ($p = 0.000$, $\eta 2 = 0.338$); Runtastic ($p = 0.000$, $\eta 2 = 0.150$), CRM ($p = 0.000$, $\eta 2 = 0.620$); MCS($p = 0.000$, $\eta 2 = 0.499$) and PCS($p = 0.000$, $\eta 2 = 0.346$).

According to the Rhythmic gymnastics and Basketball team it can be observed that wasn't any significant difference between the sport type treatments effects as per VAS, CRM, PCS and MCS ($p>0.05$ in all cases) outcomes at baseline and in the 24 weeks.

Regarding to the outcomes as Sit and Reach ($p=0.000$, $\eta 2 = 0.894$) and Runtastic ($p=0.000$, $\eta 2 = 0.734$) it can be observed a significant difference between the sport type treatments effects in the baseline. The same situation was demonstrated at the 24 weeks of treatment with a significant difference and a large affect size between the sport type treatments effect as per Sit and Reach ($p=0.000$, $\eta 2 = 0.844$) and Runtastic ($p=0.000$, $\eta 2 = 0.728$) outcomes. These results are shown in table 10.

**Table 10.Rhythmic Gymnastics and Basketball team cross groups results**

| | Sample | | | | Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Between groups | | | | Sport type Treatment | | | |
| | Rhythmic Gymnastics | | Basketball | | *p* | | *η2* | | *p* | | *η2* | |
| | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* |
| ***Outcomes*** | *Mean (95% CI)* | *Mean (95% CI)* | *Mean (95% CI)* | *Mean (95% CI)* | | | | | | | | |
| ***VAS*** | 2.78(2.54-3.02) | 2.38(2.16-2.60) | 2.61(2.21-3.01) | 2.36(1.98-2.73) | 0.012 | 0.000 | 0.052 | 0.546 | 0.474 | 0.924 | 0.004 | 0.000 |
| ***Sit and Reach*** | 17.6(17.2-18.09) | 18.9(18.3-19.5) | 4.2(3.57-5.00) | 3.9(2.95-4.95) | 0.053 | 0.000 | 0.031 | 0.338 | 0.000 | 0.000 | 0.894 | 0.844 |
| ***Runtastic*** | 134.9 (132.8-136.9) | 135.8 (133.9-137.7) | 171.8 (168.3-175.2) | 170.03 (166.7-173.2) | 0.000 | 0.000 | 0.241 | 0.150 | 0.000 | 0.000 | 0.734 | 0.728 |
| ***CRM*** | 3.8(3.53-4.15) | 3.4(3.16-3.66) | 3.8(3.30-4.34) | 3.7(3.32-4.16) | 0.034 | 0.000 | 0.037 | 0.620 | 0.957 | 0.186 | 0.000 | 0.015 |
| ***PCS*** | 37.5(36.38-38.64) | 38.3(37.26-39.48) | 39.7(37.82-41.64) | 38.9(37.06-40.81) | 0.000 | 0.000 | 0.149 | 0.346 | 0.051 | 0.613 | 0.032 | 0.002 |
| ***MCS*** | 42.8(41.73-43.98) | 43.6(42.56-44.82) | 44.5(42.65-46.45) | 43.3(41.45-45.25) | 0.000 | 0.000 | 0.191 | 0.499 | 0.134 | 0.761 | 0.019 | 0.001 |

a. Covariates appearing in the model are evaluated at the following values: StudySample = 122 participants.

### 5.4.2. Soccer and Basketball team cross groups results

Another Ancova analysis was performed regard the Soccer and Basketball team groups, where 17 participants pertaining a Soccer group (EG no=10, CG no=7) and 32 participants pertaining a Basketball team (EG no=20, CG no=12). In total a sample of 49 participants were analyzed.

Comparing the difference between groups of all outcomes at the baseline a significance with a large effect size was shown as per VAS, Sit and Reach, Runtastic, CRM, PCS and MCS ($p>0.05$ in all cases). The same situation was observed at the 24 weeks of treatment, the outcomes as per VAS ($p=0.000$, $\eta2= 0.358$); Runtastic($p= 0.001$, $\eta2= 0.221$); CRM ($p=0.000$, $\eta2= 0.484$); PCS ($p= 0.001$, $\eta2= 0.232$) and MCS($p=0.000$, $\eta2= 0.314$) demonstrated a significant difference between groups with a large effect size, except Sit and Reach ($p= 0.068$) outcome that not shown a significant difference between groups of treatment.

The analysis of the effectiveness of treatment in relation with the type of sport demonstrated that at baseline in all the study outcomes it wasn't a significant difference as per VAS, Runtastic, CRM, PCS and MCS ($p>0.05$) except the Sit and Reach outcome which shown a significant difference between the type of sport treatments ($p=0.000$, $\eta2= 0.2730$).

Referring the 24 weeks of treatment in the difference between the type of sport, the analysis of results didn't shown a significance as per VAS, CRM, PCS and MCS outcomes ($p>0.05$). The outcomes as Sit and Reach ($p=0.000$, $\eta2=0.400$) and Runtastic ($p=0.000$, $\eta2= 0.412$) shown a significant difference between the type of sport treatment with a large effect size. (Table 11)

**Table 11.Soccer and Basketball team cross groups results**

| | Sample | | | | Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Between groups | | | | Sport type Treatment | | | |
| | Soccer | | Basketball | | p | | $\eta^2$ | | p | | $\eta^2$ | |
| | T0 | T1 | T0 | T1 | T0 | T1 | T0 | T1 | T0 | T1 | T0 | T1 |
| Outcomes | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | | | | | | | | |
| VAS | 3.2(2.64-3.77) | 2.18(1.67-2.69) | 2.67(2.26-3.08) | 2.06(1.68-2.43) | 0.001 | 0.000 | 0.228 | 0.358 | 0.130 | 0.699 | 0.049 | 0.003 |
| Sit and Reach | 5.78(5.16-6.39) | 7.07(6.32-7.82) | 4.2(3.76-4.65) | 4.52(3.97-5.06) | 0.000 | 0.068 | 0.32 | 0.071 | 0.000 | 0.000 | 0.273 | 0.400 |
| Runtastic | 174.4 (170.9-177.9) | 179.9 (177.4-182.5) | 170.5 (168.01-173.08) | 171.05 (169.1-172.9) | 0.000 | 0.001 | 0.399 | 0.221 | 0.076 | 0.000 | 0.067 | 0.412 |
| CRM | 4.03(3.35-4.71) | 2.59(1.98-3.19) | 3.88(3.38-4.38) | 3.34(2.90-3.78) | 0.001 | 0.000 | 0.214 | 0.484 | 0.728 | 0.049 | 0.003 | 0.082 |
| PCS | 37.8(35.4-40.1) | 41.2(38.6-43.8) | 39.2(37.4-40.9) | 39.9(38.04-41.8) | 0.000 | 0.001 | 0.521 | 0.232 | 0.342 | 0.423 | 0.02 | 0.014 |
| MCS | 43.4(41.06-45.82) | 46.06(43.2-48.8) | 43.9(42.2-45.6) | 44.7(42.7-46.8) | 0.000 | 0.000 | 0.557 | 0.314 | 0.731 | 0.457 | 0.003 | 0.012 |

a. Covariates appearing in the model are evaluated at the following values: StudySample = 49 participants.

**5.4.3. Rhythmic Gymnastics and Soccer cross groups results**

An Ancova analysis was performed for obtaining the results between groups and the type of sport treatments of Rhythmic Gymnastics and Soccer. In total 110 participants were analyzed where 90 participants pertaining a Rhythmic Gymnastics (EG no=39, CG no=51) and 17 participants pertaining a Soccer (EG no=10, GC no=7).

In the analysis between groups at baseline it was shown a significant difference in the Runtastic ($p=0.000$, $\eta2=0.248$); PCS ($p=0.010$, $\eta2= 0.061$) and MCS ($p=0.001$, $\eta2=0.100$) outcomes. Referring to the analysis of the outcomes as VAS, Sit and Reach and CRM at the baseline, the results didn't shown a significant difference between groups ($p>0.05$).

At the 24 weeks of treatment the analysis of results shown a significant difference between groups in all study outcomes as VAS, Sit and Reach, Runtastic, CRM, PCS and MCS ($p>0.05$) with a large effect size ($\eta2>0.14$).

Analyzing the sport type treatment effects it can be said that at the baseline only the Sit and Reach($p=0.000$,$\eta2=0.817$) and Runtastic ($p=0.000$, $\eta2= 0.673$) outcomes have a significance.

The same situation appears at the 24 weeks of treatment with the significant difference in the sport type treatment, in the same study outcomes as Sit and Reach ($p=0.000$, $\eta2= 0.725$) and Runtastic ($p=0.000$, $\eta2= 0.728$) with a large effect size.

The other study outcomes doesn't show a significance regarding the sport type treatment in the baseline and after 24 weeks as per VAS, CRM, PCS and MCS ($p>0.05$) (Table 12)

**Table 12.Rhythmic Gymnastics and Soccer cross groups results**

| | Sample | | | | Effect | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Between groups | | | | Sport type Treatment | | | |
| | Rhythmic Gymnastics | | Soccer | | *p* | | $\eta^2$ | | *p* | | $\eta^2$ | |
| | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* | *T0* | *T1* |
| ***Outcomes*** | *Mean (95% CI)* | *Mean (95% CI)* | *Mean (95% CI)* | *Mean (95% CI)* | | | | | | | | |
| ***VAS*** | 2.7(2.53-2.97) | 2.4(2.20-2.67) | 3.1(2.65-3.66) | 2.5(2.00-3.10) | 0.485 | 0.000 | 0.005 | 0.537 | 0.157 | 0.710 | 0.019 | 0.001 |
| ***Sit and Reach*** | 17.6(17.26-18.12) | 18.8(18.26-19.44) | 5.8(4.89-6.88) | 6.4(5.06-7.79) | 0.187 | 0.000 | 0.017 | 0.426 | 0.000 | 0.000 | 0.817 | 0.725 |
| ***Runtastic*** | 135.1 (132.93-137.35) | 135.6 (133.64-137.69) | 176.2 (171.16-181.39) | 178.7 (174.01-183.38) | 0.000 | 0.000 | 0.248 | 0.166 | 0.000 | 0.000 | 0.673 | 0.728 |
| ***CRM*** | 3.8(3.52-4.09) | 3.47(3.24-3.71) | 4.0(3.35-4.65) | 3.1(2.57-3.66) | 0.813 | 0.000 | 0.001 | 0.726 | 0.58 | 0.239 | 0.003 | 0.013 |
| ***PCS*** | 37.6(36.62-38.73) | 38.2(37.09-39.37) | 38.3(35.94-40.84) | 39.7(37.16-42.42) | 0.010 | 0.000 | 0.061 | 0.467 | 0.597 | 0.286 | 0.003 | 0.011 |
| ***MCS*** | 43.03(41.96-44.10) | 43.4(42.34-44.62) | 44.1(41.67-46.62) | 44.1(41.50-46.78) | 0.001 | 0.000 | 0.100 | 0.600 | 0.417 | 0.649 | 0.006 | 0.002 |

a. Covariates appearing in the model are evaluated at the following values: StudySample = 107 participants

## 5.5. STUDY SAMPLE RESEARCH ANALYSIS RESULTS

### 5.5.1 Primary outcome -physiological evaluation

By observing CG and EG, it is evident that the VAS pain assessment scale in pre-post tests (T0-T1), had a significant value ($F = 32.7$; $p<0.05$; $\eta2 = 0.19$) in the between groups analysis. And the between group effect size was high during the 24 sessions of treatment ($d>0.8$).

Also for the Sit and Reach back flexibility test it can be observed a significant change between groups analysis ($F = 27.7$; $p<0.05$; $\eta2 = 0.16$). Furthermore for what concerns the between group effect size it has been confirmed as high during the intervention period ($d>0.8$).

For the Runtastic pedometer performance also in the between groups analysis it is noted a significant effect ($F = 399.1$; $p<0.05$; $\eta2 = 0.74$) and a high effect size throughout the treatment phase ($d>0.8$ as described in table .13).

### 5.5.2 Secondary outcome- psychological evaluation

The disabling status (CRM) was observed in the difference between groups and a significance was noted on the own analysis ($F = 44.2$; $p<0.05$; $\eta2 = 0.24$). Concretely, the effect size was high during the 24 weeks of treatment ($d>0.8$). And furthermore the differences between groups of the health status and the effect size analyzed for the two subscales (PCS and MCS) were also significant ($p<0.05$; $d>0.8$) (refer to Table.13).

**Table 13. Baseline, post-intervention values, and mean score changes after intervention of the outcome measures; mean _ standard deviation (95% confidence interval)**

| | Sample | | | | | |
|---|---|---|---|---|---|---|
| | Control Group (n = 70) | | Experimental Group (n = 69) | | | |
| | T0 | T1 | T0 | T1 | F | P |
| ***Outcomes*** | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | *Mean (SD)* | | |
| ***VAS*** | 2.54(1.05) | 3.53(1.08) | 3.04(1.18) | 1.17(1.07) | 32.7 | 0.00 |
| ***Sit and Reach*** | 14.6(5.7) | 13.30(5.5) | 11.67(6.9) | 14.78(8.6) | 27.7 | 0.00 |
| ***Runtastic*** | 150.74 (19.7) | 142.30(20.07) | 145.81(21.5) | 155.9(19.7) | 399.1 | 0.00 |
| ***CRM*** | 3.61(1.35) | 4.96(1.08) | 4.10 (1.49) | 1.81(1.32) | 44.2 | 0.00 |
| ***PCS*** | 40.29(5.69) | 34.63(5.3) | 35.87(5.02) | 43.12(5.4) | 6.06 | 0.01 |
| ***MCS*** | 45.94(5.85) | 38.31(5.4) | 40.72(4.8) | 49.54(5.6) | 12.8 | 0.00 |

**Table 13. Continued Baseline, post-intervention values, and mean score changes after intervention of the outcome measures; mean _ standard deviation (95% confidence interval)**

| | Difference within groups | | Effect Size | Difference between groups |
|---|---|---|---|---|
| | T1 minus T0 | | T1 | T1 minus T0 |
| ***Outcomes*** | **EG (n = 69)** | **CG (n = 70)** | **Cohen's *d*** | **GPR - CG** |
| ***VAS*** | 1.86*(0.9) | 0.98*(1.1) | 0.87 | -2.8* (-3.2,-2.4) |
| ***Sit and Reach*** | 3.11*(2.4) | -1.30*(1.4) | 2.2 | 4.4* (3.7, 5.09) |
| ***Runtastic*** | 10.17*(6.2) | -8.44*(4.6) | 3.4 | 18.6* (16.7, 20.4) |
| ***CRM*** | -2.2*(1.2) | 1.3*(1.1) | 3.04 | -3.6* (-4.03, -3.2) |
| ***PCS*** | 7.24*(4.8) | -5.6*(4.3) | 2.8 | 12.9* (11.3, 4.4) |
| ***MCS*** | 8.81*(4.4) | -7.62*(4.7) | 3.6 | 16.4*(14.9, 17.9) |

### 5.5.3 Treatment effect in the participants

In the analysis of the results within groups it was seen that the MM tactics in relation to VAS pain was significant [t (137) = -15.4, p = 0.00]. The same analysis also demonstrated a significance of the treatment over time on the CRM disability [t (137) = -17.9, p = 0.00] in the 6-month period. In this logic, the SF-12 test was analyzed with its susceptibles and demonstrated a significance of the treatment over time [PCS t (137) = 16.4, p = 0.00]; [MCS t (137) = 21.1, p = 0.00].

It is further proved that the treatment also had significant effects on the back flexibility measured with Sit and Reach test [t (137) = 12.8, p = 0.00] expressed even on the steps of 60 seconds of pedometer performance, Runtastic data [t (137) = 19.9, p = 0.00]. In this merit in Table 14, all mean difference values within groups of outcome measures of treatment at baseline and after 24 weeks of treatment are shown.

**Table 14. Independent sample t- test within groups' outcome measures evaluation in time**

| *Outcomes* | Time | Mean Diff. | *t* | P |
|---|---|---|---|---|
| ***VAS*** | T0 | 0.5(0.12,0.87) | 2.63 | 0.09 |
| | T1 | -2.3(-2.7, -1.9) | -12.8 | 0.00 |
| ***Sit and Reach*** | T0 | -2.9(1.08, -5.07) | -2.7 | 0.08 |
| | T1 | 1.4 (-0.9, 3.9) | 1.2 | 0.28 |
| ***Runtastic*** | T0 | -4.9(-11.8, 1.9) | -1.4 | 0.16 |
| | T1 | 13.6(7.003, 20.3) | 4.05 | 0.00 |
| ***CRM*** | T0 | 0.48(0.009, 0.96) | 2.01 | 0.04 |
| | T1 | -3.1(-3.5, -2.7) | -15.3 | 0.00 |
| ***PCS*** | T0 | -4.4(-6.2, -2.6) | -4.8 | 0.00 |
| | T1 | 8.4(6.6, 10.3) | 9.2 | 0.00 |
| ***MCS*** | T0 | -5.2(-7.01, -3.4) | -5.7 | 0.00 |
| | T1 | 11.2(9.3, 13.07) | 11.9 | 0.00 |

### 5.5.4 The correlations of outcome measures

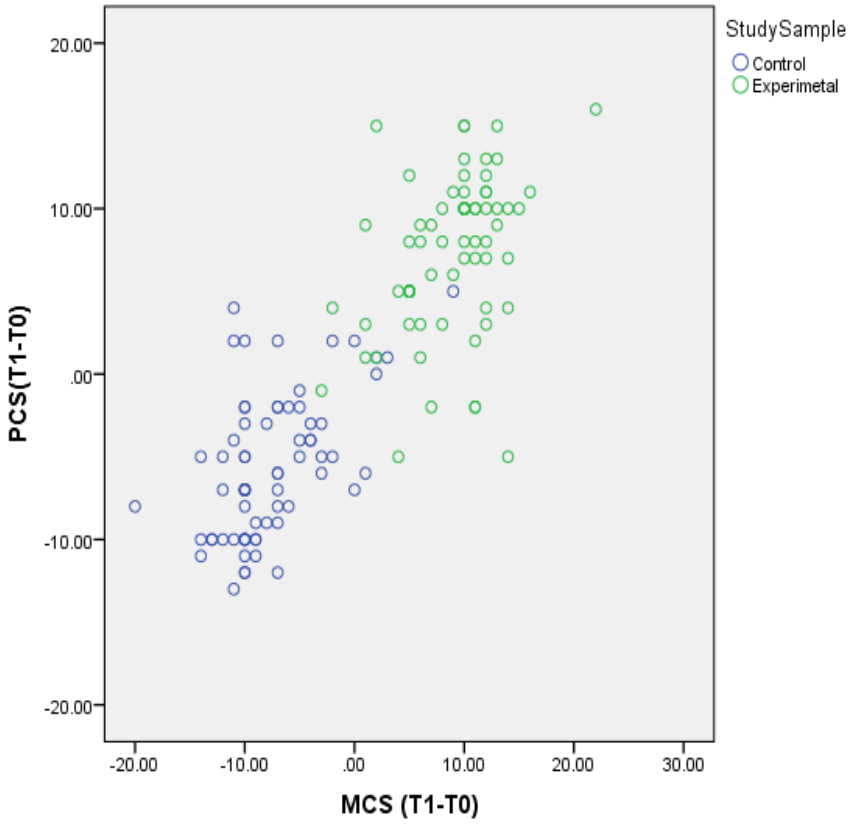
The results of Pearson correlations by the difference between outcome measurements T1-T0 and the statistical significance p = 0.01 and p = 0.05 between the improvements in the sample indicate an interaction between all given variables. In this regard, the table 15 shows the significance of each correlation.

**Table 15. The outcome measures correlations**

**Correlations**

| **Outcomes** | | VAS (T1-T0) | Sit - Reach (T1-T0) | CRM (T1-T0) | Runtastic (T1-T0) |
|---|---|---|---|---|---|
| VAS (T1-T0) | Pearson Correlation | 1 | -.645** | .780** | -.655** |
| | Sig. (2-tailed) | | .000 | .000 | .000 |
| Sit -Reach (T1-T0) | Pearson Correlation | -.645** | 1 | -.653** | .685** |
| | Sig. (2-tailed) | .000 | | .000 | .000 |
| CRM (T1-T0) | Pearson Correlation | .780** | -.653** | 1 | -.708** |
| | Sig. (2-tailed) | .000 | .000 | | .000 |
| Runtastic (T1-T0) | Pearson Correlation | -.655** | .685** | -.708** | 1 |
| | Sig. (2-tailed) | .000 | .000 | .000 | |

In addition, the correlation of secondary outcome measures SF-12 was analyzed, as previously mentioned, through a 2-core test (PCS, MCS). The purpose of this analysis consisted in verifying each of the sub-variables, meaning if there was interaction with each other and vice versa. The analysis verified the existence of a T1-T0 interaction in all these variables (see Figure 18).




**. Correlation is significant at the 0.01 level (2-tailed).

**Figure 18. Correlation of SF-12 (PCS-MCS) in T1-T0**

# VI – DISCUSSION

# VI - DISCUSSION

This study analyzed the effectiveness of MM implementation in rhythmic gymnastics, football and basketball athletes with back pain for periods longer than a month. LBP was associated with muscular disequilibrium that doesn't allow normal movement and forces the motor system to compensate.

The most common alterations here were the misalignments of the pelvis in the sagittal plane and the functional limitation that causes pain with loss of flexibility (128).

Henceforth, the MM applied in the EG uses global stretching techniques to re-establish the balance of muscular tension that causes postural alterations, especially in the lumbo-pelvic area which extends towards the caudal and the cranial (102).

Precisely, the aim of the study was to analyze the effects of MM on the variables associated with LBP (i.e: pain, flexibility, function, state of health and performance-yield).

Analyzing the different sports area as rhythmic gymnastics athletes, soccer and basketball players it can be observe that:

In the rhythmic gymnastics athletes subgroup, the implementation of MM had a high impact and therefore a high effectiveness referring to the differences between groups results ($p<0.05$ in all cases). Perhaps the high effect size of between groups difference derives from the fact that MM applied in the intervention group uses global stretching techniques to re-establish the balance of muscular tension that causes postural alterations, especially in the lumbo-pelvic area which extends towards the caudal and the cranial. The most common alterations were the misalignments of the pelvis in the sagittal plane and the functional limitation that causes pain with loss of flexibility.

Comparing these results with the soccer athletes subgroup, it can be observe that the effectiveness of MM were significant only in the VAS scale and the CRM assessment. It was the first time for the soccer athletes to face the implementation and knowledge of the MM in their treatment.

Maybe these results can be related with the lack of elasticity of the back in the soccer athletes, due to the specific training that they have.

The results of basketball players subgroup demonstrated a significant effectiveness of MM in all between groups outcomes (VAS, Sit and Reach, Runtastic, CRM, PCS, MCS). The effect size was high during all the treatment.

In the practical treatment of the sports mentioned and analyzed in this study, the athletes of three sports categories did not have in diary protocol a stretching of back and muscles. A small number of athletes practice individually the stretching exercise. The majority of the athletes did not apply the stretching exercise before and after the diary training.

Moreover, referring to the significant results of the outcomes, it can be noted that the MM positively influenced the quality of life of athletes treated.

In the analysis of Rhythmic Gymnastics and Basketball team cross groups results, it can be said that the MM treatment wasn't effective in the same way for the two type of sports analyzed.

Referring to the results between groups for these types of sports the VAS scale was significant since at baseline with a 0.16 difference of mean points. Being honest, in practice, it was evident that the rhythmic gymnastics group had more pain comparing to the Basketball team; and basing these knowledge in literature, one of the main causes about the reason why even gymnastics with a high physical condition suffer from this disease is because they often develop sports that involve disk compression movements during flexion, lifting loads or torsion movement (129, 130, 131).

Another interesting fact is that in The Sit and Reach flexibility test of Rhythmic Gymnastics results, a high and important difference of 13.4 means point was shown, comparing with the Basketball team.

Meaning that even the gymnastics athlete that has a proper muscular development of the trunk while making sport and related specific techniques in any case is exposed to a great stress in this vertebral area (131,132).

The mechanism that is evidenced in these situations of great physical stress, is that the soft tissues, such as the muscles, the cartilage of the facets, the ligaments and the inter-vertebral discs, cannot withstand the cutting movements as well as the compression or movements of twist. This begins to produce imbalances that directly influence the mechanics and biomechanics of the vertebral column (133).

In the difference between means in Runtastic pedometer performance it can be said that the basketball team comparing with the gymnastics have since at the baseline a mayor means of 36.9 points, maybe because of their type of sport area.

Observing the data results it was interesting to interpret the same outcomes in function of type of sport as per Sit and Reach and Runtastic. It is evident that at the baseline a high difference between the types of sport outcomes exists.

In the lower back pain also other factors impact such as sex, intensity and frequency of training, as well as sports technique. Other authors show that back pain is a common symptom in adolescent athletes (134).

Kipping in mind here that the youngest age of the study sample pertain at the rhythmic gymnastics athletes with a minimum of 15 years old.

Referring to the difference between groups in the cross Soccer and Basketball team results, it can be said that all the outcomes at baseline, had a significant difference with a large effect size. Maybe these results are influenced by comparing the different type of sports. Technically, the Soccer had a mayor pain with a 0.53 mean difference comparing to the Basketball team at baseline. Analyzing the difference between means at baseline and after 24 weeks of treatment, the Soccer had a 1.02 mean difference point of VAS outcome comparing to the 0.61 mean difference point of basketball team. A difference of 0.41 points in means between the two groups can be observed. The other outcomes as per Runtastic, CRM, PCS and MCS presented the same situation in all the study follow up.

It was evident that the same outcome as sit and Reach had a different approach referring to the type of sport. During all the treatment the mean difference of soccer were high with 0.68 points in favor.

Comparing the data results of Rhythmic gymnastics and Soccer cross analysis, it can be said that the same outcomes, as Sit and Reach and Runtastic are related in function of the type of sport. And observing it practically, it is so real.

Talking about the flexibility of back, the rhythmic gymnastics is characterized by the use of the gymnast's body in articulated ranges outside the physiological limits, adopting hygienically inadequate postures that can cause a large external load during the exercises of great torsion, performed even at high speed(135,136,137). Through the movements most frequently encountered in a rhythmic gymnastics exercise are hyperextensions of the lumbar spine, causing collisions between the facet joints of the spinous and transverse processes, as well as the bone contacts of the spinous processes of the vertebrae, which in some cases may facilitate the appearance of arthritis, faceted syndromes and arthritis in the joints of the posterior aspect of the spine(138).

It is therefore considered that this fact may be the main reason why low back pain has become one of the most common injuries in rhythmic gymnastics, causing even a loss of training days.(139)

Regarding the other studies it was not found any scientific reference that have applied the MM or the derivation of this method as Global Postural Reeducation (GPR), Busquet, Campignion etc., in the elite athletes with LBP. For these reason no more scientific facts are presented in this cross analysis between the types of sport.

With the purpose of not deviating from the aim of this study, for evaluating the effectiveness of MM in the elite athletes with LBP, a specific analysis of the sample research (EG= 69 participants; CG= 70 participants) results can be found in the next subchapter.

## 6.1. SAMPLE RESEARCH STUDY DISCUSSION

The results of this 24-week research study verified the hypotheses raised over the significance of MM implementation to athletes regarding the positive impact on non-specific LBP's, referring to the significance of each of the main outcomes analyzed below.

By the way, it was also noted that MM had effectiveness on sportsman's health and disability.

With special regard to the quality of life instead, referring to Pearson's correlation, a significant interaction of VAS with disability (CRM) and health status (F12) was verified.

Moreover, referring to the significant results of the primary and secondary measures outcome, it can be noted that the MM positively influenced the quality of life of athletes treated.

Therefore a significant difference was noted again between two groups of the study as EG (treated with MM) and CG (treated with conservative rehabilitation). In this context, it was also shown that after the proposed treatment, EG patients increased flexibility and reduced the percentage of functional disability.

The significance of these results regarding outcome measures, whose analysis showed effectiveness ($p \leq 0.05$ in all cases), may be related to the fact that the MM implementation in EG was accompanied by other rehabilitation treatments, enabling the athlete fast recuperation.

As far as the CG is concerned, it also pursued traditional rehab-treatments, excluding MM in contrast to EG.

Currently the management of low back pain in sport includes a series of different strategies including drug therapy, physiotherapy, needle-puncture, yoga and much more (140) . The difficulty is to evaluate their effectiveness and then organize these tools to achieve therapeutic goals (141).

Involving the patient, the objectives are shared and joined together, which can also be modified during the course of the work according to the needs of the patient, an element this that is very important in the MM. Perhaps it can be considered also one of the reasons concerning the significant results of this study.

In order to demonstrate these considerations, it has been decided to argue on other scientific studies that valorize the treatment of LBP through a multidisciplinary approach (Hydrokinesitherapy, McKenzie Mechanical Therapy, manual therapy, etc.) compared to MM or Global only with a rehabilitation method such as Postural Reeducation [Treatment of Souchard, disciple of Mezieres, by using the same therapeutic principles (142)].

Through the comparison of the techniques there is no intention to demonstrate the superiority of MM compared to the others, but the central element of this work is to support the idea that in order to achieve results and maintain them over time it is necessary to manage the sportsman in a multidisciplinary and global way, by firstly attempting to improve the quality of life (94).

The variability of the inter-subjects in the study belongs to each individual in different stretches of rehabilitative intervention (143) and justifies the necessity of the initial individual assessment as the basis for the decision of the MM protocol for each individual and, on the other hand, it is an intra-subject variability, associated with the changes produced in the different functional capacities at different times of athletes.

The intention to implement the MM, as previously mentioned, was to value other studies, even if few compared to this method, aiming to evaluate their scientific base and to intervene as a basic manual treatment with the motor control of the sportsman, simultaneously with the progression in learning of postural control and eventually lumbar stabilization. (144).

Indeed the study by Childs et al., (2004) concludes that the predictive clinical role of spinal manipulation should be considered for decision-making on interventions in non-specific mechanical low back pain. This predictive role is

based on the duration and position of symptoms, on lumbar and hip mobility and on unsafe movements (74).

Always with the aim of achieving valid and worthy results in this study, referring to the bibliography that suggests that most of the manipulation / mobilization treatments must be administered by "qualified" personnel, within their own medical specialty (osteopathy, chiropractic, manual medicine, physiotherapy), even if the qualification requirements are different among professions (75), the treatment was followed by the undersigned, certified in the "MM". Furthermore, the techniques implemented in the research were more commonly administered twice a week during a period of 24-25 weeks and this constitutes an error that perhaps influenced the significance of the results.

The use of outcome measures was intended to adequately represent even the bio-psychosocial influences of the treatment practitioner (145). The effect of physical exercise on individual psychology was an important topic of this study (146), but especially it is important to recognize the role of the psychological aspects of sportsmen (147,148).

In addition, the use of filtering tools, as described by Haldorsen et al., (2002) can help to identify patients with beliefs or fears before therapeutic exercise programs, requiring a more intensive multidisciplinary treatment program (149,150). In the mentioned study, based on 'manual treatment', significant changes were found for pain ($p = 0.001$) compared to the control groups (12).

In this context, the data obtained show that the MM is clinically relevant, and that the intra-group changes produced are slightly greater considering the effect size of those presented in the study undertaken by Pillastrini et al., (2016) who applied the GPR in a non-sports mousy of 94 people to relieve cervical pain with the same application and follow-up time of 6 months (151).

The results of Pillastrini et al., (2016) suggest that GPR was more effective than manual therapy to reduce pain after treatment as well as to reduce disability during a 6-month follow-up period in patients with non-specific chronic cervical pain.

Comparatively the data obtained show that MM is clinically relevant, and that the intra-group changes produced are somewhat greater than those presented in a meta-analysis on the interventions of therapeutic exercises on the pain scale (152).

Similarly, the results coincide with other studies acting through similar interventions, showing significant changes in the intra-group LBP (153,154). These treatments are based on training programs with integration of health education techniques and manual therapy (155).

Other previous studies instead that combined different rehabilitation modalities have shown better results when manual therapy and therapeutic exercise have been combined with the ones of control groups derived from a general medical practice considering that statistical differences are more significant for pain in favor of combined physiotherapy (73), as in the case of the present study. This also occurs when the intervention is based on the combination of strength and mobility exercises that find a significant improvement in pain ($p < 0.05$) compared to waiting list checks (80) and especially when the procedure was as intense as in athletes, where it was compared from the beginning of treatment for intensive programs, compared to other more moderate active strength proposals that maintained the effects at one year of follow-up (8).

In this study, the pain starting point of both groups did not show significant differences ($p > 0.05$), ensuring the similarity of the basic characteristics. The results show a positive response in both groups, not only statistically but also clinically. And properly for this they are considered such as clinically relevant improvements.

Regarding the significance of the results on the physical disability of CRM within the t-tests within groups evaluated over time, by comparing them even with other studies such as Hayden et al., (2005) the conformity occurs (152).

From the other side, by comparing the disability with the fact of low back pain, in order to evaluate the MCS of health status SF-12, other authors used aerobic exercises and found significant changes ($p < 0.05$) (149,150) compared with those physically inactive implemented to control groups (82).

In some other studies, between the control groups and the experimental ones, there were found no significant differences regarding the physical disability (156). However, in other cases, the treatment proposals focused on a variety of therapeutic exercises which showed almost no difference in the MCS (157,158,159 and 160).

The relationship between changes in clinical symptoms (VAS and CRM) and the improvement of physical capacity (Sit and Reach test) as well as the psychological context as a result of evidence-based MM have offered a significant interaction between lumbo-sacral mobility in sagital flexion, pain, physical and mental disability ($p = 0.00$ in all correlations, refer to Table 9).

Nonetheless as regards the subscales of SF12 (PCS, MCS), not only was verified a correlation of the exhibition at baseline and after 6 months referring to Pearson correlations, but also a significance in health status in general is evidenced. In this context should be considered the study of Bronfort et al., (1997) where the differences in physical disability in a population with LBP were assessed after three types of interventions: manual therapy and strengthening exercises, manual therapy and mobility exercises and non-steroidal anti-inflammatory drugs, although they presented physical and mental different conditions compared to the initial situation, none of them showed significant differences or clinical relevance.

In both groups, the results of all functional and psychological assessments (pain, flexibility, performance, physical disability and health status) showed significant differences in improvement in our study compared to the initial time. And the differences are very significant for the two groups in terms of improvement. In the differences within groups it can be seen a small improvement ($p = 0.00$ in all cases) in comparison with the control group perhaps due to an extra-treatment like MM.

These results are expected after a controlled, supervised and completed exercise program (Liddle et al., 2004), however the value of the intervention adaptation is centered on the mean of individual differences, between the values

in the initial evaluation and after the exercises program because in this way the course of each individual is analyzed (161).

Comparing the results with Global Postural Re-education (GPR) studies (162) that transmit the same MM principles developed by Souchard (163), it is reflected in terms of significance that with the same weekly treatment frequency and with a follow-up of 6 months (164), significant changes in LBP and cervical pain are seen on non-sporting studies (165,166).

The results of the present study are also in line with the other RCTs on LBP studies that incorporate systems in their programs to improve mobility, through manual postural therapy, joint mobilization, stretching, etc., integrating them with different names such as: GPR (167,168,169) or generically under the name of manual therapy and therapeutic exercises (170,171,172), all them somehow, use a combination similar to the present study, in which educational strategies are added (170,173). In particular this study presents a pioneering scientific intervention of MM which is a specific pragmatic test model that so far has not been able to rule out the possibility of combining different types of exercises (174,175).

Specifically the research in patients with shoulder pain (166,167,169), demonstrated the long-term effects of the GPR treatment in lumbar measurement, cervical pain, quality of life through questionnaires to assess the effects of disability. Although these studies achieved positive results after several weeks of treatment, other work did not achieve the same results. This is the case of Cunha et al., (164) which performed a 12-week research study in patients with cervical pain and in whom the overall stretching of GPR was compared with analytical stretching. In fact in this study, better results were achieved on pain reduction with analytical stretching. On the other hand, Adorno et al., 176) in their 20-week research study of patients with low back pain did not achieve improvement in pain in the GPR group compared to a group that performed isometric stretching.

Finally, Poveda-Pagán et al., conducted two studies on the effects of stretching of the anterior chain on respiratory volumes in young athletic subjects. In a first pilot study of 10 players, (177) the authors found no significant effect either on the forced vital capacity test or on the maximum expiratory and aspiratory pressure tests, although in the latter they found a tendency to improve values. Subsequently, these same authors found no effects on the same ventilation parameters in a blinded randomized clinical study retrieved from the examination of 44 athletes ( 178).

It is possible that despite of several treatment sessions that lengthen the anterior master chain and the aspiratory chain, athletes were not a population prone to improving these parameters.

Thus, in the end the aim of this work was to demonstrate how a postural therapeutic approach like MM allows a better and more global management of chronic lumbar pain. Immediately it tried to show that rehabilitation cannot use a 'dosage' approach, but must place the patient, who must be an active subject in the rehabilitation process, at the rehabilitation path. Through an integrated approach, it should be acted on the patient as well as on the context in which he/she lives (domestic environment, sports field, university, etc.), by eliminating the risk factors.

Involving the patient, the objectives are shared and reached together, which can also be modified during the course of the work on the basis of the patient needs at the time of therapy. Hereinafter the physiotherapist must provide the patient with the tools to manage and improve low back pain. Alternatively, this means that the dependence on the physiotherapist is avoided and the patient is put in a position to take care of his health independently, reducing time and costs in economic terms while keeping the results over time.

Correspondingly in this work it was tried to demonstrate how a postural rehabilitative approach like MM gives us a better and more comprehensive management of the sport in order to achieve the objectives set and keep them for a long time thanks to athlete's active participation.

# VII – CONCLUSIONS

# VII CONCLUSIONS

## 7.1. CONCLUSIVE REMARKS

A key element in the rehabilitation approach of lower back pain is to educate the athletes and to put him in charge of taking care of his state of health through self-treatment logic.

To achieve the objectives set out in the multidisciplinary approach, the athletes must first be motivated to actively participate in the rehabilitation process, called the "motivation that leads to action"; thus, so, he must be an integral part of the rehabilitation program, sharing the objectives and results with the physiotherapist.

The MM applied to treatment with conventional LBP obtained positive results for pain relief objectively assessed by validated questionnaires.

Correspondingly, it is treated as a psychosomatic treatment that opens the door to the psychological and emotional origin of musculoskeletal and visceral disorders. Beyond this, it represents a posturological approach that takes muscle chains as an element of vehiculation of disorders occurring at the level of different postural prisons.

Therefore, compared to the hypothesis raised in this study, it must be concluded that the treatment performed on athletes with LBP has caused positive effects on all the variables analyzed compared with those of the control group. By this way, the main hypothesis is confirmed.

In fact, this research implied a positive effect on health, with the statistical results obtained, thus, the MM can be also applied in established conventional protocols to alleviate pain and functionality, by improving the quality of life of the sportsman together with his physical and emotional state.

## 7.2. SPECIFIC STUDY CONCLUSIONS

**Referring to study sample (139) it can be conclude:**

1. MM was effective in lowering the back pain referring to the VAS punctuation scale.
2. After the 24 week of treatment the measure of Sit and Rich flexibility test demonstrated an improvement of the back flexibility by gaining centimeters.
3. Runtastic Pedometer Performance shown an improvement of steps per 60 seconds after MM treatment.
4. Referring CMR results was observed a decrease of physical disability.
5. After the evaluation of SF-12 the subscales PCS and MCS it is shown a major impact in physical and mental state to the average improvement of this subscales in scores.

**Referring to the sample size study hypothesis:**

- MM results effective regarding the study outcomes evaluation as VAS, Sit and Reach flexibility test, Runtastic Pedometer Performance, CRM and SF 12 questionnaire in athletes with LBP.

- MM affect the mental and physical health of athletes with LBP, referring the MCS and PCS subscale results of health status questionnaire (SF12).

- MM demonstrated an improvement of the back flexibility degrees and a notable pain relief.

- MM increased the performance of the athletes with LBP referring to the Runtastic Pedometer performance results application.

**Concluding, the split analysis of the sub groups study athletes demonstrated:**

1. The implementation of MM had a positive effect in the VAS outcome, comparing the difference between groups with a large effect size during the 24 weeks of treatment in the Rhythmic Gymnastics, Soccer and Basketball team.
2. Sit and Reach outcome had a high effect size in the between group analysis of Rhythmic Gymnastics and basketball team in all the 24 weeks of study phases. The Soccer sample didn't show a significant improvement between groups of the implementation of MM for 24 weeks consecutively.
3. A better performance of Rhythmic gymnastics and Basketball team was observed in the end of 24 weeks of treatment, referring to the analysis between groups of the Runtastic performance. The MM did not influenced in the improvement of performance of Soccer athletes, with no significance in the difference between group results.
4. The CRM scale demonstrated a positive impact in the implementation of MM in the gymnastics, basketball and soccer with a significance effect size of the between groups analysis, referring to the disability.
5. The Rhythmic Gymnastics and Basketball team shown a significant difference between groups in the health status questionnaire FS12 (PCS and MCS sub scale) during 24 weeks of treatment with a large effect size. No significant effect was shown in the soccer athletes between group analyses referring to FS12 pursuing 24 weeks of the implementation of MM.

**Regarding the type of sport area cross groups results:**

1. In the cross analysis the results shown that the type of sport does not influence the VAS scale as per: Gymnastics X Basketball; Soccer X Basketball and Gymnastics X Soccer. The difference between groups as Gymnastics X Basketball and Soccer X Basketball shown a significance in the VAS scale during the 24 weeks of treatment. Gymnastics X Soccer cross results didn't show a significant difference between groups.
2. The Sit and Reach outcome can be influenced in base of the sport type, referring to the positive results and significant difference between all cross groups analysis as Gymnastics X Basketball; Soccer X Basketball and Gymnastics X Soccer.
3. Runtastic pedometer performance is related with the type of sport area, demonstrating a positive result in the cross groups analysis and the difference between groups during the 24 weeks of treatment in all the study sub groups as per: Gymnastics X Basketball; Soccer X Basketball and Gymnastics X Soccer
4. The cross group analysis demonstrated that the disability of back pain had a significant difference between groups as Gymnastics X Basketball; Soccer X Basketball but the effectiveness of MM in the CRM not depend from the type of sport.
5. The analysis of SF 12 in the cross groups shown that MM had a positive effect in the between groups difference as per: Gymnastics X Basketball; Soccer X Basketball and Gymnastics X Soccer in the mental and physical health (MCS and PCS), but does not influence in the sporty type area.

# VIII – LIMITATIONS AND FUTURE LINES OF RESEARCH

# VIII –LIMITATIONS AND FUTURE LINES OF RESEARCH

## 8.1 STUDY LIMITS

### 8.1.1 Scientific limits

It was very difficult to find documented scientific studies elaborated from Françoise Mézières. The technique is known all over the world but the method has been modified over time and not only by respective student disciples such as Busquet (1977), Campignion (1978), Denys-Struyf (2009) etc. All the variations of the technique are exploited for a good scientific basis with the same principles but with different elements that lose the originality of the Mézières method itself and therefore limit the scientific re-production of the method in nowadays.

Based on the scientific research, Philippe Souchard presented the Mézières method, both from a technical and a theoretical point of view, but anyway a substantial evolution in its proposals was not recognized. Formed in other disciplines, Souchard contributed in the scientific and biomechanical explanations to the empirical observations of Mézières and began to experiment with psychosomatic approaches through his incipient "closed field", abandoning these ideas early and bringing his vision even closer to Mézières's classic theses, but differentiating them mainly at the technical level.

Thus, the morphological references were still present, but much more blurred than the Mézières model; since Souchard carried out all his methodological restructuring while maintaining close contact with Mézières, but however there was a sharp break between them in this regard.

Properly, this break has facilitated the emergence of Global Postural Reeducation (GPR). As a result the Souchard's remarkable ability to communicate and raise awareness has now placed the GPR at the top of global cadence methods. Inspired by this scientific lack of Mézières, and exploiting the abundant bibliographic base of GPR was born the idea of this study with the belief of loyalty to the MM effectiveness in sport.

### 8.1.2 Practical limits

During the realization of the study, various problems were compared:

- The treatment was followed only by a certified MM therapist, which makes difficult the work organization during the treatment period. No more than 5 athletes could be treated in a day, not only for the rehabilitation protocol, but also for the sportsman's willingness to wait for hours;

- The displacement of the same therapist in the various fields of sports training has been another difficulty in this study;

- The location of the sports fields was another difficulty especially for the players;

- Night hours for the treatment of basketball sports have been difficult to organize, more for the sportsmen than for the therapist;

- Meeting the availability of the Elite teams was a big limitation. 265 athletes are planned in the treatment with MM but only half of them were involved. This is due to lack of location, training, protocol, schedules and organization;

-The absence of the sportsman in response of a national and international match;

- The lack of communication with the specific medical equip that has been responsible in determining the diagnosis and the pathology of low back pain conditions of the clinical results.

All these factors limit the organization of the study over time, which for a single therapist was of great importance.

## 8.2 OPEN ISSUES

In future studies, it will be necessary to examine larger samples of sportsmen whether the implementation of the technique should be managed from more than one therapist.

The variability among individuals indicates the need to establish different strategies for each intervention, therefore, in future studies, a reliable and accurate initial functional assessment concerning the decision making in the intervention of LBP with MM should be included.

In addition the radiographic investigations must always be present at the baseline of the intervention. And moreover as a specific diagnosis often helps the therapist to prepare a specific personalized treatment that can demonstrate even more convincing results. Intuitively this favors a well performed clinical evaluation.

Psychological evaluations are also an important element in the treatment of sportsmen with MM and in the valorization of their performance. The more standardized variations are applied, better the treatment is managed.

Nonetheless through the implementation of manual therapy and specifically aiming the muscle stretching, stretching, deep breathing and self-control (MM characteristics), this doctoral thesis creates a pioneering scientific tool to develop the knowledge in the prevention and treatment line, while opens a door to future scientific studies in the field of rehabilitation.

# IX - BIBLIOGRAPHIC REFERENCES

## IX –BIBLIOGRAPHIC REFERENCES


1. Trainor, T. J. y Wiesel, S. W. (2002). Epidemiology of back pain in the athlete. *Clinical Sports Medicine, 21*, 93-103.
2. Granhed, H. y Morrelli, B. (1988). Low back pain among retired wrestlers and heavy-weight lifters. *The American Journal of Sports Medicine, 16*, 530-533.
3. Hickey, G. J., Fricker, P. A. y McDonald, W. A. (1997). Injuries to elite rowers over a 10-yr period. *Medicine and Science in Sports and Exercise*, *29*, 1567-1572.
4. Viedman, T., Sarna, S., Battie, M. C., Koskien, S., Gill, K., Paananen, H. y Gibbons, L. (1995). The long-term effects of physical loading and exercise lifestyles on back-related symptoms, disability, and spinal pathology among men. *Spine, 20*, 699-709.
5. Luttmann, A., Jäger, M., Griefahn, B., Caffier, G., Liebers, F., & World Health Organization. (2004). Prevención de trastornos musculoesqueléticos en el lugar e trabajo.
6. Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. (2010). The association between smoking and low back pain: a meta-analysis. *The American Journal of Medicine*, *123*(1), 87-e7.
7. Camargo Lemos, D. M., Orozco Vargas, L. C., Hernández Sánchez, J., & Niño Cruz, G. I. (2009). Dolor de espalda crónico y actividad física en estudiantes universitarios de áreas de la salud. *Revista de la Sociedad Española del Dolor, 16*(8), 429-436.
8. Han, T. S., Schouten, J. S. A. G., Lean, M. E. J., & Seidell, J. C. (1997). The prevalence of low back pain and associations with body fatness, fat distribution and height. *International Journal of Obesity, 21*(7), 600.
9. Currie, S. R., & Wang, J. (2004). Chronic back pain and major depression in the general Canadian population. *Pain, 107*(1-2), 54-60.
10. Barriga, A. (2008). *Dolor lumbar.* Madrid: Grupo Editorial Entheos.

11. Gera, A., Pereira, P. C. y Eapen, C. (2015). Low back pain in adolescent athletes; evaluation and rehabilitation. *Journal of Exercise Science and Physiotherapy, 11*(2), 76.
12. Seguí, M. y Gervás, J. (2002). El dolor lumbar. *Sermergen, 28*(1), 21-41.
13. Balagué, F., Mannion, A. F., Pellisé, F. y Cedraschi, C. (2012). Non-specific low back pain. *The Lancet, 379*(9814), 482-491.
14. Perez, C., Galvez, R., Huelbes, S., Insausti, J., Bouhassira, D., Diaz, S., & Rejas, J. (2007). Validity and reliability of the Spanish version of the DN4 (Douleur Neuropathique 4 questions) questionnaire for differential diagnosis of pain syndromes associated to a neuropathic or somatic component. *Health and Quality of Life Outcomes, 5*(1), 66.
15. Bono, C. M. (2004). Low-back pain in athletes. *Journal Bone Joint Surgery American Volume, 86*(2), 382-397.
16. Heneweer, H., Staes, F. y Aufdmekampe, G. (2011). Physical activity and low back pain: a systematic review of recent literature. *European Spine Journal, 20*(6), 826-845.
17. Lawrence, J. P., Greene, H. S. y Grauer, J. N. (2006). Back pain in athletes. *Journal of the American Academy of Orthopaedic Surgeons, 14*(13), 726-735.
18. Duda, M. (1989). Golfers use exercise to get back in the swing. *The Physician and Sports Medicine, 17(*8), 109-113.
19. Kirkaldy-Willis, W. H., Wedge, J. H., Yong-Hing, K. y Reilly, J. (1978). Pathology and pathogenesis of lumbar spondylosis and stenosis. *Spine, 3(*4), 319-328.
20. Dobkin, B., Barbeau, H., Deforge, D., Ditunno, J., Elashoff, R., Apple, D., ... & Saulino, M. (2007). The evolution of walking-related outcomes over the first 12 weeks of rehabilitation for incomplete traumatic spinal cord injury: the multicenter randomized Spinal Cord Injury Locomotor Trial. *Neurorehabilitation and Neural Repair, 21*(1), 25-35.
21. Mueller, F. (1998). Fatalities from head and cervical spine injuries occurring in tackle football: 50 years' experience. *Clinical Sports Medicine, 17*, 169-182.
22. Eddy, D., Congeni, J., & Loud, K. (2005). A review of spine injuries and return to play. *Clinical Journal of Sport Medicine, 15*(6), 453-458.

23. Deyo, R. A. y Tsui-Wu, Y. J. (1987). Descriptive epidemiology of low-back pain and its related medical care in the United States. *Spine, 12*, 264-268.
24. Frymoyer, J. W. y Cats-Baril, W. L. (1991). An overview of the incidences and costs of low back pain. *Orthopedic Clinics of North America, 22*, 263.
25. Kelsey, J. L. y White, A. A. (1980). Epidemiology and impact of low-back pain. *Spine, 5*, 133-142.
26. Verbiest, H. (1955). Furthest experiences on the pathologic influence of a developmental narrowing of the bony lumbar vertebral canal. *Journal Bone Joint Surgery British, 37*, 576-583.
27. Torg, J. S., Corcoran, T. A., Thibault, L. E., Pavlov, H., Sennett, B. J., Naranja Jr, R. J. y Priano, S. (1997). Cervical cord neurapraxia: classification, pathomechanics, morbidity, and management guidelines. *Journal of Neurosurgery, 87*(6), 843-850.
28. Blackley, H. R., Plank, L. D. y Robertson, P. A. (1999). Determining the sagittal dimensions of the canal of the cervical spine: the reliability of ratios of anatomical measurements. *Journal Bone Joint Surgery British, 81*, 110-112.
29. Cantu, R. C. (1998). The cervical spinal stenosis controversy. *Clinical Sports Medicine, 17*(121-126).
30. Torg, J. S., Pavlov, H., Genuario, S. E., Sennett, B., Wisneski, R. J., Robie, B. H. y Jahre, C. (1986). Neurapraxia of the cervical spinal cord with transient quadriplegia. *The Journal of Bone and Joint Surgery, 68*(9), 1354-1370.
31. Trainor, T. J. y Trainor, M. A. (2004). Etiology of low back pain in athletes. *Current Sports Medicine Reports, 3*(1), 41-46.
32. d'Hemecount, P. A., Gerbino, P. G. y Micheli, L. J. (2000). Back injuries in the young athlete. *Clinics in Sports Medicine, 19*(4), 663-679.
33. Bergstrom, G., Bodin, L., Bertilsson, H. y Jensen, I. B. (2007). Risk factors for new episodes of sick leave due to neck or back pain in a working population. A prospective study with an 18-month and a three-year follow-up. *Occupational and Environmental Medicine, 64*(4), 279-287.
34. Haynes, R. B., McKibbon, K. A., Wilcznski, N. L., Walter, S. D. y Were, R. (2005). Optimal search strategies for retrieving scientifically strong studies of treatment from Medline: analytical survey. *British Journal of Sports Medicine, 330*(7501), 1179.

35. Campello, M., Nordin, M. y Weiser, S. (1996). Physical exercise and low back pain. *Scandinavian Journal of Medicine and Science in Sports, 6*, 63-72.
36. Parthymos, P., Stergioulas, A. y Tripolitsioti, A. (2003). Strength of lower abdominals and low back pain of physical education students. Comparable study. *Sport Organ, 1*, 85-88.
37. Parthymos, P., Stergioulas, A. y Tsigganos, G. (2003). Strength of lower abdominals and low back pain. *Physical Therapy Reviews, 1,* 85-88.
38. Rodríguez-García, P. L., López-Miñarro, P. A., & Santonja, F. M. (2013). The effect of school physical education programmes on low-back pain in schoolchildren. *Journal of Physical Education & Health-Social Perspective, 2*(4), 43-48.
39. Tall, R. L. y DeVault, W. D. (1993). Spinal injury in sport: Epidemiologic considerations. *Clinics in Sports Medicine, 12*(3), 441-448.
40. Stergioulas, A. (2013). Why are elite athletes suffering from low back pain. *Biology of Exercise, 9*.2.
41. Stergioulas, A. (2005). Prevalence of low back pain in teachers of elementary schools. *Journal of Biology of Exercise, 1*, 7-13.
42. Jagadish, A., Nandyala, S. V., Marquez-Lara, A., Singh, K. y Lee, Y.-P. (2013). Spinal interventions. The role in the athlete. *Operative Techniques in Sports Medicine, 21*, 185-190.
43. Mann, D. C., Kneene, J. S. y Drummond, D. S. (1991). Unusual causes of back pain in athletes. *Journal of Spinal Disorders, 4(*3), 337-343.
44. Nachemson, A. (1992). Newest knowledge of low back pain. A critical look. *Clinical Orthopaedics and Related Research, 279*, 8-20.
45. Sward, L., Hellstrom, M., Jacobsson, B., Nyman, R. y Peterson, L. (1991). Disc degeneration and associated abnormalities of the spine in elite gymnasts. A magnetic resonance imaging study. *Spine, 16*(4), 437-443.
46. Micheli, L. J. y Wood, R. (1995). Back pain in young athletes: significant differences from adults in causes and patterns. *Archives of Pediatrics and Adolescent Medicine, 149*(1), 15-18.
47. Sassmanshausen, G. y Smith, B. G. (2002). Back pain in the young athlete. *Clinical Sports Medicine, 1*, 121-132.
48. Maroon, J. C. (2002). Current concepts in minimally invasive discectomy. *Neurosurgery, 51*, 137-145.

49. Beutler, W. J., Fredrickson, B. E., Murtland, A., Sweeney, C. A., Grant, W. D. y Baker, D. (2003). The natural history of spondylolysis and spondylolisthesis: 45-year follow-up evaluation. *Spine, 28*(10), 1027-1035.
50. Ciullo, J. V. y Jackson, D. (1985). Pars interarticularis stress reaction, spondylolysis, and spondylolisthesis in gymnasts. *Clinics in Sports Medicine, 41*(1), 95-110.
51. Rosi, F. y Dragoni, S. (1990). Lumbar spondylolysis: occurrence in competitive athletes. Updated achievements in a series of 390 cases. *The Journal of Sports Medicine and Physical Fitness, 30*(4), 450-452.
52. Morita, T., Ikata, T. A. K. A. A. K., Kathon, S. y Miyake, R. (1995). Lumbar spondylolysis in children and adolescents. *Journal of Bone and Joint Surgery, British Volume, 77*(4), 620-625.
53. Stinson, J. T. (1993). Spondylolysis and spondylolisthesis in the athlete. Clinics in Sports Medicine, 12(3), 517-528.
54. Brox, J. I., Hagen, K. B., Juel, N. G., & Storheim, K. (1999). Is exercise therapy and manipulation effective in low back pain? *Tidsskr Nor Laegeforen, 119* 2042-2050.
55. Koes BW, Assendelft WJ, van der Heijden GJ, & Bouter LM . (1996). Spinal manipulation for low back pain. An updated systematic review of randomized clinical trials. *Spine, 21* 2860-2871.
56. Harvey, E., Burton, A. K., Klaber Moffett, J., & Breen, A. (2003). Spinal manipulation for low back pain: A treatment package agreed by the UK chiropractic, osteopathy and physiotherapy professional associations. *Manual Therapy, 80* 46.
57. Abenhaim, L., & Bergeron, A. M. (1992).Twenty years of randomized clinical trials of manipulative therapy for back pain: A review. *Clinical and Investigative Medicine, 15* 527-535.
58. Assendelft, W., Koes, B., van der Heijden, GJ., & Bouter, L. (1992). The efficacy of chiropractic manipulation for back pain: Blinded review of relevant randomized clinical trials. *Journal of Manipulative and Physiological Therapeutics, 15* 487-494.

59. Assendelft, W. J., Koes, B. W., van der Heijden, G.J., & Bouter, L. M. (1996). The effectiveness of chiropractic for treatment of low back pain: An update and attempt at statistical pooling. *Journal of Manipulative and Physiological Therapeutics*, *19* 499-507.
60. Assendelft, W., & Lankhorst, G. (1998). Effectiveness of manipulative therapy in low back pain: Systematic literature reviews and guidelines are inconclusive. *Ned Tijdschr Geneeskd, 142* 684-687.
61. Assendelft, W., Morton, S., Yu, E., Suttorp, M., & Shekelle, P. (2003). Spinal manipulative therapy for low back pain. A meta-analysis of effectiveness relative to other therapies. *Annals of Internal Medicine, 138* 871-881.
62. Cherkin, D., Sherman, K., Deyo, R., & Shekelle, P. (2003). A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. *Annals of Internal Medicine*, *138* 898-906.
63. Ferrerira, P. H., Ferreira, M. L., Maher, C. G., Herbert, R. D., & Refshauge, K. (2006). Specific stabilization exercise for spinal and pelvic pain: A systematic review. *Australian Journal of Physiotherapy, 52* 79-88.
64. Koes, B. W., Bouter, L. M., Beckerman, H., van der Heijden, G.J., & Knipschild, P. G. (1991) Physiotherapy exercises and back pain: A blinded review. *British Medical Journal, 302* 1572 – 1576.
65. Ottenbacher, K., & DiFabio, R. (1985). Efficacy of spinal manipulation /mobilization therapy. A meta-analysis. *Spine, 10* 833-837.
66. Shekelle, P., Coulter, I., Hurwitz, E., Genovese, B., Adams, A., Mior, S. (1998). Congruence between decisions to initiate chiropractic spinal manipulation for low back pain and appropriateness criteria in north america. *Annals of Internal Medicine*, *129* 9-17.
67. Anderson, R., Meeker, W. C., Wirick, B. E., Mootz, R. D., Kirk, D. H., & Adams, A. (1992). A meta-analysis of clinical trials of spinal manipulation. *Journal of Manipulative and Physiological Therapeutics*, *15* 181-194.
68. Ernst, E., & Harkness, E. (2001) .Spinal manipulation: A systematic review of sham controlled, double-blind, randomized clinical trials. *Journal of Pain and Symptom Management, 22* 879-889.

-

69. Hemmila, H., Keinanen-Kiukaanniemi, S., Levoska, S., & Puska, P. (1997). Does folk medicine work? A randomized clinical trial on patients with prolonged back pain. *Archives of Physical Medicine and Rehabilitation, 78* 571-577.
70. Koes B, Bouter L, H vM, Essers A, Verstegen G, Hofhuizen D, Houben J, Knipschild P. (1992). The effectiveness of manual therapy, physiotherapy, and treatment by the general practitioner for nonspecific back and neck complaints: A randomized clinical tria. *Spine, 17* 28-35.
71. Postacchini, F., Facchini, M., & Palieri, P. (1988). Efficacy of various forms of conservative treatment in low back pain: A comparative study. Neurology and Orthopaedics, 6, 113-116.
72. Skargren, E., Oberg, B., Carlsson, P., & Gade, M. (1997). Cost and effectiveness analysis of chiropractic and physiotherapy treatment for low back and neck pain. Six-month follow-up. *Spine, 22* 2167-2177.
73. Aure, O., Nilsen, J., & Vasseljen, O. (2003). Manual therapy and exercise therapy in patients with chronic low back pain: A randomized, controlled trial with 1-year follow-up. *Spine, 28*(6) 525-532.
74. Childs, M. J., Fritz, M. J., Flynn, T. W., James Irrgang, J., Johnson, M. K. K., Majkowski, M. G. R. (2004). A clinical prediction rule to identify patients with low back pain most likely to benefit from spinal manipulation: A validation study. *Annals of Medicine Internal, 141*(12) 920-930.
75. Licciardone, J., Stoll, S., Fulda, K., Russo, D., Siu, J., Winn, W. (2003). Osteopathic manipulative treatment for chronic low back pain: A randomized controlled trial. *Spine, 28* 1355-1362.
76. van Tulder, M., Furlan, A., Bombardier, C., & Bouter, L. (2003). Updated method guidelines for systematic reviews in the cochrane collaboration back review group. *Spine, 28* 1290-1299.
77. Bronfort, G., Goldsmith, C., Nelson, C., Boline, P., & Anderson, A. (1996). Trunk exercise combined with spinal manipulative or NSAID therapy for chronic low back pain: A randomized, observer-blinded clinical trial. *Journal of Manipulative and Physiological Therapeutics*, *19* 570-582.

78. Hansen, F., Bendix, T., Skov, P., Jensen, C., Kristensen, J., Krohn, L. (1993) . Intensive, dynamic back-muscle exercises, conventional physiotherapy, or placebo-control treatment of low-back pain. A randomized, observer-blind trial. *Spine, 18* 98-108.
79. Johannsen, F., Remvig, L., Kryger, P., Beck, P., Warming, S., Lybeck, K. (1995). Exercises for chronic low back pain: A clinical trial. *Journal of Orthopaedics and Sports Physical Therapy, 22* 52-59.
80. Manniche, C., Lundberg, E., Christensen, I., Bentzen, L., & Hesselhoe, G. (1991). Intensive dynamic back exercises for chronic low back pain: A clinical trial. *Pain, 47* 53-63.
81. Manniche, C., Hesselsoe, G., Bentzen, L. (1988). Clinical trial of intensive muscle training for chronic low back pain. *Lancet, 8626*, 1473-1476.
82. Mannion, A., Muntener, M., Taimela, S., & Dvorak, J. (1999). A randomized clinical trial of three active therapies for chronic low back pain. *Spine, 24* 2435-2448.
83. Petersen, T., Kryger, P., Ekdahl, C. (2002). The effect of McKenzie therapy as compared with that of intensive strengthening training for the treatment of patients with subacute or chronic low back pain: A randomized controlled trial. *Spine, 27* 1702-1709.
84. Tritilanunt, T., & Wajanavisit, W. (2001). The efficacy of an aerobic exercise and health education program for treatment of chronic low back pain. *Journal of the Medical Association Thailand, 84* 528-533.
85. Mannion, A., Muntener, M., Taimela, S., & Dvorak, J. (2001a). Comparison of three active therapies for chronic low back pain: Results of a randomized clinical trial with one-year follow-up. *Rheumatology (Oxford), 40* 772-778.
86. Denys-Struyf, G. (2005). *El manual del mezierista* (Vol. 2). Editorial Paidotribo..
87. Mezieres, F. (1984). *Originalite de la Methode Mezieres*. Paris: Maloine S.A. Ed. (95): 64.
88. Mezieres, F. (1978). Retour à l'harmonie morphologique par une reeducation specialisee. *Kinesitherapie Scientifique, 157*, 95-106.

-

89. Truan, J. C. F. (2004). Nuevas tendencias gimnásticas. EA, *Escuela abierta: Revista de Investigación Educativa, 7*, 15-54.
90. Elgström, E. (2017). La técnica fisioterapéutica de Françoise Mézières: una solución efectiva para la corrección de las problemáticas posturales y respiratorias de los instrumentistas de viento. *Artseduca, 17*, 224-231.
91. Cittone, J. M. (1999). *Méthode Mézières*. Encyclopedia Medical. 26-085-A-10, 1999.
92. Kisner, C., & Colby, L. A. (2005). *Ejercicio terapéutico. Fundamentos y técnicas* (Vol. 88 ; traducido por Pedro Gonzalez del Campo Román). Barcelona: Editorial Paidotribo.
93. Palacín, M. (1996). La Reeducación Postural Global (RPG) de Philippe Souchard: Puntos de ruptura con la fisioterapia clásica. *Natura Medicatrix: Revista médica para el estudio y difusión de las medicinas alternativas*, (45), 28-33.
94. Souchard, P. E. (2005). *RPG. Principios de la reeducación postural global* (Vol. 88).Barcelona : Editorial Paidotribo.
95. Nisand, M. (2010). *Método Mézières. EMC-Kinesiterapia-Medicina Física, 31*(2), 1-16.
96. Mezieres, F. (1973). Methodes Orthopediques and La Fonction du Sympathique. *Cahiers de la Méthode naturelle*, 52-53.
97. *Turlin, P. (1990). Françoise Mézières sort* du *silence*. *Kiné Actualité* (*332*) : *6-7*
98. García, F. L., Cuencab, M. P., & Olavarrietaa, J. C. (2007). Ansiedad y depresión en la EPOC. *Revista Clinica Española, 207*(Supl.1), 53-57.
99. Molfino, N. A. (2004). Tratamiento de pacientes con enfermedad pulmonar obstructiva crónica (EPOC) por médicos clínicos generales. *Medicina*, *64(*5), 445-454.
100. Rous, M. R. G., Lobato, S. D., Trigo, G. R., Vélez, F. M., San Miguel, M., Cejudo, P., ... & Servera, E. (2014). Rehabilitación respiratoria. Archivos de *Bronconeumología, 50*(8), 332-344.
101. Borson, S., McDonald, G. J., Gayle, T., Deffebach, M., Lakshminarayan, S., & VanTuinen, C.(1992). Improvement in mood, physical symptoms, and function with nortriptyline for depression in patients with chronic obstructive pulmonary disease. *Psychosomatics, 33*(2), 190-201.

102. Nisand, M., & Geismar, S. (2013*). La méthode Mézières: un concept révolutionnaire: mal de dos et déformations ne sont plus une fatalité*. J. Lyon.
103. Monet, J. (2010). Naissance de la kinésithérapie et de la physiothérapie. L'émergence des instituts de rééducation (1880–1915). *Journal de Réadaptation Médicale: Pratique et Formation en Médecine Physique et de Réadaptation, 30*(4), 167-176.
104. Goussard, J. C. (1987). El método Mézières. Revue de médecine orthopédique, 9, 15-17.Hammond, A. (2004). Rehabilitation in rheumatoid arthritis: a critical review. *Musculoskeletal Care, 2*(3), 135-151.
105. Vandervael, F. (1964). Biométrie humaine. Masson & Cie.
106. Bahr, R., & Holme, I. (2003). Risk factors for sports injuries—a methodological approach. *British Journal of Sports Medicine, 37*(5), 384-392.
107. Hutchinson, M. R. (1999). Low back pain in elite rhythmic gymnasts. *Medicine & Science in Sports & Exercise, 31*(11), 1686-8.
108. Hides, J., Stanton, W., McMahon, S., Sims, K., & Richardson, C. (2008). Effect of stabilization training on multifidus muscle cross-sectional area among young elite cricketers with low back pain. *Journal of Orthopaedic & Sports Physical Therapy, 38*(3), 101-108.
109. Granhed, H., & Morelli, B. (1988). Low back pain among retired wrestlers and heavyweight lifters. *The American journal of sports medicine, 16*(5), 530-533.
110. Videman, T., Sarna, S., Battié, M. C., Koskinen, S., Gill, K., Paananen, H., & Gibbons, L. (1995). The long-term effects of physical loading and exercise lifestyles on back-related symptoms, disability, and spinal pathology among men. *Spine, 20*(6), 699-709.
111. Schmidt, C. P., Zwingenberger, S., Walther, A., Reuter, U., Kasten, P., Seifert, J., ... & Stiehler, M. (2014). Prevalence of low back pain in adolescent athletes–an epidemiological investigation. International Journal of Sports Medicine, 35(08), 684-689.
112. Videman, T., Sarna, S., Battié, M. C., Koskinen, S., Gill, K., Paananen, H., & Gibbons, L. (1995). The long-term effects of physical loading and exercise lifestyles on back-related symptoms, disability, and spinal pathology among men. *Spine, 20*(6), 699-709.

113. Kujala, U. M., Kinnunen, J., Helenius, P., Orava, S., Taavitsainen, M., & Karaharju, E. (1999). Prolonged low-back pain in young athletes: a prospective case series study of findings and prognosis. *European Spine Journal, 8*(6), 480-484.

114. Kruse, D., & Lemmen, B. (2009). Spine injuries in the sport of gymnastics. *Current Sports Medicine Reports, 8*(1), 20-28.

115. Mendizábal Albizu, S. (2001). *Fundamentos de la gimnasia rítmica: mitos y realidades.* España: Editorial Gymnos.

116. Downie, W. W., Leatham, P. A., Rhind, V. M., Wright, V., Branco, J. A., & Anderson, J. A. (1978). Studies with pain rating scales. *Annals of the Rheumatic Diseases, 37*(4), 378-381.

117. Wells, K. F., & Dillon, E. K. (1952). The sit and reach—a test of back and leg flexibility. Research Quarterly. *American Association for Health, Physical Education and Recreation, 23*(1), 115-118.

118. Thorndyke, M. A. (1995). Evaluating flexibility with the sit and reach test. *Strength & Conditioning Journal, 17*(6), 12-15.

119. Antón, A. M., & Rodríguez, B. R. (2016). Runtastic PRO app: an excellent all-rounder for logging fitness. *Brazilian Journal of Sports Medicine, 50*(11), 705-706.

120. Orr, K., Howe, H. S., Omran, J., Smith, K. A., Palmateer, T. M., Ma, A. E., & Faulkner, G. (2015). Validity of smartphone pedometer applications. *BMC Research Notes, 8*(1), 733.

121. Roland, M., & Morris, A. (1983). A study of the natural history of back pain. part I : Development of a reliable and sensitive measure of disability in low back pain. *Spine, 8* 141-144.

122. Kovacs, F. M., Llobera, J., Gil del Real, M.T., Abraira, V., Gestoso, M., Fernández, C. (2002). Validation of the spanish version of the Roland Morris Questionnaire. *Spine, 27* 538-542.

123. Luo, X., Lynn George, M., Kakouras, I., Edwards, C., Pietrobon, R., Richardson, W.(2003). Reliability, validity, and responsiveness of the short form 12-item survey (SF-12) in patients with back pain. *Spine,* 1 1739-1745.

124. Ware, J., & Sherbourne, C. (1992). The MOS 36-item short form health survey (SF- 36). I. conceptual frame work and item selection. *Medical Care, 30* 447-483.

125. Gandek, B., Ware, J. E., Aaronson, N. K., Apolone, G., Bjorner, J. B., Brazier, J. E., ... & Sullivan, M. (1998). Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. *Journal of clinical epidemiology, 51*(11), 1171-1178.

126. Jenkinson, C., Layte, R., Jenkinson, D., Lawrence, K., Petersen, S., Paice, C., & Stradling, J. (1997). A shorter form health survey: can the SF-12 replicate results from the SF-36 in longitudinal studies? *Journal of Public Health, 19*(2), 179-186.

127. Cohen, J. (1992). A power primer. *Psychological bulletin, 112*(1), 155.

128. Williams, K., Steinberg, L., & Petronis, J. (2003). Therapeutic application of Iyengar yoga for healing chronic low back pain. *International Journal of Yoga Therapy, 13*(1), 55-67.

129. Rodríguez-García, P. L., López-Miñarro, P. A., & Santonja, F. M. (2013). The Effect of school physical education pogrammeson low-back-pain in schoolchildren. *Journal of Physical Education & Health-Social Perspective, 2*(4), 43-48.

130. Trompeter, K., Fett, D., & Platen, P. (2017). Prevalence of back pain in sports: a systematic review of the literature. *Sports Medicine*, *47*(6), 1183-1207.

131. Ghofrani, M., Olyaei, G., Talebian, S., Bagheri, H., Malmir, K., & Mousavi, S. (2017). Immediate Effects of Lumbosacral Belt on Postural Control During Challenging Tasks in Patients With Chronic Low Back Pain. *Journal of Modern Rehabilitation*, 119-126.

132. Pajek, M. B., & Pajek, J. (2009). Low back pain and the possible role of pilates in Artistic Gymnastics. *Science of gymnastics journal, 1*(1).

133. Apostolos, S. (2013). Why are elite athletes suffering from low back pain. *Biology of Exercise, 9*(2), 5-7.

134. Schmidt, C. P., Zwingenberger, S., Walther, A., Reuter, U., Kasten, P., Seifert, J., ... & Stiehler, M. (2014). Prevalence of low back pain in adolescent athletes–an epidemiological investigation. *International journal of sports medicine, 35*(08), 684-689.

135. Paillard, T. (2017). Plasticity of the postural function to sport and/or motor experience. *Neuroscience & Biobehavioral Reviews, 72*, 129-152.
136. Zerf, M. (2017). Body composition versus body fat percentage as predictors of posture/balance control mobility and stability among football players under 21 years. *Physical education of students, 21*(2), 96-102.
137. Potop, V., Boloban, V., Triboi, V., Gorascenco, A. (2017) Correlative analysis of the biomechanical characteristics and performances achieved by junior gymnasts in balance beam events. *Sport Kinetotherapy Journal*, *2*(48).
138. Kruse, D., & Lemmen, B. (2009). Spine injuries in the sport of gymnastics. *Current Sports Medicine Reports, 8*(1), 20-28.
139. Hsu, W. K., & Jenkins, T. J. (2017). Management of lumbar conditions in the elite athlete. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons, 25*(7), 489-498.
140. Van Middelkoop, M., Rubinstein, S. M., Kuijpers, T., Verhagen, A. P., Ostelo, R., Koes, B. W., & van Tulder, M. W. (2011). A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *European Spine Journal, 20*(1), 19-39.
141. Morningstar, M. W., Woggon, D., & Lawrence, G. (2004). Scoliosis treatment using a combination of manipulative and rehabilitative therapy: a retrospective case series. *BMC Musculoskeletal Disorders, 5*(1), 32.
142. Souchard, P. E. (1981). *Postures mézières.* Le Pousse.
143. O'Sullivan, P., & Beales, D. (2007). Diagnosis and classification of pelvic girdle pain disorders—Part 1: A mechanism based approach within a biopsychosocial framework. *Manual Therapy, 12*(2), 86-97.
144. Hodges, P. W., & Richardson, C. (1996). Inefficient muscular stabilization of the lumbar spine associated with low back pain. *Spine, 21* 2640-2650.
145. Adams, N., Ravey, J., & Bell, J. (1994). Investigation of personality characteristics in chronic low back pain patients attending physiotherapy out-patient departments. *Physiotherapy, 80*(8), 514-519.

146. Bentsen, H., Lindgarde, F., & Manthorpe, R. (1997). The effect of dynamic strength back exercise and/or a home training program in 57-year old women with chronic low back pain: Results of a prospective randomized study with a 3-year follow-up period. *Spine, 22* 1494-1500.
147. Arvinen-Barrow, M., Penny, G., Hemmings, B., & Corr, S. (2010). UK chartered physiotherapists' personal experiences in using psychological interventions with injured athletes: an interpretative phenomenological analysis. *Psychology of Sport and Exercise, 11*(1), 58-66.
148. Francis, S. R., Andersen, M. B., & Maley, P. (2000). Physiotherapists' and male professional athletes' views on psychological skills for rehabilitation. *Journal of Science and Medicine in Sport, 3*(1), 17-29.
149. Haldorsen, E. M. H., Grasdal, A. L., Skouen, J. S., Risa, A. F., Kronholm, K., & Ursin, H. (2002) .Is there a right treatment for a particular patient group? comparison of ordinary treatment, light multidisciplinary treatment, and intensive multidisciplinary treatment for long-term sick-listed employess with musculoskeletal pain. *Pain, 95* 49-63.
150. Chatzitheodrou, D. L., Kabitsis, C., Malliou, P., & Mougios, V. (2007). A pilot study of the effects of high-intensity aerobic exercise versus passive interventions on pain, disability strain, and serum cortisol concentrations in people wtin chronic low back pain. Physical Therapy, 87(3) 304-312.
151. Pillastrini, P., de Lima e Sá Resende, F., Banchelli, F., Burioli, A., Di Ciaccio, E., Guccione, A. A., ... & Vanti, C. (2016). Effectiveness of global postural re-education in patients with chronic nonspecific neck pain: randomized controlled trial. *Physical therapy, 96*(9), 1408-1416.
152. Hayden, J. A., van Tulder, M. W., & Malmivaara, A. (2005). Meta-analysis: Exercise therapy for non-specific low back pain. *Annals of Internal Medicine, 142* 765-775.
153. Niemisto, L., Lahtinen-Suopanki, T., Rissanen, P., Lindgren, K., Sarna, S., & Hurri, H. (2003, A randomized trial of combined manipulation, stabilising exercises, and physician consultation compared to physician consultation alone for chronic low back pain. *Spine,* 28 2185-2191.

154. Cairns, M. C., Foster, N. E., & Wright, C. W. (2006) . Randomized controlled trial of Specific Spinal stabilization exercises and conventional physiotherapy for recurrent low back pain. *Spine, 31*(19) E670-e681.

155. Risch, S., Norvell, N., Pollock, M., Risch, E., Langer, H., Fulton, M., et al. (1993). Lumbar strengthening in chronic low back pain patients. Physiologic and psychological benefits. *Spine, 18* 232-238.

156. Bendix, T., Bendix, A., Labriola, M., Hæstrup, C., & Ebbehøj, N. (2000). Functional restoration versus outpatient physical training in chronic low back pain: a randomized comparative study. *Spine, 25*(19), 2494-2500.

157. Calmels, P., Jacob, J. F., & Fayolle-Minon, I. (2004). Use of isokinetic techniques vs standard physiotherapy in patients with chronic low back pain: Preliminary results. *Annales de Réadaptation et de Médecine Physique, 47* 20-27.

158. Cairns, M. C., Foster, N. E., & Wright, C. W. (2006) . Randomized controlled trial os SpecifiSpinal stabilization exercises and conventional physiotherapy for recurrent low back pain. *Spine, 31*(19) E670-e681.

159. Frost, H., Lamb, S. E., Doll, H. A., Carver, P. T., & Stewart-Brown, S. (2004). Randomised controlled trial of physiotherapy compared with advice for low back pain. *British Medical Journal, 329*(7468), 708.

160. Jousset, N., Fanello, S., Bontoux, L., Dubus, V., Billabert, C., Vielle, B. (2004). Effects of functional restoration versus 3 hours per week physical therapy: A randomized controlled study. *Spine, 29* 487-493.

161. La Touche, R., Fernández-de-Las-Peñas, C., Fernández-Carnero, J., Escalante, K., Angulo-Díaz-Parreño, S., Paris-Alemany, A., & Cleland, J. A. (2009). The effects of manual therapy and exercise directed at the cervical spine on pain and pressure pain sensitivity in patients with myofascial temporomandibular disorders. *Journal of Oral Rehabilitation, 36*(9), 644-652.

162. Vanti, C., Generali, A., Ferrari, S., Nava, T., Tosarelli, D., & Pillastrini, P. (2007). Rééducation Posturale Globale in musculoskeletal diseases: scientific evidence and clinical practice. *Reumatismo, 59*(3), 192-201.

163. Souchard P.E, Meli, O., Sgamma, D., Pillastrini, P. (2009): Rieducazione posturale globale EMC (Elsevier Masson SAS, Paris), Medicina Riabilitativa, 26-061-A-15.

164. Cunha, A. C. V., Burke, T. N., França, F. J. R., & Marques, A. P. (2008). Effect of global posture reeducation and of static stretching on pain, range of motion, and quality of life in women with chronic neck pain: a randomized clinical trial. *Clinics*, *63*(6), 763-770.

165. Teodori, R. M., Negri, J. R., Cruz, M. C., & Marques, A. P. (2011). Global Postural Re-education: a literature review. *Brazilian Journal of Physical Therapy*, *15*(3), 185-189.

166. de Amorim, C. S. M., Gracitelli, M. E. C., Marques, A. P., & dos Santos Alves, V. L. (2014). Effectiveness of global postural reeducation compared to segmental exercises on function, pain, and quality of life of patients with scapular dyskinesis associated with neck pain: a preliminary clinical trial. *Journal of manipulative and physiological therapeutics*, *37*(6), 441-447.

167. Lawand, P., Júnior, I. L., Jones, A., Sardim, C., Ribeiro, L. H., & Natour, J. (2015). Effect of a muscle stretching program using the global postural reeducation method for patients with chronic low back pain: a randomized controlled trial. *Joint Bone Spine*, *82*(4), 272-277.

168. Bonetti F, Curti S, Mattioli S, et al. Effectiveness of a "Global Postural Reeducation" program for persistent low back pain: a non-randomized controlled trial. *BMC Musculoskeletal Disorders*. 2010;11:285.

169. Castagnoli, C., Cecchi, F., Del Canto, A., Paperini, A., Boni, R., Pasquini, G., ... & Macchi, C. (2015). Effects in short and long term of Global Postural Reeducation (GPR) on chronic low back pain: a controlled study with one-year follow-up. *The scientific world journal*, 271436.

170. Gomes-Neto, M., Lopes, J. M., Conceição, C. S., Araujo, A., Brasileiro, A., Sousa, C., ... & Arcanjo, F. L. (2017). Stabilization exercise compared to general exercises or manual therapy for the management of low back pain: A systematic review and meta-analysis. *Physical Therapy in Sport*, *23*, 136-142.

171. Louw, A., Farrell, K., Landers, M., Barclay, M., Goodman, E., Gillund, J., ... & Timmerman, L. (2017). The effect of manual therapy and neuroplasticity education on chronic low back pain: a randomized clinical trial. *Journal of Manual & Manipulative Therapy, 25*(5), 227-234.

172. Bade, M., Cobo-Estevez, M., Neeley, D., Pandya, J., Gunderson, T., & Cook, C. (2017). Effects of manual therapy and exercise targeting the hips in patients with low-back pain—A randomized controlled trial. *Journal of Evaluation in Clinical Practice, 23*(4), 734-740.

173. Vibe Fersum, K., O'Sullivan, P., Skouen, J. S., Smith, A., & Kvåle, A. (2013). Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: A randomized controlled trial. *European Journal of Pain, 17*(6), 916-928.

174. Cleland, J. A., Fritz, J. M., Kulig, K., Davenport, T. E., Eberhart, S., Magel, J., & Childs, J. D. (2009). Comparison of the effectiveness of three manual physical therapy techniques in a subgroup of patients with low back pain who satisfy a clinical prediction rule: a randomized clinical trial. *Spine, 34*(25), 2720-2729.

175. Tamer, S., Öz, M., & Ülger, Ö. (2017). The effect of visceral osteopathic manual therapy applications on pain, quality of life and function in patients with chronic nonspecific low back pain. *Journal of back and Musculoskeletal Rehabilitation, 30*(3), 419-425.

176. Adorno, M. L. G. R., & Brasil-Neto, J. P. (2013). Assessment of the quality of life through the SF-36 questionnaire in patients with chronic nonspecific low back pain. *Acta Ortopedica Brasileira, 21*(4), 202.

177. Poveda-Pagán, E. J., Miralles-Bueno, J. J., García-Miguel, R., Hernández-Sánchez, S., Toledo-Marhuenda, J. V., & Batalle-Richart, M. L. (2009). Influencia en los valores espirométricos del estiramiento de la cadena maestra anterior con la técnica reeducación postural global en futbolistas. *Cuestiones de Fisioterapia, 38*(3), 191-198.

178. Poveda-Pagán, E. J., Ballester-Berman, C., Ratcliffe, S. J., Giner-Gran, M. A., & García-López, J. D. (2012). Estiramiento de la cadena muscular anterior con la técnica de RPG en deportistas y sus posibles consecuencias en los datos espirométricos. Cuestiones de Fisioterapia, 41(1), 25-32.

# X – ANNEXES

**ANNEX 1:** Ethical Committee Approval

UCAM
UNIVERSIDAD CATÓLICA SAN ANTONIO

## UCAMETHICS COMMITTEE



### PROJECT DATA

| | | |
|---|---|---|
| **Title:** | "The Effectiveness of Mézières Therapy in the UCAM's Athletes with Low Back Pain" | |
| **Principle Researcher** | **Name** | **Email** |
| **PhD.** | José Luis Martínez Gil | jlmgil@ucam.edu |

### COMITTEE REPORT

| | |
|---|---|
| **Date** | **25/11/2016** |

**Typeof Experimentation**

| | |
|---|---|
| Experimental clinical research involving human subjects. | |
| Using human tissues from patients, embryonic or fetal tissue. | |
| Using human tissues, embryonic or fetal tissue from banks or tissue samples. | |
| Observational research with humans or use of personal data, genetic information, etc. | X |
| Animal studies. | |
| Use of biological agents of risk to human health, animal or plant. | |
| Use of genetically modified organisms (GMOs). | |

| **Comments regarding the type of experimentation** |
|---|
| No problem |

| **Comments regarding the methodology of experimentation** |
|---|
| No problem |

UCAM
UNIVERSIDAD CATÓLICA
SAN ANTONIO

# UCAMETHICS COMMITTEE

| **Suggestionsfortheresearcher** |
| --- |
| |

**In view of the application of the attached report by the Researcher and the above mentioned recommendations, the opinion of the Committee is to:**

| | |
| --- | --- |
| Issue a favorable report | X |
| Issueanunfavorablereport | |
| Issue a favorable report with subject to correction | |

| **MOTIVATION** |
| --- |
| It can increase the knowledge |

Approved by the President,

Approved by the Secretary,

UNIVERSIDAD CATOLICA SAN ANTONIO
COMITE DE ETICA

Sig.: José Alberto Cánovas Sánchez

Sig.:José Alarcón Teruel

**ANNEX 2:** Informed Consent

## CONSENTIMIENTO INFORMADO

Yo , con DNI:

DECLARO:

Haber sido informado/a del estudio y procedimientos de la investigación del Proyecto titulado:

**The Effectiveness of Mézières Therapy in the UCAM's Athletes with Low Back Pain**

Los investigadores que van a acceder a mis datos personales y a los resultados de las pruebas son: **José Luis Martínez Gil, María Gómez Gallego y Orges Lena**

Asimismo, he podido hacer preguntas del estudio, comprendiendo que me presto de forma voluntaria al mismo y que en cualquier momento puedo abandonarlo sin que me suponga perjuicio de ningún tipo.

CONSIENTO:

1.-) Someterme a las siguientes pruebas exploratorias (en su caso**): Ejercicios físicos, de equilibrio, diafragmáticos, estiramiento corporal, pompage global.**

2.-) El uso de los datos obtenidos según lo indicado en el párrafo siguiente: En cumplimiento de la Ley Orgánica 15/1999, de 13 de diciembre, de Protección de Datos de Carácter Personal, le comunicamos que la información que ha facilitado y la obtenida como consecuencia de las

exploraciones a las que se va a someter pasará a formar parte del fichero automatizado INVESALUD, cuyo titular es la FUNDACIÓN UNIVERSITARIA SAN ANTONIO, con la finalidad de INVESTIGACIÓN Y DOCENCIA EN LAS ÁREAS DE CONOCIMIENTO CIENCIAS EXPERIMENTALES Y CIENCIAS DE LA SALUD. Tiene derecho a acceder a esta información y cancelarla o rectificarla, dirigiéndose al domicilio de la entidad, en Avda. de los Jerónimos de Guadalupe 30107 (Murcia). Esta entidad le garantiza la adopción de las medidas oportunas para asegurar el tratamiento confidencial de dichos datos.

En Guadalupe (Murcia) a 17 de noviembre de 2016

El investigador,

**ANNEX 3:** Information document for subjects submitted to study

UCAM
UNIVERSIDAD CATÓLICA
SAN ANTONIO

**DOCUMENTO DE INFORMACIÓN PARA SUJETOS SOMETIDOS A ESTUDIO**
**(HOJA INFORMATIVA)**

## 1. EN QUÉ CONSISTE Y PARA QUÉ SIRVE:

Este proyecto de investigación tiene como objetivo la re-armonización de las cadenas cinéticas y la postura, basada en la atrofia muscular espinal y el estiramiento global intenta probar la eficacia de este método en temas deportivos sobre:
A) Armonización de las cadenas musculares estáticas y dinámicas mediante el estiramiento y restauración de la elasticidad;
B) Identificación y eliminación de las compensaciones posturales que dificultan la normalización de la eficacia estática y gestual;
El método basado en un trabajo activo que parte de Postura de Mézières, en una completa descompensación de estiramiento, conduce a resultados más exitosos que los obtenidos de las terapias físicas pasivas donde los sujetos han tenido un poco de éxito;
La investigación sirve para comprobar la eficacia de la terapia de Mézières en la prevención y tratamiento del dolor vertebral en los atletas de la Universidad de Murcia-UCAM.

## 2. COMO SE REALIZA:

Los atletas serán sometidos a tres meses de Método Mezieres dos veces por semana, con una sesión individual de máximo una hora. Durante la sesión se realizará una extensión estática activa y pasiva de las cadenas musculares, con una tensión muy prolongada en el tiempo, durante minutos consecutivos,

limitando el acortamiento de las otras áreas del cuerpo. Después de tres meses de tratamiento dos veces por semana, el método Mézières se reducirá a una vez por semana durante otros 3 meses. Para concluir la investigación del primer año, los tres últimos meses de terapia se organizarán en una sesión individual cada diez días.

**3. QUÉ EFECTOS LE PRODUCIRÁ:**

- Mejora de la estabilidad y fluidez;
- Iniciando una re-armonización de la morfología de la columna vertebral;
- Mejorar el estilo de vida con una respuesta socio-relacional y emocional positiva;
- Reducción de los episodios dolorosos.
- Conocimiento de los atletas a la autogestión de su problema;
- Reducción de la importancia de los factores de riesgo individuales;
- Establecer la preparación física tanto en las cadenas globales como en las miofasciales - "teniendo cuidado de quitar los frenos antes de intentar conseguir los movimientos"

**4. EN QUÉ LE BENEFICIARÁ:**

- Planificar medidas preventivas para un abordaje correcto del deporte que no preceda a los resultados de la búsqueda a cualquier costo para el bienestar psicológico del sujeto;
- Investigar condiciones de entrenamiento saludables aplicando una metodología apropiada para mejorar el rendimiento sin violar las leyes que subyacen a la postura, a una biomecánica equilibrada de las cadenas musculares y un desarrollo fisiológico igualmente equilibrado;
- La implementación de medidas preventivas para evitar lesiones así como la muscularización que a menudo no puede garantizar la resistencia y la eficiencia.

**5. QUÉ RIESGOS TIENE:** No tiene ningún riesgo

**5.1 LOS MÁS FRECUENTES: -**
**5.2 LOS MÁS GRAVES: -**

**5. SITUACIONES ESPECIALES QUE DEBEN SER TENIDAS EN CUENTA:**

No serán tratado personas con tumores espinales y hernias discales de segundo grado.

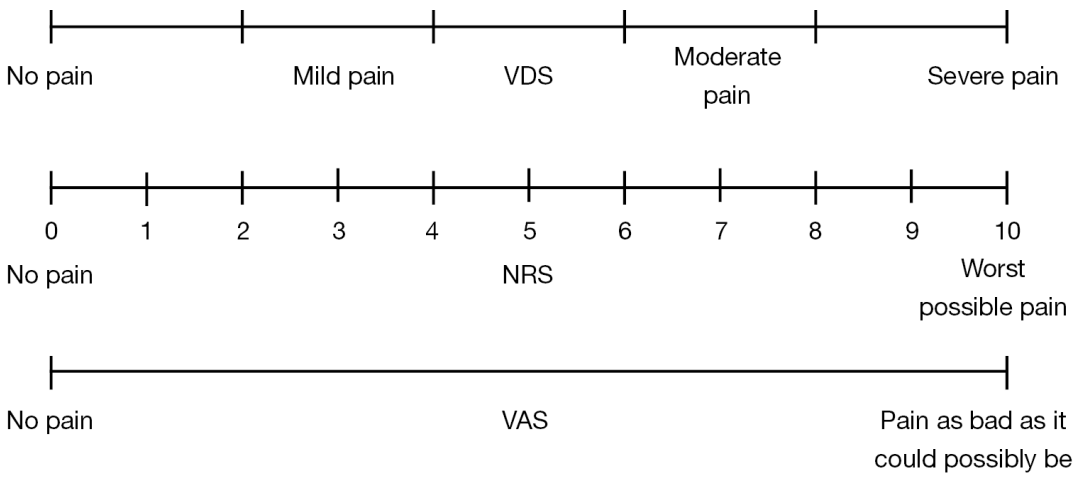
**7. OTRAS INFORMACIONES DE INTERÉS (a considerar por el/la profesional)**

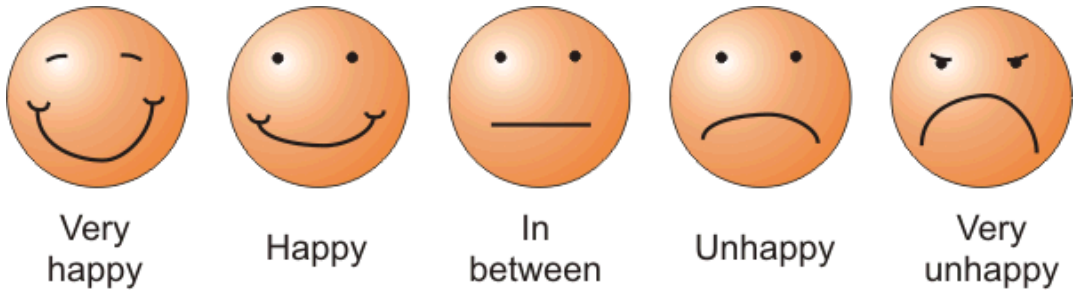
La novedad en este proyecto de investigación es evaluar la efectividad de la terapia de Mézières sobre problemas deportivos y de dolor vertebral, evitando terapias físicas y muchos otros métodos de rehabilitación.
A partir de las consideraciones técnicas y educativas expuestas en el plan de investigacion, este proyecto subraya la necesidad, en el área motora, deportiva y rehabilitadora, de la técnica de Mézières que tiene un enfoque más global, que da más ventajas a la extensión muscular y para salvar la normalización del aparato musculo-esqueleto a los efectos de una acción preventiva a los desequilibrios posturales en la práctica motora y deportiva.

**8. OTRAS CUESTIONES PARA LAS QUE LE PEDIMOS SU CONSENTIMIENTO**

Para utilizar los datos en análisis estadísticas de los resultados de investigación siempre para conservar el anonimato.

**ANNEX 4 :** VAS – Visual Analogue Scale




(Crichton, N. (2001). Visual analogue scale (VAS). J Clin Nurs, 10(5), 706-6.)

**ANNEX 5:** Sit and Reach – Flexibility Test

## FLEXIBILITY TEST – SIT AND REACH

### Purpose

This test is designed to test the flexibility of the lower back and hamstring muscles. This test can be modified for elders with the use of a chair and having them raise one leg and reach towards it.

### Procedure

1. This test is best completed after a substantial amount of warm up is completed in order to ensure the best results as well as being a safety precaution. When a warm up is involved it is critical that the same warm up is completed each time the test is conducted.
2. To begin this test, have the client sit on the floor with both feet straight out against a box for them to press their feet against.
3. Make sure their feet are bare, both knees are pressed down to the floor, and their palms are facing downward.
4. Have them reach as far as they can towards their toes, or if they are really flexible, over the box.
5. With a ruler, or some sort, record the length of which the client can reach measuring from their toes to their finger tips.
6. Make sure that both hands are even and one is not reaching further than the other.
7. The client is aloud some practice reaches before you record their final hold.
8. The client should not be making any jerky or quick movements while recording.

### Equipment

- A ruler
- A box

## Results

Measure the distance from their toes to their fingertips, and record. If their fingers are passed their toes, the results are positive, if the fingers are behind the toes, the results are negative. Use the chart below to gauge their ability.

The measurements are in cm.

| | Very Poor | Poor | Fair | Average | Good | Excellent | Super |
|---|---|---|---|---|---|---|---|
| Female | < -15 | -15 to -8 | -7 to 0 | +1 to +10 | +11 to +20 | +21 to +30 | > +30 |
| Male | < -20 | -20 to -9 | -8 to -1 | 0 to +5 | +6 to +16 | +17 to +27 | > +27 |

(Prepared by the Australian College of Sport & Fitness 2013)

**Original article**

Wells, K. F., & Dillon, E. K. (1952). The sit and reach—a test of back and leg flexibility. Research Quarterly. American Association for Health, Physical Education and Recreation, 23(1), 115-118.

**ANNEX 6**: Pedometer Performance –Runtastic Pro Application


Source: http://www.runtastic.com/en/apps/pedometer

**ANNEX 7**: Roland Morrison Questionnaire CRM

FUNDACION KOVACS

## ESCALA DE ROLAND-MORRIS



Cuando le duele la espalda, puede que le sea difícil hacer algunas de las cosas que habitualmente hace. Esta lista contiene algunas de las frases que la gente usa para explicar cómo se encuentra cuando le duele la espalda (o los riñones). Cuando las lea, puede que encuentre algunas que describan su estado de *hoy*. Cuando lea la lista, piense en cómo se encuentra usted *hoy*. Cuando lea usted una frase que describa como se siente hoy, póngale una señal. Si la frase no describe su estado de hoy, pase a la siguiente frase. Recuerde, tan solo señale la frase si está seguro de que describe cómo se encuentra usted hoy.

1.- □ Me quedo en casa la mayor parte del tiempo por mi dolor de espalda.
2.- □ Cambio de postura con frecuencia para intentar aliviar la espalda.
3.- □ Debido a mi espalda, camino más lentamente de lo normal.
4.- □ Debido a mi espalda, no puedo hacer ninguna de las faenas que habitualmente hago en casa.
5.- □ Por mi espalda, uso el pasamanos para subir escaleras.
6.- □ A causa de mi espalda, debo acostarme más a menudo para descansar.
7.- □ Debido a mi espalda, necesito agarrarme a algo para levantarme de los sillones o sofás.
8.- □ Por culpa de mi espalda, pido a los demás que me hagan las cosas.
9.- □ Me visto más lentamente de lo normal a causa de mi espalda.
10.- □ A causa de mi espalda, sólo me quedo de pie durante cortos períodos de tiempo.
11.- □ A causa de mi espalda, procuro evitar inclinarme o arrodillarme.
12.- □ Me cuesta levantarme de una silla por culpa de mi espalda.
13.- □ Me duele la espalda casi siempre.
14.- □ Me cuesta darme la vuelta en la cama por culpa de mi espalda.
15.- □ Debido a mi dolor de espalda, no tengo mucho apetito.
16.- □ Me cuesta ponerme los calcetines - o medias - por mi dolor de espalda.
17.- □ Debido a mi dolor de espalda, tan solo ando distancias cortas.
18.- □ Duermo peor debido a mi espalda.
19.- □ Por mi dolor de espalda, deben ayudarme a vestirme.
20.- □ Estoy casi todo el día sentado a causa de mi espalda.
21.- □ Evito hacer trabajos pesados en casa, por culpa de mi espalda.
22.- □ Por mi dolor de espalda, estoy más irritable y de peor humor de lo normal.
23.- □ A causa de mi espalda, subo las escaleras más lentamente de lo normal.
24.- □ Me quedo casi constantemente en la cama por mi espalda.

Original article : Kovacs, F. M., Llobera, J., del Real, M. T. G., Abraira, V., Gestoso, M., & Fernández, C. (2002). Validation of the Spanish version of the Roland-Morris questionnaire. Spine, 27(5), 538-542.

**ANNEX 8**: Health Status Questionaire (SF 12)

## CUESTIONARIO DE SALUD SF-12

**INSTRUCCIONES:** Las preguntas que siguen se refieren a lo que usted piensa sobre su salud. Sus respuestas permitirán saber como se encuentra usted y hasta qué punto es capaz de hacer sus actividades habituales.

Por favor, conteste cada pregunta marcando una casilla. Si no está seguro/a de cómo responder a una pregunta, por favor, conteste lo que le parezca más cierto.

**1.** En general, usted diría que su salud es:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |
| **Excelente** | **Muy buena** | **Buena** | **Regular** | **Mala** |

Las siguientes preguntas se refieren a actividades o cosas que usted podría hacer en un día normal. Su salud actual, ¿le limita para hacer esas actividades o cosas? Si es así, ¿cuánto?

| | 1<br>**Sí, me limita mucho** | 2<br>**Sí, me limita un poco** | 3<br>**No, no me limita nada** |
|---|---|---|---|
| **2.** **Esfuerzos moderados,** como mover una mesa, pasar la aspiradora, jugar a los bolos o caminar más de 1 hora | ☐ | ☐ | ☐ |
| **3.** Subir **varios** pisos por la escalera | ☐ | ☐ | ☐ |

Durante **las 4 últimas semanas,** ¿ha tenido alguno de los siguientes problemas en su trabajo o en sus actividades cotidianas, **a causa de su salud física?**

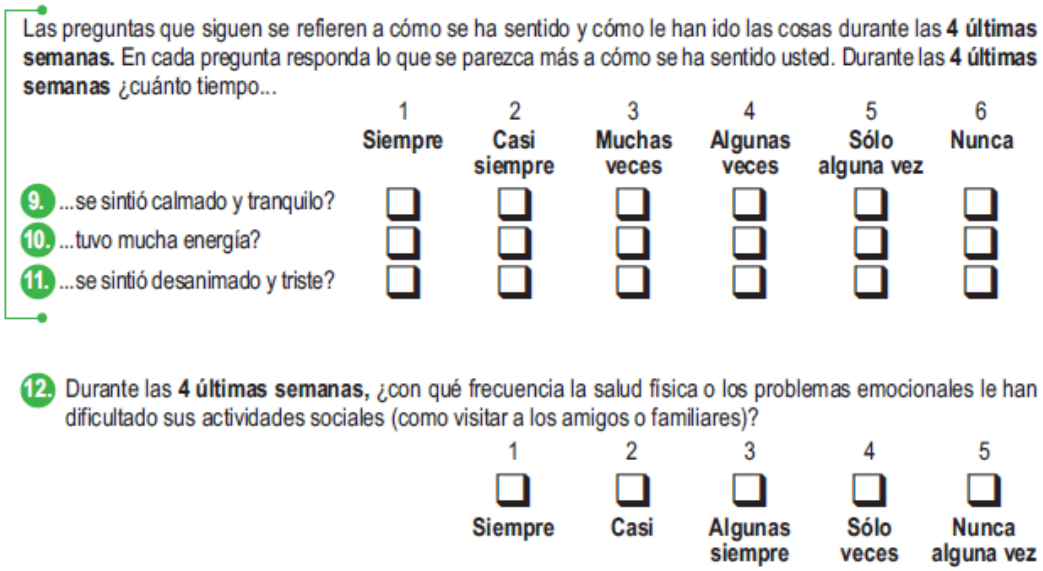
| | 1<br>**Sí** | 2<br>**No** |
|---|---|---|
| **4.** ¿**Hizo menos** de lo que hubiera querido hacer? | ☐ | ☐ |
| **5.** ¿Tuvo que **dejar de hacer algunas tareas** en su trabajo o en sus actividades cotidianas? | ☐ | ☐ |

Durante las **4 últimas semanas,** ¿ha tenido alguno de los siguientes problemas en su trabajo o en sus actividades cotidianas, **a causa de algún problema emocional** (como estar triste, deprimido, o nervioso)?

| | 1<br>**Sí** | 2<br>**No** |
|---|---|---|
| **6.** ¿**Hizo menos** de lo que hubiera querido hacer, **por algún problema emocional**? | ☐ | ☐ |
| **7.** ¿No hizo su trabajo o sus actividades cotidianas tan **cuidadosamente** como de costumbre, **por algún problema emocional**? | ☐ | ☐ |

**8.** Durante las **4 últimas semanas,** ¿hasta qué punto **el dolor** le ha dificultado su trabajo habitual (incluido el trabajo fuera de casa y las tareas domésticas)?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |
| **Nada** | **Un poco** | **Regular** | **Bastante** | **Mucho** |



Las preguntas que siguen se refieren a cómo se ha sentido y cómo le han ido las cosas durante las **4 últimas semanas.** En cada pregunta responda lo que se parezca más a cómo se ha sentido usted. Durante las **4 últimas semanas** ¿cuánto tiempo...

| | 1 Siempre | 2 Casi siempre | 3 Muchas veces | 4 Algunas veces | 5 Sólo alguna vez | 6 Nunca |
|---|---|---|---|---|---|---|
| 9. ...se sintió calmado y tranquilo? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. ...tuvo mucha energía? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. ...se sintió desanimado y triste? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

12. Durante las **4 últimas semanas,** ¿con qué frecuencia la salud física o los problemas emocionales le han dificultado sus actividades sociales (como visitar a los amigos o familiares)?

| 1 Siempre | 2 Casi | 3 Algunas siempre | 4 Sólo veces | 5 Nunca alguna vez |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

Original Article: Ware Jr, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Medical care, 220-233.