ESCOLA
SUPERIOR
DE SAÚDE
POLITÉCNICO
DO PORTO

P.PORTO

M

MESTRADO
Fisioterapia – Opção Terapia Manual Ortopédica

The immediate effect of mobilization with movement on dorsiflexion and performance variables in futsal athletes with chronic ankle instability: a randomized controlled trial

Júlio Alexandre Carvalho Portela

09/**2020**

ESCOLA SUPERIOR DE SAÚDE

The immediate effect of mobilization with movement on dorsiflexion and performance variables in futsal athletes with chronic ankle instability: a randomized controlled trial

Autor

Júlio Alexandre Carvalho Portela

Orientador(es)

Professor Doutor/António Mesquita Montes/ Escola Superior de Saúde do Politécnico do Porto

Professor Doutor/Paulo Carvalho/ Escola Superior de Saúde do Politécnico do Porto

Professor Doutor/Carlos Crasto/ Escola Superior de Saúde do Politécnico do Porto

Dissertação apresentada para cumprimento dos requisitos necessários à obtenção do grau de Mestre em **Fisioterapia** – Opção Terapia Manual Ortopédica pela Escola Superior de Saúde do Instituto Politécnico do Porto.

Agradecimentos

Aos participantes deste estudo agradecemos pela disponibilidade ao longo das recolhas.

À Fisioterapeuta Rita Duarte e à Fisioterapeuta Mariana Maia pela ajuda prestada ao longo do desenvolvimento desta Dissertação.

Abstract

Background: Chronic ankle instability (CAI) is an increasingly prevalent condition among futsal athletes. Mobilization with Movement (MWM) is a conservative rehabilitation strategy commonly used in this condition. Even so, the effects of two MWM dorsiflexion techniques on sports performance are not known. **Aim:** To analyze the immediate effect of two MWM techniques on the dorsiflexion range of motion and the performance variables in futsal athletes with CAI. Also, to analyze the impact of performing them in a different order. **Methods:** A randomized controlled study was carried out with a voluntary sample of 18 male futsal athletes with CAI, aged between 18 and 35 years old, randomly divided into two experimental groups [MWM1 (n = 7) and MWM2 (n = 5)] and a Placebo group (n = 6). The experimental groups, later merged into a single Intervention group, received two MWM techniques whose order of application was reversed between groups. Weight-bearing dorsiflexion range of motion (weight-bearing lunge test – WBLT), jump (side hop test – SHT) and sprint performance (sprint test) were assessed before and after the intervention protocol. The independent samples t test was used to compare groups (MWM1 vs MWM2 and Intervention vs Placebo Group), with significance set at 0.05. **Results:** After the intervention protocol, there were no significant differences between MWM1 and MWM2. When analyzing the difference variable [post-intervention (-) pre-intervention], there was a greater significant increase in WBLT (p=0.001) and a further decrease in the SHT (p=0.043) in Intervention group, when compared with Placebo group. There were no significant differences between groups in the sprint test. **Conclusion:** In the present study, there seems to be a positive effect of the two ankle dorsiflexion MWM techniques on the dorsiflexion range of motion, but inconclusive results have been found regarding sports performance in amateur futsal players with CAI. Nevertheless, the impact of performing the techniques in a different order seems to be not relevant.

Keywords: Ankle sprain; Mulligan Concept; Physical Therapy; Range of motion; Sports performance.

Resumo

Introdução: A instabilidade crónica do tornozelo (ICT) é uma condição cada vez mais prevalente entre atletas de futsal. A mobilização com movimento (MWM) é uma estratégia de reabilitação conservadora habitualmente utilizada nesta condição. Ainda assim, não são conhecidos os efeitos das duas técnicas de MWM para ganhos de dorsiflexão na performance desportiva. **Objetivo:** Analisar o efeito imediato de duas técnicas de MWM na amplitude de dorsiflexão e nas variáveis de performance em atletas de futsal com ICT. Além disso, analisar os efeitos da sua aplicação com uma ordem distinta **Métodos:** Foi realizado um estudo randomizado controlado com uma amostra voluntária de 18 atletas de futsal do sexo masculino com ICT, com idades entre 18 e 35 anos, divididos aleatoriamente em dois grupos experimentais [MWM1 (n=7) e MWM2 (n=5)] e um Placebo (n=6). Os grupos experimentais, posteriormente fundidos num só grupo de Intervenção, foram submetidos a duas técnicas de MWM cuja ordem de aplicação foi invertida entre grupos. Foram avaliados, antes e após a intervenção, a amplitude de dorsiflexão do tornozelo em carga (weight-bearing lunge test – WBLT), a performance do salto (side hop test - SHT) e do sprint (sprint test). O teste T para amostras independentes foi usado para a comparação entre grupos (MWM1 vs MWM2 e Intervenção vs Placebo), com um nível de significância de 0.05. **Resultados:** Após a intervenção, não se verificaram diferenças significativas entre MWM1 e MWM2. Na comparação entre os grupos de Intervenção e Placebo, através da análise da variável diferença [pós-intervenção (-) pré-intervenção], verificou-se no primeiro, um maior aumento significativo no WBLT (p=0.001) e uma maior diminuição no SHT (p=0.043) quando comparado com o Placebo. Não se verificaram diferenças significativas entre grupos no Sprint test. **Conclusão:** No presente estudo, parece haver um efeito positivo das duas técnicas de dorsiflexão de MWM na amplitude de dorsiflexão, mas resultados inconclusivos foram encontrados no que concerne à performance desportiva de jogadores amadores de futsal com ICT. No entanto, o impacto acerca da sua ordem de aplicação parece não ser relevante.

Palavras-chave: Entorse da tibiotársica; Conceito de Mulligan; Fisioterapia, Amplitude de movimento, Performance desportiva

Índice

1. Introduction

Futsal is one of the most popular sports worldwide and demands intermittent high-intensity actions, requiring considerable physical, technical and tactical efforts from the athletes (López-Segovia, Vivo Fernández, Herrero Carrasco, & Pareja Blanco, 2019; Yeemin, Dias, & Fonseca, 2016). These team sport characteristics associated to jumps, sprints, changes in directions, accelerations and decelerations that frequently occur during the game carry out a high risk of injury (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Castagna, D'Ottavio, Vera, & Álvarez, 2009). Also, the small pitch dimensions provides regular contact with opponents which can also lead to injuries (López-Segovia et al., 2019).

According to several authors the anatomical region most injured in futsal is the ankle joint (Angoorani, Haratian, Mazaherinezhad, & Younespour, 2014; López-Segovia et al., 2019; Manuel Serrano, Shahidian, da Cunha Voser, & Leite, 2013). Moreover, Manuel Serrano et al. (2013) verified that the ankle sprain accounted for 48.8% of all injuries recorded during one season in Portugal's professional and amateur leagues. The high prevalence of this condition in athletes, namely lateral ankle sprain, can result in significant loss of players' availability and associated expenses, so it is important to adapt effective rehabilitation strategies (Cruz et al., 2020). Despite functional treatment of an acute ankle sprain leads to full recovery in most of the cases, more than 40% of these patients feature residual symptoms (e.g.: pain, edema), subjective feelings of instability and/or recurrent sprains, which can lead to chronic ankle instability (CAI) (Delahunt, 2007; Delahunt et al., 2010; Hossain & Thomas, 2015). In fact, athletes with CAI may present functional performance deficits, that can lead to a decrease of physical activity and/or other musculoskeletal injuries (Ko, Rosen, & Brown, 2018).

Optimal sports performance relies on the finely tuned integration of the body's many systems to produce highly skilled dynamic movement. At a biomechanical level, athletes with CAI may present dorsiflexion range of motion (DFROM) limitations (Delahunt et al., 2010). This deficit may restrict movement pathways, potentially causing proximal compensation and, in turn, excessive stress to active and passive tissues of the athletes (Howe, 2015). Besides that, these athletes may be prevented from training and competing at a high level due to mechanoreceptors injury of the muscular and ligament structures of the ankle, changing the proprioceptive input of the joint (Delahunt et al., 2010). Regardless the mechanical changes that may be present, currently the proprioceptive changes seem to be more relevant (Bialosky, Bishop, Price, Robinson, & George, 2008; Hegedus, Goode, Butler, & Slaven, 2011; Schmid, Brunner, Wright, & Bachmann, 2008). These proprioceptive deficits, in turn, modify athletes' postural control, conditioning their sports performance, particularly regarding dynamic balance and jumps in single leg stance (Han, Anson, Waddington, Adams, & Liu, 2015). Considering the above, increasing our understanding of the role of the rehabilitation of CAI may help to reduce injury incidence in futsal players and improve their performance.

Among existing conservative interventions, several ankle joint mobilization procedures have been developed and described by renowned manual therapists, including Mulligan's Mobilization with movement (MWM) (Weerasekara, Osmotherly, Snodgrass, Tessier, & Rivett, 2019). MWM is defined as the application of a sustained passive accessory movement to a joint while the patient actively performs a movement/ task that was previously painful or limited (Vicenzino, Hing, Hall, & Rivett, 2011). A recent systematic review, which included studies focusing on MWM in chronic ankle sprains, identified positive effects of MWM in weight-bearing DFROM in the short-term. However, the results were inconclusive for immediate effect on the dynamic balance. Even though, it is plausible that immediate improvements in dynamic balance following joint mobilization may increase the individual's confidence and assist him to more safely proceed to the next level of functional exercise in the rehabilitation process (Weerasekara et al., 2018). Despite futsal's popularity, limited research has been undertaken (Naser, Ali, & Macadam, 2017) and, to our knowledge, sports performance has never been studied despite its importance to athletes (Hennig, 2011; Weerasekara et al., 2018).

Even though Mulligan described two ankle dorsiflexion MWM techniques (glide applied on talus and glide applied at the distal tibiofibular joint) in order to contribute to optimal arthrokinematics of the ankle joint complex, the majority of the studies focusing on CAI choose to only apply MWM on the talocrural joint (Delahunt, Cusack, Wilson, & Doherty, 2013). As far as we are aware, there is no literature that studied the effect of applying the two MWM techniques simultaneously. Nevertheless, the clinical relevance of the order of application of the techniques is unknown.

Taking this into account, we aim to investigate the immediate effect of two MWM techniques (glide applied on talus and glide applied on the distal tibiofibular joint) on DFROM and the performance variables in futsal athletes with CAI, and the impact of performing them in a different order. Our hypothesis is that this intervention will have a positive effect on DFROM and sports performance. However, considering the lack of investigation as to the effect of the order of application of these MWM techniques on the mentioned variables, it is not possible for us to state an investigation hypothesis.

2. Methods

2.1. Design

The research methodology was quantitative, with a randomized controlled trial study design. Consenting participants were randomly allocated into three groups: two experimental groups – MWM1 and MWM2, and a Placebo group. Afterwards, both experimental groups were merged into an Intervention group. MWM1 and MWM2 groups received two ankle dorsiflexion MWM techniques, in partial weight bearing. In both groups' glides were applied at fibula and talus. The glide application order distinguished the groups.

The Placebo group performed the same number of sets and repetitions of lean/lunge forward into dorsiflexion, without any glide applied. The participants were blinded as to whether they were receiving the MWM's techniques or the placebo intervention.

2.2. Participants

The target population were male senior futsal athletes aged between 18 and 35 from Portugal's amateur futsal teams. All volunteered athletes (convenience non-probabilistic sampling process) were selected according to the criteria for CAI, adapted from the International Ankle Consortium (Table 1) (Gribble et al., 2013).

Table 1 – Inclusion and exclusion criteria (adapted from Gribble et al., [2013]).

Inclusion criteria	Exclusion criteria
• A history of at least one significative ankle sprain: - Initial sprain must have occurred at least 12 months prior to study enrolment; - Was associated with inflammatory symptoms; - Created at least one interrupted day of desired physical activity; - The most recent injury must have occurred more than 3 months prior to study enrolment. • A history of the previously injured ankle joint "giving way" and/or recurrent sprain and/or "feelings of instability": - Participants should report at least two episodes of "giving way" in the 12 months prior to study	• A history of previous surgeries to the musculoskeletal structures (i.e., bones, joint structures, nerves) in either lower extremity. • A history of bilateral ankle sprain. • A history of a fracture in either lower extremity requiring realignment. • Acute injury to musculoskeletal structures of other joints of the lower extremity in the previous 3 months that impacted joint integrity and function (i.e., sprains, fractures), resulting in at least one interrupted day of desired physical activity. • Have conditions for which manual therapy is generally contraindicated (such as the

enrolment, to account for the seasonal nature of futsal; – Recurrent sprain was defined as two or more sprains to the same ankle. • Self-reported ankle instability should be confirmed with the Ankle Instability Instrument: answer "yes" to at least 5 yes/no questions.	presence of a tumour, fracture, rheumatoid arthritis, osteoporosis, prolonged history of steroid use, or severe vascular disease). • Receiving concurrent physiotherapy treatment in the last 3 months. • Inability to read Portuguese.

2.3. Instruments

2.3.1. Sample selection and characterization

The questionnaire (Appendix I – Eligibility Questionnaire) ensured the eligibility of the participants, guaranteed that the inclusion and exclusion criteria were respected, and also characterized the sample (i.e., age).

The Ankle Instability Instrument (AII) (Appendix II – Ankle Instability Instrument, Portuguese version), developed by Docherty, Gansneder, Arnold, & Hurwitz (2006), also helped to guarantee the criteria defined. This is a self-reported assessment tool for functional ankle instability and includes twelve items (Gribble et al., 2013). This tool was adapted to Portuguese population by Silva et al., (2018), suggesting good internal consistency with a Kuder–Richardson coefficient of 0.79 (95% CI = 0.71-0.85).

2.3.2. Weight Bearing Lunge Test

The dorsiflexion range of motion (DFROM) of the ankle joint was measured by the Weight-Bearing Lunge Test (WBLT). This instrument is probably the most widely used measurement method to assess DFROM (Cejudo, Sainz de Baranda, Ayala, & Santonja, 2014). A millimetre measuring tape 150 cm long, with a longitudinal line drawn in the middle, was placed on the ground perpendicular to a wall. In this wall, a similar measuring tape was placed as a continuation of the ground line (adapted from Langarika-Rocafort, Emparanza, Aramendi, Castellano, & Calleja-González (2017)), as demonstrated in Figure 1. In the present study, this instrument has demonstrated excellent test-retest reliability (intraclass correlation coefficient – ICC = 0.984).

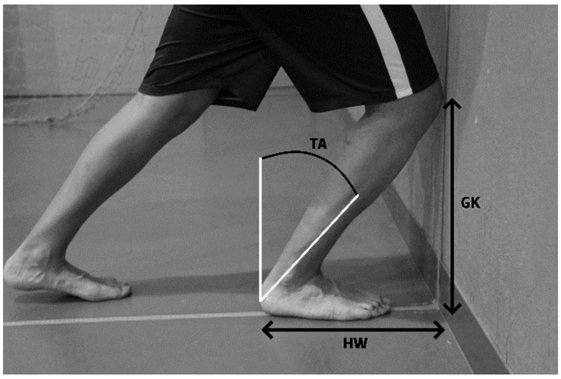

Figure 1 - Weight bearing lunge test (adapted from Langarika-Rocafort et al. [2017])

2.3.3. Side Hop test

The Side Hop test involves jumps with changes of direction and has been proved to be highly demanding to detect functional-performance deficits (Caffrey, Docherty, Schrader, & Klossner, 2009; Docherty, Arnold, Gansneder, Hurwitz, & Gieck, 2005). This test combines multiple components, such as muscular strength, neuromuscular coordination and joint stability (Docherty et al., 2005). Participants were instructed to hop laterally a distance of 30 cm (marked on the floor with tape) and back for a total of 10 repetitions with the ipsilesional limb (Figure 2) (Docherty et al., 2005). In the present study, this instrument has demonstrated good test-retest reliability (ICC = 0.850).

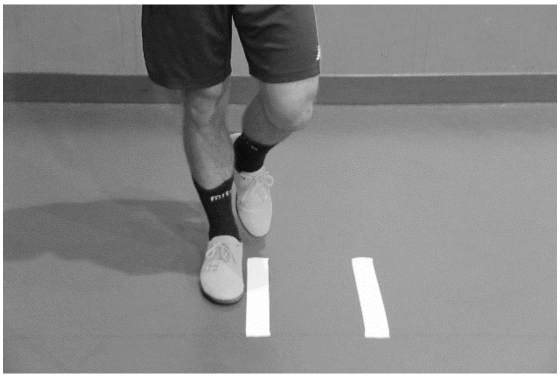

Figure 2 – Side Hop test

2.3.4. Sprint test

The ability to sprint repeatedly and change direction while sprinting is a determinant of sports performance, such as futsal (Sheppard & Young, 2006). Sprint test was designed to cover the technical demands of futsal game during a zigzag sprint, around eight cones, without a ball, through a course of 15 meters. The eight cones were positioned on two parallel lines, 230 cm from one another, the first was positioned at the beginning of the right line, and three others were positioned on the same line, 430 cm apart. The same placement was used on the left line with the remaining cones, wherein the first one was placed 215 cm from the beginning of the line (Ré, Cattuzzo, Henrique, & Stodden, 2016; Ré, Corrêa, & Böhme, 2010) (Figure 3). In the present study, this instrument has demonstrated excellent test-retest reliability (ICC = 0.956).

2.3.5. Procedures

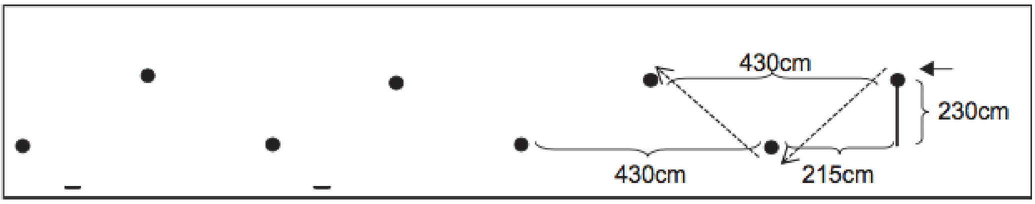

Figure 3 - Sprint test (adapted from [Ré et al., 2016])

2.3.5.1 Pilot Study

The pilot study was conducted to standardize and verify the possible need of adjustments in the selection and characterization questionnaire, as well as data collection procedures. A test-retest reliability study was also performed for the WBLT, Sprint and Side Hop tests. The measurements were made with 11 participants with the same characteristics of the final sample with CAI (n=11 participants), as described above. No adjustments were required.

2.3.5.2 Data Collection

The recruitment of the sample was conducted by telephonic invitation to 23 clubs of the "Associação de Futebol do Porto" to determine if they would be willing to participate. The teams that accepted the invitation were visited by the researchers. An eligibility and characterization questionnaire was distributed individually to the participants. Thereafter, the volunteers, who according to the questionnaire met the inclusion criteria, answered the AII to define final sample. Finally, an appointment for data collection was schedule.

The following procedures, measurements and interventions described below were performed on the participating teams' sports hall. To avoid inter-rater error and ensure that the participants conditions were similar, the same researcher performed the same tasks during the whole study. The researchers registered the test results before and after the interventions on separate sheets, so that they did not know the scores obtained before. At the beginning of each testing session, several anatomical reference points were marked with a non-permanent pen. Also, each participant watched an exemplifying video of the WBLT.

Anthropometric and body composition measures were assessed in all participants. Height (m) and body mass (kg) were measured respectively using a seca 222 stadiometer with a precision of 1.0 mm and a seca 760 scale with a precision of 1.0 kg (seca – Medical Scales and Measuring Systems, Hamburg, Germany).

Before and after the intervention protocol, the participants performed the WBLT, Side Hop and Sprint tests (in this order for all participants).

Before the WBLT, the most distal point of the heel and the anterosuperior edge of the patella of all participants were marked with a non-permanent pen (participants in supine position). Therefore, participants, barefoot, positioned their test foot, so that the centre of their heel and first toe were aligned on the centre line of the ground line. Then, they were instructed to lunge towards the wall, flexing the knee, ankle and hip, of the tested leg, to touch with the anterosuperior edge of the patella on the wall and keep their heel in contact with the floor. The aim was to find the maximum distance from the wall to the tested foot, by touching the wall with the knee without raising the heel in test (Figure 1). During the test, participants were allowed to put the non-tested leg in a comfortable position and place their hands on the wall to maintain their balance There were no restrictions on the number of attempts, but on each attempt the participants had to remove their knee from the wall (Langarika-Rocafort et al., 2017). After maximal DFROM was found, the following measurements were taken (Figure 1): a) Heel-wall distance (HW): the distance between the wall and the most distal point of the heel; b) Ground-Knee distance (GK): the distance between the ground and the anterosuperior edge of the patella.

The trigonometric angle (TA) was calculated using a simple trigonometric function (Langarika-Rocafort et al., 2017; Pope, Herbert, & Kirwan, 1998):

$$TA = 90 - \tan^{-1}\frac{GK}{HW}$$

A higher TA value represented a higher DFROM.

In the Side Hop test assessment participants were instructed to perform 10 consecutive medio-lateral jumps at maximum speed with the ipsilesional limb, with their training shoes. Before taking the participants in the test, a researcher demonstrated the execution of it and participants had the opportunity to experience the task to reduce the learning effect. Each test was considered valid when a minimum distance of 30 cm in the medio-lateral direction was achieved in each jump, otherwise participants repeated the trial after 2 minutes of rest period. For each test, the total time was recorded with a hand-held stopwatch to the nearest 0.01 second (Caffrey et al., 2009; Docherty et al., 2005; D. C. F. Silva et al., 2019). Less time needed to perform the task was associated with a higher performance.

For the Sprint test participants were instructed to complete the course 2 times, with their training shoes, as demonstrated by one researcher. First in a comfortable speed to recognize the course and then in full speed sprint. The time was recorded with a hand-held stopwatch to the nearest 0.01 second at the end of the course, when the participant crossed the last cone (Ré et al., 2016). Less time needed to perform the task was associated with a higher performance.

2.3.6. Intervention Protocol

Participants were divided into two experimental groups – MWM1 and MWM2, and a Placebo group. Afterwards, both experimental groups were merged into an Intervention group. MWM1 and MWM2 groups received, two ankle dorsiflexion MWM techniques, with glides applied at fibula and talus. The difference between interventions groups, was the order of application of the glides.

The MWM technique with the glide applied on talus was performed with participants in partial weight-bearing, half kneeling, barefoot, on a treatment table. Treatment belt was looped around the participant's distal lower leg, at a right angle to the lower leg, and around the researcher's hips. Researcher fixated the talus with the web-space of both hands to prevent movement of the talus anteriorly. Afterwards, an anterior glide was applied on the tibia by the treatment belt while the participant lunged forward over his foot into dorsiflexion, as described by, Hing, Hall, Rivett, Vicenzino, & Mulligan (2015) (Figure 5). Three sets of 10 repetitions were administrated (Hing et al., 2015) Participants were also instructed that if they felt pain at any moment, performing the technique, they should notify the researcher immediately.

The MWM technique with the glide applied at the distal tibiofibular joint was performed in the same position as described in the talus technique. The researcher fixated the tibia with one hand posteriorly and cupped the distal end of the fibula (lateral malleolus) with thenar eminence. After, applied a posterior and cephalad glide while the participant lunged forward over his foot into dorsiflexion, as described by, Hing, Hall, Rivett, Vicenzino, & Mulligan (2015) (Figure 4). Once more, three sets of 10 repetitions were administrated and the participant advised to report any kind of pain to the researcher immediately.

The Placebo group participants performed the same number of sets and repetitions of lean/lunge forward into dorsiflexion, without any glide application, in the same position.

Figure 5 – Weight-bearing mobilization with movement treatment. The belt applies a posteroanterior force to the distal tibia, while the talus and foot remain stationary.

Figure 4 - Weight-bearing mobilization with movement treatment. Therapist fixates the tibia with one hand posteriorly and glides the fibula in a posterolateral direction.

2.4. Statistical analysis

IBM's Statistical Package for the Social Science® software version 26.0 (IBM Corporation, Armonk NY, United States of America) was used for descriptive and inferential data analysis, with significance set at 0.05. The Shapiro-Wilk test was used to test the normality of the data. Mean (±standard deviation) was used to describe the distribution of quantitative variables. Independent samples t test was used to compare the quantitative data between groups, to verify the immediate effect of two MWM techniques (MWM1 vs. MWM2), and the impact of performing them in a different order (Placebo vs. Intervention group) in all variables (Marôco, 2018).

2.5. Ethics approval and consent to participate

The Health School of the Porto Polytechnic's Research Ethics Committee previously approved the present study (registration nº E0027 in 31/10/2019). All participants provided their written informed consent (Appendix III – Informed Consent) in compliance with the Declaration of Helsinki, and their anonymity and the confidentiality of their data were guaranteed. After the study, all the participants had the opportunity to receive the experimental protocol.

3. Results

3.1. Sample characterization

The final sample was randomly divided into two intervention groups (MWM1 and MWM2) and a Placebo group (Figure 6). MWM1 group was composed by 7 participants (23.14±6.20 years of age) and MWM2 group with 5 participants (23.20±3.83 years of age). These groups were later merged into an Intervention group with 12 participants (23.17±5.13 years of age). For the placebo group, 6 participants (25.00±5.25 years of age) were also able to participate. Age and anthropometric data were similar between MWM1 and MWM2 groups and between Intervention and Placebo groups (Table 2).

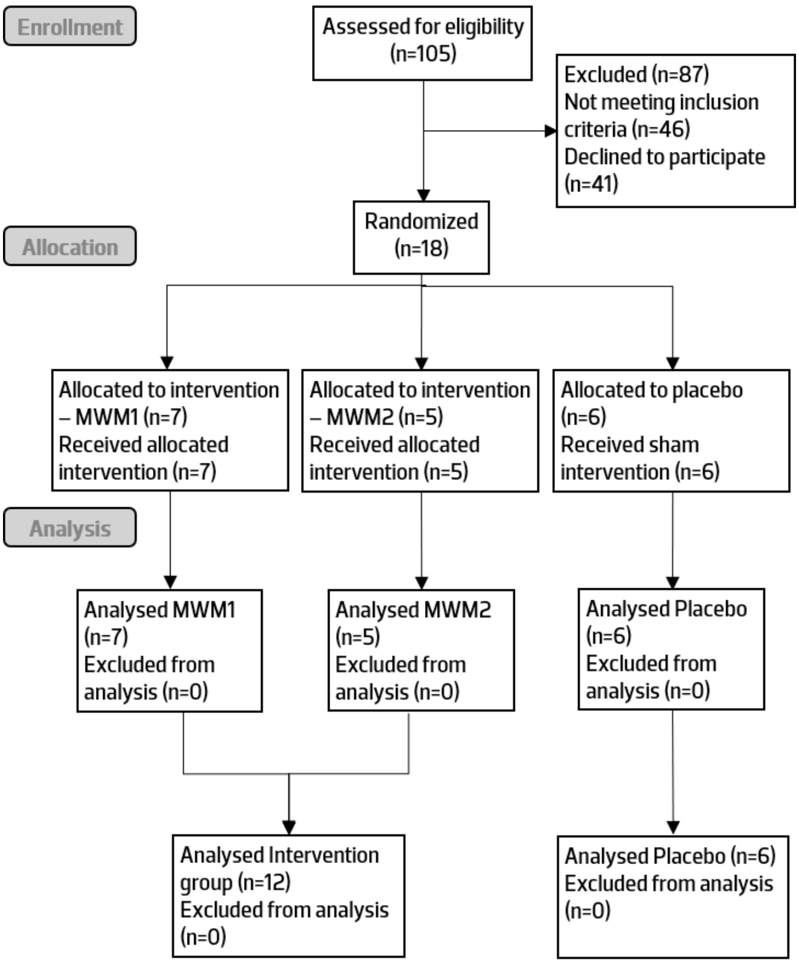

Figure 6 – Sample flow diagram, from amateur futsal players of "Associação de Futebol do Porto".

Table 2 – Sample characterization: sociodemographic and anthropometric data. Data are presented as mean (±standard deviation). p values reflect the between-groups comparison.

Variable		**Age (years)**	**Body mass (kg)**	**Height (m)**	**BMI (kg/m²)**
Intervention group (n=12)		23.17±5.13	77.88±10.88	1.72±0.07	26.24±3.01
MWM1 group (n=7)		23.14±6.20	78.03±10.67	1.72±0.09	26.50±2.90
MWM2 group (n=5)		23.20±3.83	77.68±12.43	1.73±0.03	25.87±3.46
Placebo group (n=6)		25.00±5.25	80.15±13.41	1.75±0.05	26.20±3.14
Between-groups comparison (*p* value)	**MWM1 vs. MWM2**	0.986	0.959	0.747	0.738
	Placebo vs. Intervention	0.488	0.704	0.488	0.980

MWM: mobilization with movement; BMI: body mass index.

3.2. MWM1 group vs. MWM2 group

At the pre- and post-intervention assessment, and in the difference variable [post-intervention (–) pre-intervention], the DFROM (°), the Side Hop test (s) and the Sprint test (s) were similar between MWM1 and MWM2 groups (Table 3).

Table 3 – Ankle dorsiflexion range of motion (expressed as °) and performance of the Side Hop and Sprint tests (expressed as s), at the pre- and post-intervention assessment, in MWM1 and MWM2 groups. Data are presented as mean (± standard deviation). p values reflect the comparison between groups at the pre- and post-intervention assessment, as well as in the difference variable [post-intervention (–) pre-intervention].

Group	Pre-intervention	Post-intervention	Post-intervention (–) pre-intervention	Between-groups comparison		
				Pre-intervention (*p* value)	Post-intervention (*p* value)	Post-intervention (–) pre-intervention (*p* value)
DFROM						
MWM1 (n=7)	40.38±6.34	41.49±6.17	1.11±0.61	0.729	0.947	0.204
MWM2 (n=5)	39.34±1.32	41.30±1.82	1.96±1.21			
Side hop test (s)						
MWM1 (n=7)	10.64±1.08	9.09±1.03	-1.55±0.99	0.619	0.966	0.411
MWM2 (n=5)	10.13±2.33	9.06±1.75	-1.07±0.86			
Sprint test (s)						
MWM1 (n=7)	8.31±0.54	8.05±0.55	-0.27±0.27	0.295	0.441	0.518
MWM2 (n=5)	8.74±0.79	8.31±0.57	-0.42±0.55			

DFROM: dorsiflexion range of motion; MWM: mobilization with movement.

3.3. Intervention group vs. Placebo group

At the pre- and post-intervention assessment, there were not significant differences between Intervention and Placebo groups. However, when analysing the difference variable [post-intervention (–) pre-intervention], a significant difference between groups was observed on the DFROM (p=0.001) and the Side hop test (p=0.043). In opposite to Placebo group, DFROM increased in Intervention group. Side hop test decreased further in Intervention group, when compared with Placebo group (Table 4).

Table 4 – Ankle dorsiflexion range of motion (expressed as °) and performance of the Side Hop and Sprint tests (expressed as s), at the pre- and post-intervention assessment, in Intervention and Placebo groups. Data are presented as mean (± standard deviation). p values reflect the comparison between groups at the pre- and post-intervention assessment, as well as in the difference variable [post-intervention (–) pre-intervention].

Group	Pre-intervention	Post-intervention	Post-intervention (–) pre-intervention	Between-groups comparison		
				Pre-intervention (*p* value)	Post-intervention (*p* value)	Post-intervention (–) pre-intervention (*p* value)
DFROM						
Intervention (n=12)	39.95±4.78	41.41±4.69	1.46±0.96	0.914	0.465	0.001
Placebo (n=6)	40.21±4.56	39.61±5.06	-0.60±0.94			
Side hop test (s)						
Intervention (n=12)	10.43±1.64	9.08±1.30	-1.35±0.93	0.235	0.778	0.043
Placebo (n=6)	9.26±2.35	8.84±2.26	-0.42±0.62			
Sprint test (s)						
Intervention (n=12)	8.49±0.66	8.16±0.55	-0.33±0.39	0.577	0.422	0.083
Placebo (n=6)	8.25±1.13	8.39±0.56	0.14±0.69			

DFROM: dorsiflexion range of motion; MWM: mobilization with movement.

4. Discussion

Results revealed that there is no effect of the order of application of two ankle dorsiflexion MWM techniques (glide applied on talus and glide applied at the distal tibiofibular joint) in amateur futsal athletes with CAI. To our knowledge, there are no studies focusing on the effects of the order in which both techniques are applied. Therefore, we hypothesized that, to improve DFROM and sports performance, the important thing is to mobilize the ankle joint and not so much the order of application of the techniques. In fact, Cruz-Díaz, Lomas Vega, Osuna-Pérez, Hita-Contreras, & Martínez-Amat (2015) defend that MWM can be a good approach within joint mobilization, since it has the particularity of requiring the participant to perform an active movement while the therapist mobilizes the joint, unlike other forms of passive mobilization.

Once there were no significant differences between MWM1 and MWM2 groups, it was decided to merge them into a single Intervention group in order to answer the secondary aim of the present study, which was to analyse the effects of application of these two ankle dorsiflexion MWM techniques on DFROM and sports performance of amateur futsal athletes. Therefore, a significant improvement was found on the DFROM and the Side Hop test in the Intervention group. In turn, there were no significant differences between groups on the Sprint test.

Regarding DFROM, the findings of this investigation suggest that the application of two ankle dorsiflexion MWM techniques improves DFROM in amateur futsal athletes with CAI. According to Kumari, Nijhawan, & Paresh (2014) and Weerasekara et al. (2020) both techniques, alone, have physiological effects in increasing DFROM. One possible explanation for these results can be based on latest evidence which suggests neurophysiologically and biomechanically mediated mechanisms to explain how these joint mobilization procedures may work. Evidence suggests that MWM techniques can produce local effects (on local neuron receptors) but also influence sympathetic nervous system function and the proposed biomechanical mechanism relates to a reduction of an entrapped, meniscoid or synovial, fringe by a specifically directed MWM glide (McCarthy, Bialosky, & Rivett, 2015; Paungmali, O'Leary, Souvlis, & Vicenzino, 2003; Vicenzino, Hing, Hall, & Rivett, 2011). Furthermore, it is hypothesized that joint mobilization effectively promotes the activity of mechanoreceptors due to the stretching performed in the capsule and ligaments of the ankle, which increase their sensory output, as gamma motor neurons activate with this tissue traction (Hiller, Refshauge, Bundy, Herbert, & Kilbreath, 2006; Mattacola & Dwyer, 2002). In fact, Cruz-Díaz et al. (2015) suggest that a possible restoration of joint arthrokinematics after joint mobilization can explain the DFROM gains and the subsequent improvement in other variables affected in those with CAI, such as dynamic postural control, proprioception, and the self-reported feeling of "giving way".

The results previously described, are in agreement with those found by Marrón-Gómez, Rodríguez-Fernández, & Martín-Urrialde (2015) and Cruz-Díaz et al. (2015) in individuals with CAI. Regarding the first-mentioned authors, they observed an average increase of 1.7 cm (distance between the second toe and the wall to estimate an indirect measure of DFROM), in the WBLT immediately after applying one of the MWM techniques (glide applied on the talus) used in the present study (Marrón-Gómez et al., 2015). Equally considerable gains in DFROM were seen in the study of Cruz-Díaz et al. (2015), after 10 repetitions of MWM technique with glide applied on the talus. Surprisingly, in these two studies, considerably fewer sets and repetitions were applied (one set of 10 repetitions and two sets of 10 repetitions) compared to the six sets of 20 repetitions used in the present study. Taking this into account, we can hypothesize that a greater number of repetitions does not necessarily mean greater gains in DFROM in individuals with CAI, and it could be explored in future investigations.

Notwithstanding the aforementioned, our findings should be analysed with caution as they differ in magnitude from those found by Marrón-Gómez, Rodríguez-Fernández, & Martín-Urrialde (2015) and Cruz-Díaz et al. (2015). The inclusion criteria used by these authors were not in accordance with those proposed by the International Ankle Consortium and this may help to justify the results obtained. Also, the type of sport practiced by our population (futsal) differs from the studies previously mentioned. In fact, Jorge et al. (2019) found in their study that amateur futsal players (average age of 18.5 years) showed degradation values of collagen type II significantly higher than the control group and other sports studied (volleyball, swimming, handball and field soccer). This must be considered since the affected target tissue of the ankle joint (tendons, ligaments and connective tissues) after ankle sprains is comprised approximately 70% collagen and joint degradation can negatively influence the results of therapeutic interventions (Dressler et al., 2018; Kjær et al., 2009).

Knowing that performance is one of the biggest concerns of athletes, we decided to evaluate sports performance (Hennig, 2011). Again, to our knowledge this is the first study to evaluate the acute effects of MWM on sports performance. Thus, and in order to make the evaluation more specific and directed to the characteristics of our sample, it was decided to introduce two tests that could, in some way, evaluate the performance of the participants in actions like jump (Side Hop test) and sprint with changes of direction (Sprint test). A recent systematic review points the Side Hop test as one of the most effective tools to identify patients with CAI as it challenges an individual directly in the frontal plane. In fact, the medial-lateral stress placed on the ankle joint is more effective to disrupt those with CAI compared with sagittal plane tasks (Rosen, Needle, & Ko, 2017). In addition, in the past decades' researchers have described dynamic postural control deficits in those with CAI, which may be due, to somatosensory impairments, motor impairments or both (Hertel & Corbett, 2019). The Sprint test replicates several features of the futsal game that occur frequently such as sprints, changes of directions, accelerations and decelerations (López-Segovia, Vivo Fernández, Herrero Carrasco, & Pareja Blanco, 2019). These features, can be the cause of numerous injuries that occur in this sport due to the stress applied to the ankle joint (Manuel Serrano, Shahidian, da Cunha Voser, & Leite, 2013). Our results suggest that MWM techniques improve positively the Side Hop ability in amateur futsal athletes with CAI, but the same does not occur in the Sprint test, as expected. Evidence highlights the importance of restoring DFROM after ankle injuries and their frequent sequelae, for normal activities of daily living as well as sports activities (Abassi, Bleakley, & Whiteley, 2019). However, in the present study, the improvements in DFROM might be questionable from the point of view of the clinical relevance as suggested by Reid et al. (2007). This small improvement did not invalidate a positive effect of MWM on the Side Hop test, which seems to indicate that sports performance was, once again, influenced by the neurophysiological effects of the techniques. As mentioned above, the joint mobilization through MWM techniques promotes an improvement in sensorimotor systems and it is plausible to think that these improvements could extend to the Side Hop test.

Lastly, no positive effects were found in our study regarding the Sprint test. These findings were not expected, but they might be explained by the complexity of the Sprint test, when compared to the Side Hop test. It is known that DFROM plays a crucial role in running as 20-30 degrees are required for this activity (Dugan & Bhat, 2005; Howe, 2015). By itself, the increase of DFROM could lead to a trend towards better sprint performance, as observed in the present study. However, proper running biomechanics involves synchronous movements of all components of the kinetic chain and joints like the spine, pelvis, hip and knee also need to present suitable range of motion (Dugan & Bhat, 2005; Fox, 2018). Beyond joints' range of motion, muscle function also plays a key role in sprinting. If we focus on ankle joint, there is evidence that greater ankle plantarflexion moments have been associated with improved performance during side-step cuts. Also, concentric ankle power is an important performance indicator in sprinting and finally, power and force generation by the ankle muscles is likely of great importance during the final stages of change-of-direction maneuvers (Debaere, Delecluse, Aerenhouts, Hagman, & Jonkers, 2013; Fox, 2018; Havens & Sigward, 2015; Marshall et al., 2014). Despite the sensorimotor gains of MWM, the requirements of the Sprint test and the limited gains of DFROM may explain why it was not possible to verify a positive effect on this performance test. Taking all results into account, it remains to be studied whether greater gains from DFROM (presumably achieved after more MWM sessions) would increase sports performance, or whether an intervention based exclusively on MWM for individuals with CAI is not capable of producing such effects. Summing up, it can still be explored if the neurophysiological effects of MWM and the better "perception of movement", may be enough to increase sports performance in athletes with CAI.

4.1. Methodological considerations

Despite all the studies mentioned above used the WBLT, the methods of measurement of DFROM during the test were very different. With this in mind, Langarika-Rocafort, Emparanza, Aramendi, Castellano, & Calleja-González (2017) state that the trigonometric function is the most repeatable and precise method to assess dorsiflexion angle in WBLT and for that reason, it was used in our study.

4.2. Limitations of the present study

The small sample size may compromise the external validity of our results. Although we consider the Cumberland Ankle Instability Tool (recommended by the International Ankle Consortium) to be more relevant to our study population compared to the AII questionnaire, it was not used because it was not validated for the Portuguese population.

4.3. Future investigations

In relation to the MWM, different intervention volumes are often used among studies and it might be important to analyze its influence in individuals with CAI. Moreover, future studies combining MWM with other interventions are recommend to explore how to enhance the sports performance of those with CAI. Finally, we propose that future studies investigate if there is any difference between the application of MWM's glide applied on talus and at the distal tibiofibular joint for individuals with CAI.

5. Conclusion

In the present study, there seems to be a positive effect of two ankle dorsiflexion MWM techniques on the dorsiflexion range of motion in amateur futsal male athletes with CAI. From our perspective, the influence on sports performance is inconclusive and additional studies are strongly recommended with other tests to assess sports performance. Nevertheless, the impact of performing the techniques in a different order seems to be not relevant.

6. Bibliography

Abassi, M., Bleakley, C., & Whiteley, R. (2019). Athletes at late stage rehabilitation have persisting deficits in plantar- and dorsiflexion, and inversion (but not eversion) after ankle sprain. *Physical Therapy in Sport*, *38*, 30–35. https://doi.org/10.1016/j.ptsp.2019.04.015

Beattie, P., Isaacson, K., Riddle, D. L., & Rothstein, J. M. (1990). Validity of derived measurements of leg-length differences obtained by use of a tape measure. *Physical Therapy*, *70*(3), 150–157. https://doi.org/10.1093/ptj/70.3.150

Caffrey, E., Docherty, C. L., Schrader, J., & Klossner, J. (2009). The ability of 4 single-limb hopping tests to detect functional performance deficits in individuals with functional ankle instability. *Journal of Orthopaedic and Sports Physical Therapy*, *39*(11), 799–806. https://doi.org/10.2519/jospt.2009.3042

Cejudo, A., Sainz de Baranda, P., Ayala, F., & Santonja, F. (2014). A simplified version of the weight-bearing ankle lunge test: Description and test-retest reliability. *Manual Therapy*, *19*(4), 355–359. https://doi.org/10.1016/j.math.2014.03.008

Cruz-Díaz, D., Lomas Vega, R., Osuna-Pérez, M. C., Hita-Contreras, F., & Martínez-Amat, A. (2015). Effects of joint mobilization on chronic ankle instability: A randomized controlled trial. *Disability and Rehabilitation*, *37*(7), 601–610. https://doi.org/10.3109/09638288.2014.935877

Debaere, S., Delecluse, C., Aerenhouts, D., Hagman, F., & Jonkers, I. (2013). From block clearance to sprint running: Characteristics underlying an effective transition. *Journal of Sports Sciences*, *31*(2), 137–149. https://doi.org/10.1080/02640414.2012.722225

Docherty, C. L., Arnold, B. L., Gansneder, B. M., Hurwitz, S., & Gieck, J. (2005). Functional-performance deficits in volunteers with functional ankle instability. *Journal of Athletic Training*, *40*(1), 30–34.

Docherty, C. L., Gansneder, B. M., Arnold, B. L., & Hurwitz, S. R. (2006). Development and reliability of the ankle instability instrument. *Journal of Athletic Training*, *41*(2), 154–158.

Dressler, P., Gehring, D., Zdzieblik, D., Oesser, S., Gollhofer, A., & König, D. (2018). Improvement of functional ankle properties following supplementation with specific collagen peptides in athletes with chronic ankle instability. *Journal of Sports Science and Medicine*, *17*(2), 298–304. https://doi.org/10.1016/j.jbmt.2018.09.037

Dugan, S. A., & Bhat, K. P. (2005). Biomechanics and analysis of running gait. *Physical Medicine and Rehabilitation Clinics of North America*, *16*(3), 603–621. https://doi.org/10.1016/j.pmr.2005.02.007

Farahmand, B., Ebrahimi Takamjani, E., Yazdi, H. R., Saeedi, H., Kamali, M., & Bagherzadeh Cham, M. (2019). A systematic review on the validity and reliability of tape measurement method in leg length discrepancy. *Medical Journal of the Islamic Republic of Iran*, *33*, 46. https://doi.org/10.34171/mjiri.33.46

Fox, A. S. (2018). Change-of-Direction Biomechanics: Is What's Best for Anterior Cruciate Ligament Injury Prevention Also Best for Performance? *Sports Medicine*, *48*(8), 1799–1807. https://doi.org/10.1007/s40279-018-0931-3

Gribble, P. A., Delahunt, E., Bleakley, C., Caulfield, B., Docherty, C., Fourchet, F., … Wikstrom, E. (2013). Selection Criteria for Patients With Chronic Ankle Instability in Controlled Research: A Position Statement of the International Ankle Consortium. *Journal of Orthopaedic & Sports Physical Therapy*, *43*(8), 585–591. https://doi.org/10.2519/jospt.2013.0303

Havens, K. L., & Sigward, S. M. (2015). Cutting mechanics: Relation to performance and anterior cruciate ligament injury risk. *Medicine and Science in Sports and Exercise*, *47*(4), 818–824. https://doi.org/10.1249/MSS.0000000000000470

Hennig, E. M. (2011). The influence of soccer shoe design on player performance and injuries. *Research in Sports Medicine*, *19*(3), 186–201. https://doi.org/10.1080/15438627.2011.582823

Hertel, J., & Corbett, R. O. (2019). An updated model of chronic ankle instability. *Journal of Athletic Training*, *54*(6), 572–588. https://doi.org/10.4085/1062-6050-344-18

Hiller, C. E., Refshauge, K. M., Bundy, A. C., Herbert, R. D., & Kilbreath, S. L. (2006). The Cumberland Ankle Instability Tool: A Report of Validity and Reliability Testing. *Archives of Physical Medicine and Rehabilitation*, *87*(9), 1235–1241. https://doi.org/10.1016/j.apmr.2006.05.022

Howe, L. (2015). Restricted ankle dorsiflexion : methods to assess and improve joint function. *Professional Strength & Conditioning*, (37), 7–15.

Jorge, P. B., Sprey, J. W. C., Runco, G. M., Lima, M. V. De, Severino, N. R., & Santili, C. (2019). Diferença na degeneração articular de acordo com o tipo de esporte. *Revista Brasileira de Ortopedia*, *54*(5), 509–515. https://doi.org/10.1016/j.rboe.2018.02.012

Kjær, M., Langberg, H., Heinemeier, K., Bayer, M. L., Hansen, M., Holm, L., … Magnusson, S. P. (2009). From mechanical loading to collagen synthesis, structural changes and function in human tendon. *Scandinavian Journal of Medicine and Science in Sports*, *19*(4), 500–510. https://doi.org/10.1111/j.1600-0838.2009.00986.x

Kumari, N., Nijhawan, A. M., & Paresh, P. (2014). Efficacy of Weight Bearing Distal Tibiofibular Joint Mobilization With Movement (Mwm) in Improving Pain, Dorsiflexion Range and Function in

Patients With Postacute Lateral Ankle Sprain. *International Journal of Physiotherapy and Research*, *2*(3), 542–548.

Langarika-Rocafort, A., Emparanza, J. I., Aramendi, J. F., Castellano, J., & Calleja-González, J. (2017). Intra-rater reliability and agreement of various methods of measurement to assess dorsiflexion in the Weight Bearing Dorsiflexion Lunge Test (WBLT) among female athletes. *Physical Therapy in Sport*, *23*, 37–44. https://doi.org/10.1016/j.ptsp.2016.06.010

López-Segovia, M., Vivo Fernández, I., Herrero Carrasco, R., & Pareja Blanco, F. (2019). Preseason Injury Characteristics in Spanish Professional Futsal Players. *Journal of Strength and Conditioning Research*, (20), 1. https://doi.org/10.1519/jsc.0000000000003419

Manuel Serrano, J., Shahidian, S., da Cunha Voser, R., & Leite, N. (2013). Incidence and injury risk factors in portuguese futsal players. *Revista Brasileira de Medicina Do Esporte*, *19*(2), 123–129. https://doi.org/10.1590/S1517-86922013000200011

Marôco, J. (2018). *Análise Estatística com o SPSS Statistics* (7ª Edição). ReportNumber.

Marrón-Gómez, D., Rodríguez-Fernández, Á. L., & Martín-Urrialde, J. A. (2015). The effect of two mobilization techniques on dorsiflexion in people with chronic ankle instability. *Physical Therapy in Sport*, *16*(1), 10–15. https://doi.org/10.1016/j.ptsp.2014.02.001

Marshall, B., Franklyn-Miller, A., King, E., Moran, K., Strike, S., & Falvey, É. (2014). Biomechanical Factors Associated With Time to Complete a Change of Direction Cutting Maneuver. *Journal of Strength and Conditioning Research*, *28*(10), 2845–2851. https://doi.org/10.1519/JSC.0000000000000463

Mattacola, C. G., & Dwyer, M. K. (2002). Rehabilitation of the ankle after acute sprain or chronic instability. *Journal of Athletic Training*, *37*(4), 413–429.

McCarthy, C., Bialosky, J., & Rivett, D. (2015). Spinal Manipulation. In G. Jull, A. Moore, D. Falla, J. Lewis, C. McCarthy, & M. Sterling (Eds.), *Grieve's Modern Musculoskeletal Physiotherapy* (4th ed., pp. 278–282). Australia: Elsevier.

Paungmali, A., O'Leary, S., Souvlis, T., & Vicenzino, B. (2003). Hypoalgesic and Sympathoexcitatory Effects of Mobilization With Movement for Lateral Epicondylalgia. *Physical Therapy*, *83*(4), 374–383. https://doi.org/10.1093/ptj/83.4.374

Plisky, P. J., Rauh, M. J., Kaminski, T. W., & Underwood, F. B. (2006). Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *Journal of Orthopaedic and Sports Physical Therapy*, *36*(12), 911–919. https://doi.org/10.2519/jospt.2006.2244

Pope, R., Herbert, R., & Kirwan, J. (1998). Effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on injury risk in Army recruits. *Australian Journal of Physiotherapy*, *44*(3), 165–172. https://doi.org/10.1016/S0004-9514(14)60376-7

Ré, A. H. N., Cattuzzo, M. T., Henrique, R. dos S., & Stodden, D. F. (2016). Physical characteristics that predict involvement with the ball in recreational youth soccer. *Journal of Sports Sciences*, *34*(18), 1716–1722. https://doi.org/10.1080/02640414.2015.1136067

Ré, A. H. N., Corrêa, U. C., & Böhme, M. T. S. (2010). Anthropometric characteristics and motor skills in talent selection and development in indoor soccer. *Perceptual and Motor Skills*, *110*(3), 916–930. https://doi.org/10.2466/pms.110.3.916-930

Reid, A., Birmingham, T. B., & Alcock, G. (2007). Efficacy of mobilization with movement for patients with limited dorsiflexion after ankle sprain: a crossover trial. *Physiotherapy Canada*, *59*(3), 166–172. https://doi.org/10.2310/6640.2007.00016

Rosen, A. B., Needle, A. R., & Ko, J. (2017). Ability of Functional Performance Tests to Identify Individuals With Chronic Ankle Instability: A Systematic Review With Meta-Analysis. *Clinical Journal of Sport Medicine : Official Journal of the Canadian Academy of Sport Medicine*, *0*(0), 1–14. https://doi.org/10.1097/JSM.0000000000000535

Sheppard, J., & Young, W. (2006, September). Agility literature review: Classifications, training and testing. *Journal of Sports Sciences*. https://doi.org/10.1080/02640410500457109

Silva, D. C. F., Santos, R., Vilas-Boas, J. P., MacEdo, R., Montes, A. M., & Sousa, A. S. P. (2019). Different Cleat Models do Not Influence Side Hop Test Performance of Soccer Players with and without Chronic Ankle Instability. *Journal of Human Kinetics*, *70*(1), 156–164. https://doi.org/10.2478/hukin-2019-0029

Silva, D. C., Paulo Vilas-boas, J., Carvalho Mesquita, C., Maia, J., Santos, R., André Teixeira Peixoto, T., … Sousa, A. S. (2018). Cross-cultural adaptation and measurement properties of the Portuguese version of the Ankle Instability Instrument. *Trends in Sport Sciences*, *4*(25), 187–194. https://doi.org/10.23829/TSS.2018.25.4-3

van Melick, N., Meddeler, B. M., Hoogeboom, T. J., Nijhuis-van der Sanden, M. W. G. G., & van Cingel, R. E. H. H. (2017). How to determine leg dominance: The agreement between self-reported and observed performance in healthy adults. *PLoS ONE*, *12*(12), e0189876. https://doi.org/10.1371/journal.pone.0189876

Vicenzino, B., Hing, W., Hall, T., & Rivett, D. (2011). *Mobilisation with Movement: The art and science*. Elsevier Australia.

Weerasekara, I., Deam, H., Bamborough, N., Brown, S., Donnelly, J., Thorp, N., & Rivett, D. A. (2020). Effect of Mobilisation with Movement (MWM) on clinical outcomes in lateral ankle sprains: A systematic review and meta-analysis. *Foot*, *43*(November 2019), 101657. https://doi.org/10.1016/j.foot.2019.101657

7. Appendix

7.1. Appendix I – Eligibility Questionnaire

O efeito imediato da mobilização com movimento na dorsiflexão e variáveis de desempenho em atletas de futsal com instabilidade crônica do tornozelo: um ensaio clínico randomizado

No âmbito da Unidade Curricular "Dissertação/Estágio com relatório final" do 2° ano do curso de Mestrado em Fisioterapia da Escola Superior de Saúde do Porto (ESS-P.PORTO) foi elaborado o seguinte questionário para selecionar os participantes para o estudo de investigação supracitado. Este estudo tem como objectivo analisar os efeitos imediatos da Mobilização com Movimento no tornozelo no controlo neuromuscular e na performance de atletas de futsal com história anterior de entorse lateral da tibiotársica.
O preenchimento deste questionário demorará no máximo 10 minutos.
Agradecemos desde já a sua disponibilidade.

Consentimento Informado

Estou informado de que o estudo de investigação anteriormente mencionado se destina à análise dos efeitos imediatos da Mobilização com Movimento no meu controlo neuromuscular e performance enquanto jogador de futsal.
É-me garantido que todos os dados relativos à minha identificação neste estudo são confidenciais e que será mantido o anonimato.
Sei que posso recusar-me a participar ou interromper a qualquer momento a minha participação no estudo, sem nenhum tipo de penalização por este facto.
Compreendi a informação que me foi dada.
Caso seja aceite como voluntário, aceito participar de livre vontade no estudo acima mencionado, e ser contactado telefonicamente para a realização do estudo.
Também autorizo a divulgação dos resultados obtidos no meio científico, garantindo o anonimato.

Concorda com o consentimento informado acima descrito? *

- ◯ Sim
- ◯ Não

Contacto telefónico

Caso cumpra os critérios de participação deste estudo de investigação, necessitamos de o contactar para proceder à realização do protocolo experimental. Deste modo, agradecemos que nos ceda o seu contacto telefónico e avance para a secção seguinte do questionário.

Número de Telemóvel *

Sua resposta

Dados Sociodemográficos

Nível competitivo a que pratica futsal: *

- ○ Nacional
- ○ Distrital

Idade: *

(anos)

Sua resposta

Habilitações literárias: *

- ◯ 4º Ano
- ◯ 9º Ano
- ◯ 12º Ano
- ◯ Formação profissional
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento

Historial Clínico

Teve pelo menos uma entorse do tornozelo há mais de um ano? *

- ◯ Sim
- ◯ Não

Historial Clínico A

Em que tornozelo? *

- ◯ Tornozelo Direito
- ◯ Tornozelo Esquerdo
- ◯ Ambos

Esse(s) episódio(s) impediu(ram) a sua participação em pelo menos um treino/jogo? *

- ◯ Sim
- ◯ Não

Teve duas ou mais entorses no mesmo tornozelo? *

- ◯ Sim, no tornozelo direito
- ◯ Sim, no tornozelo esquerdo
- ◯ Sim, em ambos
- ◯ Não

Historial Clínico B

Nos últimos 3 meses, teve alguma entorse no tornozelo? *

- ◯ Sim
- ◯ Não

Historial Clínico C

No último ano sentiu pelo menos dois episódios, em que o(s) seu(s) tornozelo(s) "falhou/falharam" (sensação de que ia ocorrer uma entorse mas não aconteceu), durante atividades como caminhar ou correr? *

- ◯ Sim, no tornozelo direito
- ◯ Sim, no tornozelo esquerdo
- ◯ Sim, em ambos os tornozelos
- ◯ Não

Alguma vez sentiu instabilidade no(s) tornozelo(s) (falta de confiança/medo de ter uma entorse)? *

- ◯ Sim, no tornozelo direito
- ◯ Sim, no tornozelo esquerdo
- ◯ Sim, em ambos os tornozelos
- ◯ Não

Historial Clínico D

Nos últimos 3 meses teve algum tipo de lesão no membro inferior que o tenha retirado do treino/jogo pelo menos um dia? *

- ◯ Sim
- ◯ Não

Historial Clínico E

Alguma vez fez uma fratura (partir um osso) nos membros inferiores? *

- ◯ Sim
- ◯ Não

Alguma vez foi submetido a alguma cirurgia no membro inferior? *

- ◯ Sim
- ◯ Não

Historial Clínico F

Que tipo de intervenção foi realizada? *

Sua resposta

Há quanto tempo? *

Sua resposta

Historial Clínico G

Está a receber ou recebeu nos últimos 3 meses algum tipo de intervenção em Fisioterapia no membro inferior? *

(Apenas considere lesões/condições que o tenham afastado pelo menos um dia do treino/jogo)

- ○ Sim
- ○ Não

Utiliza algum tipo de medida preventiva (incluindo ligaduras funcionais) no(s) tornozelo(s)? *

- ○ Sim, no tornozelo direito
- ○ Sim, no tornozelo esquerdo
- ○ Sim, em ambos os tornozelos
- ○ Não

Historial Clínico H

Toma alguma medicação? *

- ○ Sim
- ○ Não

Historial Clínico I

Por favor indique qual ou quais. *

Sua resposta

Historial Clínico J

Possui alguma patologia/doença diagnosticada? *

- ◯ Sim
- ◯ Não

Historial Clínico K

Por favor indique qual ou quais. *

Sua resposta

7.2. Appendix II – Ankle Instability Instrument, Portuguese version

ID:____________

Este formulário será usado para categorizar a instabilidade do seu tornozelo. Por favor, preencha o formulário na totalidade. Se tiver alguma dúvida, por favor, pergunte ao investigador. Obrigado pela sua participação.

1. Alguma vez já torceu o seu tornozelo?

☐ Sim ☐ Não

2. Alguma vez consultou um médico por causa de uma entorse do tornozelo?

☐ Sim ☐ Não

2.1. Se sim, como é que o médico classificou a sua entorse mais grave do tornozelo?

☐ Ligeira (grau I) ☐ Moderada (grau II) ☐ Severa (grau III)

3. Alguma vez utilizou algum auxiliar de marcha (como muletas) por incapacidade de suportar o peso corporal devido a uma entorse do tornozelo?

☐ Sim ☐ Não

3.1. Se sim, na entorse mais grave do tornozelo, quanto tempo utilizou o auxiliar de marcha (muletas) referido anteriormente?

☐ 1 a 3 dias ☐ 4 a 7 dias ☐ 1 a 2 semanas ☐ 2 a 3 semanas ☐ > 3 semanas

4. Alguma vez teve a sensação de o seu tornozelo ceder/falhar?

☐ Sim ☐ Não

4.1. Se sim, quando foi a última vez que o seu tornozelo cedeu/falhou?

☐ < 1 mês atrás ☐ 1 a 6 meses atrás ☐ 6 a 12 meses atrás ☐ 1 a 2 anos atrás ☐ > 2 anos atrás

5.Alguma vez sentiu o seu tornozelo instável durante a marcha em superfície plana?

☐ Sim ☐ Não

6. Alguma vez sentiu o seu tornozelo instável durante a marcha em piso irregular?

☐ Sim ☐ Não

7. Alguma vez sentiu o seu tornozelo instável durante atividades recreativas ou desportivas?

☐ Sim ☐ Não

8. Alguma vez sentiu o seu tornozelo instável ao subir escadas?

☐ Sim ☐ Não

9. Alguma vez sentiu o seu tornozelo instável ao descer escadas?

☐ Sim ☐ Não

7.3. Appendix III – Informed Consent

TERMO DE CONSENTIMENTO INFORMADO

O termo de consentimento informado deve ser específico do Estudo de Investigação (o modelo deve ser adaptado ao estudo em causa, acrescentando outros dados considerados pertinentes ou eliminando partes não aplicáveis).
Compete ao Investigador Principal, prestar aos Participantes do estudo as informações necessárias ao consentimento livre e esclarecido.

Declaração de Consentimento Informado

Conforme alei 67/98 de 26 de Outubro e a "Declaração de Helsínquia" da Associação Médica Mundial (Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996, Edimburgo 2000; Washington 2002, Tóquio 2004, Seul 2008, Fortaleza 2013) – quando se aplicar

O efeito imediato da mobilização com movimento na dorsiflexão e variáveis de desempenho em atletas de futsal com instabilidade crônica do tornozelo: um ensaio clínico randomizado

DESIGNAÇÃO DO ESTUDO

Eu, abaixo-assinado ____

Fui informado de que o Estudo de Investigação acima mencionado se destina a **investigar o efeito imediato da mobilização com movimento na dorsiflexão e variáveis de desempenho em atletas de futsal com instabilidade crônica do tornozelo: um ensaio clínico randomizado**

Sei que neste estudo está prevista a realização de **avaliação antropométrica (altura e peso), avaliação de amplitude de dorsiflexão do tornozelo e desempenho no Side Hop *e* Sprint test, antes e após da aplicação de duas técnicas de mobilização com movimento no tornozelo,** tendo-me sido explicado em que consistem e quais os seus possíveis efeitos.

Foi-me garantido que todos os dados relativos à identificação dos Participantes neste estudo são confidenciais e que será mantido o anonimato.

Sei que posso recusar-me a participar ou interromper a qualquer momento a participação no estudo, sem nenhum tipo de penalização por este facto.

Compreendi a informação que me foi dada, tive oportunidade de fazer perguntas e as minhas dúvidas foram esclarecidas.

Aceito participar de livre vontade no estudo acima mencionado. Também autorizo a divulgação dos resultados obtidos no meio científico, garantindo o anonimato.

Júlio Alexandre Carvalho Portela (alexandre95portela@gmail.com)

______/_______/_______ ____

DATA ASSINATURA

7.4. Appendix IV – Raw Data

Table 5 – Raw data from the characterization questionnaire

Subjects	Groups		Age (years)	Body mass (kg)	Height (m)	BMI (kg/m²)
0	IG	MWM2	18	82,90	1,74	27,38
1	IG	MWM1	19	65,60	1,73	21,92
2	GP		25	87,70	1,75	28,64
3	IG	MWM2	21	84,60	1,77	27,00
4	IG	MWM1	21	68,30	1,64	25,39
5	GP		27	79,20	1,76	25,57
6	GP		34	101,40	1,84	29,95
7	GP		24	63,20	1,70	21,87
8	IG	MWM1	27	88,10	1,88	24,93
9	IG	MWM1	18	75,40	1,60	29,45
10	IG	MWM2	25	59,40	1,69	20,80
11	GP		19	79,30	1,69	27,77
12	IG	MWM2	28	71,00	1,71	24,28
13	IG	MWM1	24	75,80	1,70	26,23
14	IG	MWM1	35	77,10	1,69	26,99
15	IG	MWM2	24	90,50	1,74	29,89
16	IG	MWM1	18	95,90	1,77	30,61
17	GP		21	70,10	1,73	23,42

IG: Intervention group; PB: Placebo group; MWM1: Mobilization with movement 1 group; MWM2: Mobilization with movement 2 group; BMI: Body mass index

Table 6 – Raw data from the WBLT

Subjects		Distance GK	Distance HW	DFROM	DFROM [M1 (–) M0]
0	M0	43.60	34.00	37.95	1.54
	M1	42.60	35.10	39.49	
1	M0	41.30	33.90	39.98	1.72
	M1	40.00	34.90	41.10	
2	M0	46.20	28.60	31.76	–0.90
	M1	46.70	27.90	30.86	
3	M0	42.70	34.80	39.18	0.93
	M1	41.90	35.30	40.11	
4	M0	42.20	30.20	35.59	2.16
	M1	40.30	31.20	37.75	
5	M0	42.40	37.00	41.11	0.21
	M1	43.00	37.80	41.32	
6	M0	44.40	36.00	39.04	–2.17
	M1	46.80	35.10	36.87	
7	M0	38.10	36.90	44.08	–0.38
	M1	38.30	36.60	43.70	
8	M0	43.70	37.60	40.71	0.49
	M1	43.30	37.90	41.20	
9	M0	37.80	31.20	39.54	0.57
	M1	37.40	31.50	40.11	
10	M0	39.60	34.10	40.73	0.87
	M1	39.20	34.80	41.60	
11	M0	38.20	33.50	41.25	–0.79
	M1	39.40	33.60	40.46	
12	M0	42.70	33.60	38.20	2.91
	M1	40.80	35.60	41.11	
13	M0	39.70	33.40	40.07	1.02
	M1	39.10	34.10	41.09	
14	M0	31.90	43.20	53.56	0.87
	M1	34.40	43.90	54.43	
15	M0	45.50	30.50	33.84	0.95
	M1	45.20	31.40	34.79	
16	M0	42.10	33.30	38.34	5.38
	M1	38.90	37.20	43.72	
17	M0	38.40	37.10	44.01	0.46
	M1	38.10	37.40	44.47	

DFROM: Dorsiflexion range of motion; M0: Pre-intervention; M1: Post-intervention; GK: Ground-knee; HW: Heel-wall

Table 7 – Raw data from de Side hop test

Subjects	M0	M1	Side hop test [M1 (–) M0]
0	9,23	9,21	–0,02
1	9,42	8,03	–1,39
2	8,57	7,62	–0,95
3	9,28	8,59	–0,69
4	11,10	9,40	–1,70
5	7,31	7,01	–0,30
6	13,50	12,97	–0,53
7	7,62	8,37	0,75
8	10,00	9,81	–0,19
9	12,78	10,23	–2,55
10	8,77	7,90	–0,87
11	10,44	9,78	–0,66
12	9,08	7,60	–1,48
13	10,55	7,64	–2,91
14	10,50	10,03	–0,47
15	10,13	8,50	–1,63
16	9,35	8,97	–0,38
17	8,12	7,28	–0,84

M0: Pre-intervention; M1: Post-intervention

Table 8 - Raw data from the Sprint test

Subjects	M0	M1	Sprint test [M1 (-) M0]
0	9,08	8,63	-0,45
1	8,13	7,71	-0,42
2	8,78	8,30	-0,48
3	9,15	8,95	-0,20
4	8,85	8,72	-0,13
5	6,35	7,73	1,38
6	9,28	9,25	-0,03
7	8,31	8,28	-0,03
8	7,30	7,43	0,13
9	8,93	8,80	-0,13
10	9,53	8,17	-1,36
11	9,24	8,81	-0,43
12	7,54	7,43	-0,11
13	8,21	7,71	-0,50
14	8,47	8,30	-0,17
15	8,31	7,67	-0,64
16	8,61	8,48	-0,13
17	7,55	7,95	0,40

M0: Pre-intervention; M1: Post-intervention