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Massage Therapy May Help Pain and Endurance Performance in Modern Pentathlon Athletes with Plantar Fasciitis

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ORIJINAL ARTICLE

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Abstract

Plantar fasciitis (PF) is common among both sports and inactive individuals and several treatment approaches are available. There is no study that examines the effect of massage on PF in multi-discipline athletes such as modern pentathletes. This study evaluated the effectiveness of massage on modern pentathletes suffering from PF. Twelve male athletes between the ages of 18 and 25 who had a history of plantar fasciitis pain and participated in modern pentathlon sports took part in the study. Every athlete received a 15-minute deep friction massage (DFM) between 13:00 and 17:00 on each day of the week for 15 days. Before and after the massage, all athletes' pain and endurance levels were measured. For pain assessments, pressure pain algometry was utilised, and for endurance evaluations, the yo-yo intermittent endurance test was utilised. Athletes participating in the study before (3.5 (2-5)) and after (7 (6-8)) pain average measurements and before massage (830±60) and after (1498.33±52.88) endurance average measurements pretest-post It was determined that there was a statistically significant difference between test values. According to the study, massage, an alternative therapeutic strategy, can be used to address the PF issue. To increase the accuracy of the findings and to assert that massage is the definitive treatment for PF, it is proposed that other sample groups with PF diagnoses be included in the studies, or that the treatment time for a single sample group be extended.

Keywords: Massage, Plantar Fasciitis, Modern Pentathlon.

Masaj Terapisi Plantar Fasiitli Modern Pentatlon Sporcularında Ağrı ve Dayanıklılık Performansına Yardımcı Olabilir

Öz

Plantar fasiit (PF) problemi sedanter bireylerde olduğu kadar sporcularda da sıklıkla görülmekte ve tedavi etmek amacıyla farklı yöntemler kullanılmaktır. Yapılan çalışmalar incelendiğinde masajın PF problemi olan bireylerde yaygın bir şekilde kullanım alanı olduğu fakat bu çalışmalar arasında modern pentatlon sporu gibi çoklu branşlara katılım sağlayan sporcular üzerinde masajın PF probleminde etkisini belirleyen çalışmanın olmadığı belirlenmiştir. Bu çalışma, PF modern pentatloncularda masaj uygulamasının etkisini değerlendirme amacıyla yapılmıştır. Çalışmaya PF ağrı öyküsü bulunup modern pentatlon sporu yapan 18-25 yaş aralığında 12 erkek sporcu katıldı. Tüm sporculara 15 gün boyunca haftanın her günü 13:00-17:00 saatleri arasında toplam 15 dakika boyunca derin friksiyon masajı (DFM) uygulandı. Masaj öncesi ve sonrası tüm sporcuların ağrı ve dayanıklılık ölçümleri alındı. Ağrı ölçümü değerlendirmeleri basınç ağrı algometresi, dayanıklık ölçümleri için ise yo-yo aralıklı dayanıklık testi kullanılarak ölçüldü. Araştırmaya katılan sporcuların masaj öncesi (3.5 (2-5)) ve sonrası (7 (6-8)) ağrı ortalamaları ölçümleri ve masaj öncesi (830±60) ve sonrası (1498.33±52.88) dayanıklılık ortalamaları ölçümleri ön test-son test değerleri arasında istatiksel olarak anlamlı farklılık olduğu belirlendi. Yapılan çalışmaya göre PF problemini tedavi etmek amacıyla alternatif tedavi yöntemlerinden olan masajın kullanılabileceği belirlenmiştir. Fakat elde edilen bulguların doğruluğunu arttırmak ve PF tedavisinde masajın kesin çözüm olduğunu söyleyebilmek amacıyla PF tanısı konulmuş farklı örneklem gruplarının çalışmalara dahil edilmesi veya tek örneklem grubu üzerinden tedavi gün süresinin uzatılması önerilmektedir.

Anahtar kelimeler: Masaj, Plantar Fasiit, Modern Pentatlon.

Introduction

The original purpose of the pentathlon in ancient Greece was to assess the general physical prowess of Greek soldiers. At the fifth Olympic Games, held in Stockholm in 1912, the pentathlon became a regular sport. Later, in 2009, the Pentathlon became what it is today, when the rules of the game at Union Internationale were changed by combining shooting and running (Jeong, 2006). The modern pentathlon; Laser run is an Olympic event that consists of five disciplines, including fencing, swimming, horseback riding, and cross-country running (Le et al., 2012). Due to the diversity of these disciplines, the modern pentathlon needs a high level of physical condition and is regarded as an exceedingly difficult competition. In addition, the maximal oxygen consumption (VO2max) and endurance capacity of pentathletes are quite high in comparison to athletes in other sports (Le et al., 2012; Loureiro et al., 2015; Sadowska et al., 2019). Pentathletes must possess exceptional endurance, concentration, and technique in order to compete in all five events concurrently. Specifically, elite pentathletes' performance is highly tied to their endurance level (Le et al., 2010; An and Lee, 2012; Lim et al., 2018) evaluated performance characteristics for 14 pentathletes and found a substantial difference between elite and non-elite level pentathletes in cross-country running. In addition, Kim et al. (2016) examine the performance of 16 pentathletes on different skills, suggesting that the development of strength and endurance improves running performance. In order for athletes to be successful in contests, health indicators have also been incorporated into training plans to ensure optimal performance. The sole, ankle, knee, and hip joints, tendons, and ligaments must be robust in order for the running parameters of the sportsmen to be at a high level. Inflammation or injuries in this area will negatively impact the athletes' performance. Specifically, the pain in the designated regions has a profound effect on the muscular system (Böer, 2006; Bressel et al., 2007; Foss et al., 2014; Matthews, et al., 2016). Inflammations of the plantar fascia (PF), which are typically found on the bottoms of the feet, are also among the most common ailments reported by athletes (Hunt and Anderson, 2009; Petraglia et al., 2017). Approximately 10% of the global population will experience PF at least once in their lifetime (Goff and Crawford, 2011). Pain under the heel and along the medial side of the PF characterise (Singh et al., 1997). It is caused by recurrent microtrauma at the origin of the medial tuberosity of the calcaneus. Although its cause is multifaceted, anatomical and biomechanical variables play a role (Berkowitz et al., 1991). The diagnosis of PF is usually made by clinical evaluation, and imaging methods are not needed (Puttaswamaiah and Chandran, 2007). Patients report that there is increased pain on the first step in the medial heel, especially when they get up on the first step in the morning or after sitting for a long time (McPoil et al., 2008). Achilles tendon tension is also present in 80% of cases (Singh et al., 1997). PF is often a self-limiting condition for six months. If the disease still has not limited itself after the sixth month; rest, hot-cold pack protocol, nonsteroidal anti-inflammatory drug, heel pad, night splint, plantar fascia and Achilles

stretching exercise, massage deep friction massage (DFM), trigger point, reflexology, taping, ultrasound, steroid injection, extracorporeal shock wave therapy (ESWT), platelet-rich plasma injection, pulse radiofrequency electromagnetic therapy and surgical treatment options can be applied (Tahririan et al., 2012). Massage practice, which is frequently used in the rehabilitation process among athletes, is also used by athletes with PF problems. Athletes with PF problem usually apply transverse friction massage as a massage protocol, and when studies conducted in recent years are examined, it is stated that massage protocol is effective in people with PF problem (Farooq et al., 2019; Yelverton et al., 2019; Juchli, 2021).

It is of the utmost importance to safeguard the health of athletes in fields requiring tremendous endurance, such as modern Pentathlon competitions. Consequently, it is essential to explore the studies that lead to the performance variations of the health indicators that influence the athletes' competition performance. The effects of massage protocols, which are commonly utilised by athletes between rehabilitation stages and believed to contribute to their recovery state, vary. Observable studies on the acute effect of massage protocols on athletes are available. However, as far as the authors are aware, there is no research in the scientific literature discussing the contribution of long-term massage on modern pentathlon competitors. The purpose of this study was to examine the effects of massage on modern pentathlon competitors diagnosed with PF. The hypotheses of the study were determined to affect the pain and endurance parameters of DFM.

Materıal and Method

The study is a single group pretest-posttest experimental study. Twelve male athletes aged 18-25, who have been doing modern pentathlon sports for at least 3 years, participated in the study (age, 19.50±1.16 years; height, 173.5±3.84 cm; 70.16±2.25 kg; BMI 23.31±.47). The power analysis program G*Power (version 3.1.9.3, Germany) was used to determine the study group. As a result of the power analysis (confidence interval=.95, alpha value=.05 and beta value=.80, and effect size value=.60), it was determined that the number of athletes to be included in the study should be at least 12 athletes (Faul et al., 2007). Inclusion criteria for the study; Inclusion and exclusion criteria were determined as (1) having PF pain for at least 6 months, (2) actively doing modern pentathlon sports, (3) regularly participating in the study; It was determined as (1) having foot pain but no history of PF pain, (2) not participating in the massage application regularly, and (3) receiving extra treatment support other than massage application. All participants were given necessary information before the study and signed an informed consent form stating that they understood the procedures to be performed during the study. Throughout the duration of the study, the athletes were told not to take any drugs (anabolic steroids, other hormones, metabolic modulators, diuretics, non-steroidal anti-inflammatory drugs NSAIDs, etc.) or get any medical treatment. Before beginning the study, approval

was granted by the Malatya Turgut Ozal University Non-Invasive Clinical Research Ethics Committee (Ethics Committee Protocol Number: 2022/10).

Experimental Design

The athletes included in the study consisted of a single group. Before the study, pain and endurance measurements of all participants were taken and massage was performed for 15 days, and the same measurements were repeated 15 days later. Each measurement was made 72 hours apart (Bowers et al., 2012). During the study period, two training sessions were carried out with 72 hours apart, one week before the study, in order for the participants to get used to the test procedures. All protocols were performed at the same time of the day (13:00-17:00) to avoid the effects of circadian rhythm (Souissi et al., 2004).

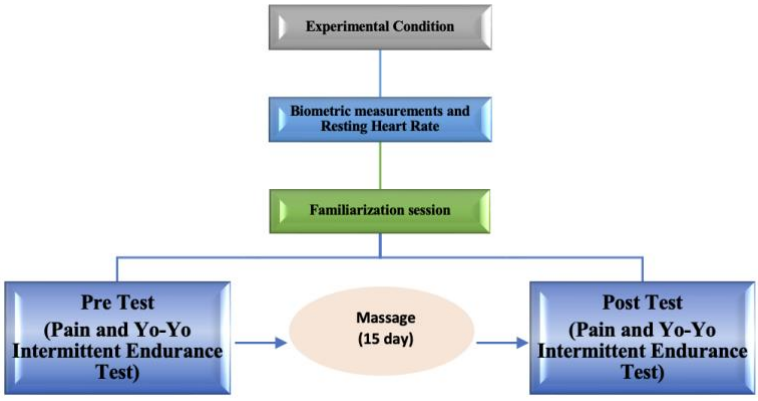

Figure 1. Experimental Design

Massage Protocol

DFM was applied to the soles of the feet of the athletes participating in the study with PF pain for a total of 15 minutes. In order to prevent the diurnal rhythm effect, massage protocols were applied at the same time of the day and efflorage, friction and pressing protocols from DFM protocols were used (Weerapong et al., 2005; Açak and Öncü, 2006; Jelvéus, 2011; Gürkan, 2018). Massage was administered at a pace of roughly 2 to 3 cycles per second, within the patient's tolerance, from the proximal to the distal at the PF's most sensitive area (Moshrif et al., 2020). Accordingly, massage treatments were administered daily between 13:00 and 17:00 for fifteen days. To maintain consistency in the massage treatments administered to the athletes, the same masseuse massaged all of the athletes. Aromatic oils, which are capable of altering the effect of massage when utilising traditional baby oil as massage oil, were not utilised in massage application. Approximately 15 millilitres of oil were used to massage each athlete.

Pain measurement

In order to determine the pain scores of the athletes participating in the study before and after the study, pressure pain threshold measurement was performed with a pressure pain algometer (Baseline 22 pounds) at the trigger points. The tender points in the PF area were asked to the patient and the pain status of these areas was also determined by palpation. Pain points were marked with a pencil for evaluation before and after the study. For the assessment of the pressure pain threshold, the patients were instructed to state "stop" at the pressure value at which they first experienced discomfort, i.e. the greatest pressure they could take without experiencing pain. Measurements were performed with three repetitions and a 1-minute rest period in between. Pain measurement values were recorded in kg by taking the average of the three measurements.

Yo-Yo Intermittent Endurance Test

Studies show that Yo-Yo tests are a valid and reliable measurement tool with high reproducibility in determining high-intensity aerobic capacity for athletes from various sports and competition levels (Castagna et al., 2005; Thomas et al., 2006; Souhail et al., 2010; Deprez et al., 2014)**.** Yo-Yo intermittent endurance test was applied before and after the study to evaluate performance measures. All obtained values were recorded as pretest-posttest. The Yo-Yo Intermittent Endurance Test consists of shuttle runs, in which a 2.5-meter recovery zone is added to the 20-meter running area and 5 seconds (2.5 m) of active rest is added for every 40-meter run. Two measurement methods, level-1 and level-2, are applied in each Yo-Yo test group. Level-1; While it is mostly used for athletes who are less trained or who cannot be heavily loaded due to injury, level-2; It is applied to elite, healthy athletes who will have high loading intensity (Fanchini et al., 2014). Accordingly, the level-1 test was applied to the groups of athletes included in the study. Failure to reach the shuttle run twice on time resulted in the test ending, and the distance traveled on the last fully successful shuttle was recorded, representing the test result. The test was terminated if dizziness, confusion, ataxia, cold and moist skin, regression in heart rate despite increased exercise load, and severe fatigue, either physically observed or verbally reported by the subject, were observed during the applied tests.

Data Analysis

The Shapiro-Wilk test was used to evaluate the assumption of normal distribution of quantitative data. Mean and standard deviation are used to summarise regularly distributed quantitative data, while median is used to summarise non-normally distributed quantitative data (minimum and maximum). Additionally, mean and median confidence intervals were determined. When comparing dependent groups, the Paired Samples t-test and Wilcoxon signed-rank test were utilised as appropriate. The rank correlation coefficient of Spearman was performed to analyse the

correlations between algometer and yo-yo variables. The significance threshold was set at $p < 0.05$. During the analysis, version 26.0 of IBM SPSS Statistics for Windows was used (New York; USA).

Results

The mean age, height, weight, and body mass index (BMI) of the participants were 19.50 ± 1.16, 173.50 ± 3.84, 70.16 ± 2.25, 23.31 ± 0.47, respectively (Table 1).

Table 1

Descriptive Statistics on The Demographic Information of the Participants (n=12)

Variable	**Mean ± SD**
Age (year)	19.50 ± 1.16
Height (cm)	173.50 ± 3.84
Weight (kg)	70.16 ± 2.25
BMI	23.31 ± 0.47

BMI; Body mass index, SD; standard deviation.

Table 2

Changes to the First and Last Measurements of Pain and Endurance Variables

Variable	**n=12**	**95% CI**	***p*-value**
Pain-1*	3.5 (2 - 5)	3 - 4	0.002
Pain-2*	7 (6 - 8)	7 - 8	
Endurance-1**	830 ± 60	791.87 - 868.12	<0.001
Endurance-2**	1498.33 ± 52.88	1464.73 - 1531.93	

*; Variables are summarized with median (minimum-maximum) (Wilcoxon signed-rank test), **; Variables are summarized as mean ± standard deviation (Paired Samples t-test), CI; confidence interval.

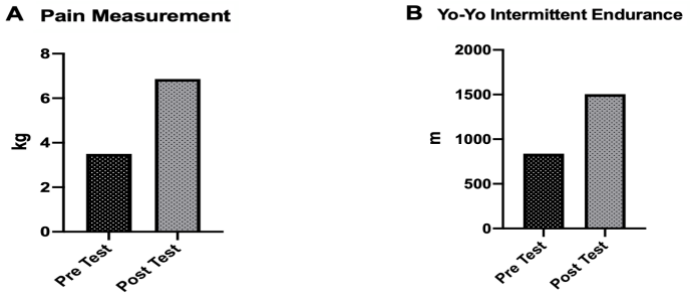

Figure 1

Pre-test-post-test values of pain and endurance measurements before/after massage

(A) Pre-test-post-test comparisons of pain measurements before and after massage; (B) Pre-test-post-test comparisons of endurance measurements before and after massage.

The changes in the pain and endurance results of the participants are presented in Table 2. According to the data of the study, a statistically significant difference was found between the first and last measurements of pain and endurance measurements ($p<0.05$). The results of the last measurement of pain and endurance increased approximately 2 times compared to the results of the first measurement, and this increase is statistically significant.

Table 3

Correlations Between Pain and Endurance Variables

Variable	Statistics	Pain-2	Endurance-1	Endurance-2
Pain-1	r	0.215	-0.403	0.040
	p-value	0.503	0.194	0.901
Pain-2	r		0.473	-0.150
	p-value		0.121	0.642
Endurance-1	r			0.184
	p-value			0.566

According to Table 3, the correlation coefficients between the variables of pain and endurance were not statistically significant ($p<0.05$).

Dıscussıon and Conclusıons

It is believed that an athlete's endurance performance is crucial in sports that require high endurance, such as the modern Pentathlon. To this end, sports scientists are continually seeking to improve the performance of athletes and attempting to identify the settings in which athletes perform at their peak (Lim et al., 2018). However, it is believed that the performance metrics are affected by the players' health factors. In addition, it is believed that evaluating the disability status of the athletes and following the most appropriate treatment protocols based on the identified disability status will have a favourable impact on the athletes' performance status. Individuals with PF issues are treated with a variety of therapeutic approaches, including massage applications (Buchbinder, 2004). Nonetheless, the effect of massage alone on the pain and performance condition of modern pentathlon athletes is not yet known. Especially in sports that require endurance, such as the modern pentathlon, it is essential to assess the extent to which massage protocols administered after injury contribute to performance enhancement. Studies studying the impact of post-injury massage treatments may contribute novelty to the literature for modern pentathletes. Our study aims to determine the effects of massage on modern pentathlon competitors diagnosed with PF. According to our hypotheses, DFM had a positive effect on pain and endurance metrics.

To the best of our knowledge, there is no other study that investigates the effects of massage on the levels of pain experienced by modern pentathletes as well as their endurance performance. The incorporation of this method into the ongoing research makes it possible for the massage protocol to provide distinct physiological and performance outcomes regarding pain status and endurance performance during the course of the study. The results of our research indicate that the use of DFM on modern pentathlon athletes who are suffering from PF problems has a beneficial effect on performance.

Although this study is the first to examine the acute effect of DFM applied to modern pentathlete athletes diagnosed with PF on pain status and endurance performance, our findings are consistent with studies with similar characteristics examining the effect of massage in people diagnosed with PF. For example, Formosa and Smith (2011) showed a reduction in both outcome measures for pain at the end of 6 weeks of treatment, comparing two groups in which transverse friction massage (TFM) and home exercise protocol (HEP) were applied. These results demonstrated the feasibility of a clinical trial for TFM to treat PF. Yi et al. (2018) determined DFM with local steroid injection for the treatment of lateral epicondylitis, reported that DFM had a significant beneficial effect and that DFM could be used in patients who failed non-surgical treatments. Vasseljen (1992) recommended the combination of both local steroid injection and DFM for the treatment of lateral epicondylitis in his studies. He also stated that DFM is more effective than these physical methods in reducing pain and increasing wrist extension strength. Gomaa investigated the effect of massage accompanied exercise program on plantar fasciitis foot in athletes. As a result of the study, it was determined that the exercise program accompanied by massage had a positive effect on the PF of the foot in some athletes, and improved the degree of pain along with the balance of the foot and ankle joint in some athletes (Gomaa, 2016). In addition, when comparing the TFM and calf muscle stretching effectiveness of PF Flexor digitorum brevis, it was stated that both treatment protocols were equally effective in the treatment of PF (Farooq et al., 2019). Rittu (2016) Conducted a comparative study to evaluate the effectiveness of myofascial release technique and DFM technique on foot function and flexibility in patients with chronic PF. 30 patients with chronic PF were included in the study and the patients participating in the study were divided into two groups. The results of the study show statistically that both techniques are effective in improving foot function and flexibility in patients with chronic PF. Similarly, the three most effective treatment protocols for individuals afflicted with PF (mobilization and manipulation of the foot and ankle, PF cross friction massage and stretching of the gastroc-soleus complex) were compared. Cross friction massage and gastrosoleus stretching were determined as the most effective treatment protocol for PF, Rama (2012) and using massage as a rehabilitation method in PF patients will help patients (Lakhwani and Phansopkar, 2021). However, when the relevant literature is examined, it is observed that there are

conflicting results that DFM is effective in PF patients. For example; Although DFN was found to be less effective than local steroid injection for PF in a study conducted at 2 and 6 weeks of follow-up, it was stated that it could be used as an auxiliary physical modality (Moshrif et al., 2020). Hassan et al. (2016) carried out research to investigate the impact that DFM has on the stretching of the wrist extensor muscles in the context of the therapy of tennis elbow. The findings of the study led the researchers to the conclusion that stretching exercises were superior to DFM in terms of the effects they had.

Conclusion

The sample size of our study is rather limited, the treatment was only administered for a short period of time, and there was no post-treatment ultrasonographic evaluation. It was discovered from the findings of this study that DFM had a positive influence on the levels of pain and endurance performance values experienced by athletes who suffered from PF issues. In addition, although the mechanism underlying the PF problem solution of DFM has not been fully explained, it is thought that DFM may be caused by accelerating blood circulation and increasing the elasticity in the muscles. As a result, the utilisation of DFM in athletes and patients struggling with PF issues might be able to contribute to the therapy process. However, additional research with a greater level of specificity are required in order to acquire data that are more accurate and to explain the role of DFM application to performance. It is anticipated that new scientific research will be carried out as a result of elucidating the physiological process underlying the DFM protocol.

Etik Kurul İzin Bilgileri

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Araştırmacıların Katkı Oranları Beyanı

Araştırmanın yöntem, bulgular ve İngilizce yazım kısmıyla ilgili süreçler birinci, ikinci, üçüncü ve dördüncü yazar, giriş kısmı ile ilgili süreçler beşinci ve altıncı yazar, tartışma ve sonuç kısmı ile ilgili süreçler ise birinci, ikinci ve üçüncü yazar tarafından gerçekleştirilmiştir.

Çatışma Beyanı

Yazarların araştırma ile ilgili bir çatışma beyanı bulunmamaktadır.

References

Açak, M., & Öncü, E. H. (2006). *Step by step massage teaching* (1st edition). Malatya: Size chart.

An, C. S., & Lee, S. I. (2012). The comparative study of shooting, swimming, track and field between world record and national record in modern pentathlon players. *Korean J. Sport*, *10*, 157–163.

Berkowitz, J. F., Kier, R. & Rudicel, S. (1991). Plantar fasciitis: MR imaging. *Radiology*, *179*(3), 665–667. https://doi.org/10.1148/radiology.179.3.2027971

Böer, J. R. (2006). *Charakterisierung des balance verhaltens von gesunden, hüft-und kniepatienten auf dem posturomed*. Eberhard Karls Universität.

Bowers, R., Foss, M., & Fox, E. (2012). *Beden eğitimi ve sporun fizyolojik temelleri*. Spor Yayınevi.

Buchbinder, R. (2004). Clinical practice: Plantar fasciitis. *N Engl J Med*, 350: 2159-2166. Doi: 10.1056/NEJMcp032745

Bressel, E., Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *Journal of Athletic Training*, *42*(1), 42–46.

Castagna, C., Abt, G. & D'Ottavio, S. (2005). Competitive-level differences in Yo-Yo intermittent recovery and twelve minute run test performance in soccer referees. *Journal of Strength and Conditioning Research*, *19*(4), 805–809.

Deprez, D., Coutts, A. J., Lenoir, M., Fransen, J., Pion, J., Philippaerts, R. & Vaeyens, R. (2014). Reliability and validity of the Yo-Yo intermittent recovery test level 1 in young soccer players. *Journal of Sports Sciences*, *32*(10), 903–910. https://doi.org/10.1080/02640414.2013.876088

Fanchini, M., Castagna, C., Coutts, A. J., Schena, F., McCall, A., & Impellizzeri, F. M. (2014). Are the Yo-Yo intermittent recovery test levels 1 and 2 both useful? Reliability, responsiveness and interchangeability in young soccer players. *Journal of Sports Sciences*, *32*(20), 1950–1957. https://doi.org/10.1080/02640414.2014.969295

Farooq, N., Aslam, S., Bashir, N., Awan, W. A., Shah, M., & Irshad, A. (2019). Effectiveness of transverse friction massage of Flexor digitorum brevis and Calf muscle stretching in Plantar fasciitis on foot function index scale: A randomized control trial. *Isra Med J*, *11*(4), 305–309.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191. https://doi.org/10.3758/BF03193146

Formosa, G., & Smith, G. (2011). Transverse frictional massage for plantar fasciitis: a clinical pilot trial. *International Musculoskeletal Medicine*, 33(3), 107–114. https://doi.org/10.1179/1753615411Y.0000000008

Foss, K. D. B., Myer, G. D., & Hewett, T. E. (2014). Epidemiology of basketball, soccer, and volleyball ınjuries in middle-school female athletes. *The Physician and Sportsmedicine*, 42(2), 146-153. https://doi.org/10.3810/psm.2014.05.2066

Goff, J. D., & Crawford, R. (2011). Diagnosis and treatment of plantar fasciitis. *American Family Physician*, 84(6), 676–682.

Gomaa, E. H. (2016). The impact of rehabilitative exercise program accompanied by massage on foot plantar fasciitis in some athletes. *Journal of Applied Sports Science*, 6(3), 97–105. https://doi.org/10.21608/jass.2016.84581

Gürkan, A. (2018). Spor masajı. *Iğdır Üniversitesi Spor Bilimleri Dergisi*, 1(1), 24-28.

Hassan, S. M., Hafez, A. R., Seif, H. E., & Kachanathu, S. J. (2016). the effect of deep friction massage versus stretching of wrist extensor muscles in the treatment of patients with tennis elbow. *Open Journal of Therapy and Rehabilitation*, 04(01), 48-54. https://doi.org/10.4236/ojtr.2016.41004

Hunt, K. J., & Anderson, R. B. (2009). Heel pain in the athlete. *Sports Health: A Multidisciplinary Approach*, *1*(5), 427–434. https://doi.org/10.1177/1941738109338357

Jelvéus, A. (2011). *Integrated sports massage therapy a comprehensive handbook*. Elsevier Ltd. All rights reserved.

Jeong, C. S. (2006). *Characteristics of performance-related physical fitness and physique in elite modern pentathlon players*. Korea National University.

Juchli, L. (2021). Effectiveness of massage ıncluding proximal trigger point release for plantar fasciitis: a case report. *International Journal of Therapeutic Massage & Bodywork*, *14*(2), 22–29.

Kim, Y. S., Yoon, J. R., & Hur, S. (2016). Comparison of new combined event performance by performance level in modern pentathlon athletes. *Exercise Science*, *25*(4), 282–287. https://doi.org/10.15857/ksep.2016.25.4.282

Lakhwani, M., & Phansopkar, P. (2021). Efficacy of percussive massage versus calf stretching on pain, range of motion, muscle strength and functional outcomes in patients with plantar fasciitis–a randomized control trial. *Journal of Pharmaceutical Research International*, *33*(44(B)), 532–539.

Le, M. Y., Dorel, S., Baup, Y., Guyomarch, J. P., Roudaut, C., & Hausswirth, C. (2012). Physiological demand and pacing strategy during the new combined event in elite pentathletes. *European Journal of Applied Physiology*, *112*(7), 2583–2593. https://doi.org/10.1007/s00421-011-2235-2

Le, M. Y., Hausswirth, C., Abbiss, C., Baup, Y., & Dorel, S. (2010). Performance factors in the new combined event of modern pentathlon. *Journal of Sports Sciences*, *28*(10), 1111–1116. https://doi.org/10.1080/02640414.2010.497816

Lim, C. H., Yoon, J. R., Jeong, C. S., & Kim, Y. S. (2018). An Analysis of the performance determinants of modern pentathlon athletes in laser-run, a newly-combined event in modern pentathlon. *Exercise Science*, *27*(1), 62–70. https://doi.org/10.15857/ksep.2018.27.1.62

Loureiro, L. L., Fonseca, S., Castro, N. G. C. de O. e, dos Passos, R. B., Porto, C. P. M., & Pierucci, A. P. T. R. (2015). Basal metabolic rate of adolescent modern pentathlon athletes: agreement between ındirect calorimetry and predictive equations and the correlation with body parameters. *Plos One*, *10*(11), e0142859. https://doi.org/10.1371/journal.pone.0142859

Matthews M.J., Matthews H., Yusuf M., & Doyle C. (2016). Traditional martial arts training enhances balance and neuromuscular control in female modern martial artists. *Journal of Yoga & Physical Therapy*, *06*(01). https://doi.org/10.4172/2157-7595.1000228

McPoil, T. G., Martin, R. L., Cornwall, M. W., Wukich, D. K., Irrgang, J. J., & Godges, J. J. (2008). Heel pain-plantar fasciitis. *Journal of Orthopaedic & Sports Physical Therapy*, *38*(4), A1–A18. https://doi.org/10.2519/jospt.2008.0302

Moshrif, A., Elwan, M., & Daifullah, O. S. (2020). Deep friction massage versus local steroid injection for treatment of plantar fasciitis: a randomized controlled trial. *Egyptian Rheumatology and Rehabilitation*, *47*(1), 11. https://doi.org/10.1186/s43166-020-00013-6

Petraglia, F., Ramazzina, I., & Costantino, C. (2017). Plantar fasciitis in athletes: diagnostic and treatment strategies. A systematic review. *Muscles, Ligaments and Tendons Journal*, *7*(1), 107–118. https://doi.org/10.11138/mltj/2017.7.1.107

Puttaswamaiah, R., & Chandran, P. (2007). Degenerative plantar fasciitis: A review of current concepts. *The Foot*, *17*(1), 3–9. https://doi.org/10.1016/j.foot.2006.07.005

Rama, S. (2012). *The efficacy of chiropractic care in the treatment of plantar fasciitis utilising foot and ankle manipulation, gastrocsoleus stretching and cross friction massage of the plantar fascia.* University of Johannesburg.

Rittu, S. B. (2016). *A comparative study on the effectiveness of myofascial release and deep friction massage in the management of foot function and flexibility among chronic plantar fasciitis patients*. RVS College of Physiotherapy.

Sadowska, D., Lichota, M., Sacewicz, T., & Krzepota, J. (2019). Influence of running phases on the postural balance of modern pentathlon athletes in a laser run event. *International Journal of Environmental Research and Public Health*, *16*(22), 4440. https://doi.org/10.3390/ijerph16224440

Singh, D., Angel, J., Bentley, G., & Trevino, S. G. (1997). Fortnightly review: Plantar fasciitis. *BMJ*, *315*(7101), 172–175. https://doi.org/10.1136/bmj.315.7101.172

Souhail, H., Castagna, C., Mohamed, H. Yahmed, Younes, H., & Chamari, K. (2010). Direct validity of the yo-yo ıntermittent recovery test in young team handball players. *Journal of Strength and Conditioning Research*, *24*(2), 465–470. https://doi.org/10.1519/JSC.0b013e3181c06827

Souissi, N., Gauthier A., Sesboüé B., Larue J., & Davenne D. (2004). Circadian rhythms in two types of anaerobic cycle leg exercise: force-velocity and 30-s wingate tests. *International Journal of Sports Medicine*, *25*(1), 14–19. https://doi.org/10.1055/s-2003-45226

Tahririan, M. A., Motififard, M., & Tahmasebi M. N. (2012). Plantar fasciitis. *J Res Med Sci*, 17, 799–804.

Thomas, A., Dawson, B., & Goodman, C. (2006). The Yo-Yo test: Reliability and association with a 20-m shuttle run and VO2max. *International Journal of Sports Physiology and Performance*, *1*(2), 137–149. https://doi.org/10.1123/ijspp.1.2.137

Weerapong, P., Hume, P. A., & Kolt, G. S. (2005). The Mechanisms of massage and effects on performance, muscle recovery and ınjury prevention. *Sports Medicine*, *35*(3), 235–256. https://doi.org/10.2165/00007256-200535030-00004

Yelverton, C., Rama, S., & Zipfel, B. (2019). Manual therapy interventions in the treatment of plantar fasciitis: A comparison of three approaches. *Health SA Gesondheid*, 24, 1-9. https://doi.org/10.4102/hsag.v24i0.1244

Yi, R., Bratchenko, W. W., & Tan, V. (2018). Deep friction massage versus steroid ınjection in the treatment of lateral epicondylitis. *Hand*, *13*(1), 56–59. https://doi.org/10.1177/1558944717692088