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Effectiveness of Tendo-Muscular Massage for Pain Reduction and ROM Improvement Post-Injury Knee Joint

Eficacia del masaje tendo-muscular para la reducción del dolor y la mejora del ROM articulación de la rodilla tras una lesión

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Abstract. This study aims to determine the effectiveness of tendo-muscular massage. The method used in the research is descriptive quantitative. The sample in this study amounted to 30 people who had mild to moderate knee injuries during sports and other physical activities. The order of data collection, namely starting with the pretest measurement, then given a one-time tendo-muscullar massage treatment which is carried out for 8 minutes and ends with a posttest measurement. The research data that has been obtained is then analysed with descriptive quantitative. Interval and ratio scale data that met the normality test were analysed using the paired sample t-test parametric statistical test, while data that did not meet the normality test using the wilcoxon non-parametric statistical tests. The results of measurements with the Visual Analogue Scale (VAS) experienced an average pain reduction of 2.5 and a significance of 0.000 <0.05, while the range of motion measured with a goniometer experienced an average increase of 6 degrees, T count of 6,819 and Significance 0.000 in flexion movements and an average increase of 0.88 degrees, T count of 7,848 and Significance 0.000 in extension movements, as well as an increase in joint motion function of 28.83%. So it can be concluded that Tendo-muscular massage has a significant effect on reducing pain and increasing the range of motion (ROM) of the knee joint.
Keyword. Effectiveness, Tendo-Muscular Massage, Pain Reduction, ROM Improvement, Knee

Resumen. Este estudio pretende determinar la eficacia del masaje tendo-muscular. El método utilizado en la investigación es cuantitativo descriptivo. La muestra de este estudio ascendió a 30 personas que habían sufrido lesiones de rodilla de leves a moderadas durante la práctica de deportes y otras actividades físicas. El orden de recogida de datos, a saber, se inicia con la medición pretest, a continuación se aplica un único tratamiento de masaje tendo-muscular que se lleva a cabo durante 8 minutos y finaliza con una medición postest. A continuación, los datos de la investigación obtenidos se analizan con métodos cuantitativos descriptivos. Los datos de la escala de intervalos y proporciones que cumplían la prueba de normalidad se analizaron mediante la prueba estadística paramétrica de la prueba t de muestras pareadas, mientras que los datos que no cumplían la prueba de normalidad mediante las pruebas estadísticas no paramétricas de wilcoxon. Los resultados de las mediciones con la escala visual analógica (EVA) experimentaron una reducción media del dolor de 2,5 y una significación de 0,000 <0,05, mientras que la amplitud de movimiento medida con un goniómetro experimentó un aumento medio de 6 grados, recuento T de 6,819 y significación 0,000 en los movimientos de flexión y un aumento medio de 0,88 grados, recuento T de 7,848 y significación 0,000 en los movimientos de extensión, así como un aumento de la función de movimiento articular del 28,83%. Por lo tanto, se puede concluir que el masaje tendo-muscular tiene un efecto significativo en la reducción del dolor y el aumento de la amplitud de movimiento (ROM) de la articulación de la rodilla.
Palabras Clave. Eficacia, masaje tendo-muscular, reducción del dolor, mejora del ROM, rodilla

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Introduction

Sports injuries are all kinds of movement errors that arise during training, during the game, or after the game. The importance of injury prevention in various activities is increasing (Kozin et al., 2021). Warming up is not carried out optimally, which will cause injury to the muscles of the body (Racinais et al., 2017). Risk involves sensorimotor functions that are impaired during exercise, which can result in injury (Young, 2019). When experiencing an injury, treatment must be given immediately so as not to aggravate the injury (Paterno et al., 2018). If the injury is not treated properly, it will cause a more severe injury and spread to the body parts around the injury (Askenberger et al., 2018). Body parts that are injured due to forces that work beyond the body's ability will have a striking response from the body (Weerapong et al., 2005). The risks involved in the injury will result in the injury recurring with a greater chance (Dekker et al., 2017). Muscles must adapt first to increase body temperature and muscle readiness so as to reduce the risk of injury (Sharma et al., 2021). From the various descriptions above, it can be seen that injury is all kinds of motion errors involving sensorimotor functions that must be treated immediately. Injury and epidemiological studies are fundamental elements of concerted efforts to protect health (Bahr et al., 2020). Age has an influence on tissue strength and elasticity. If there is an increase in age, injury healing also takes longer. Muscle strength and elasticity relatively decrease at the age of 30-40 years (Black et al., 2021). To speed up the injury healing process, it is necessary to take care of it (McPherson et al., 2019). Injury also has an impact on reducing a person's ability to move and the quality of motion because the body's organs do not function optimally. Injuries to the knee have an impact on the function of walking, going up and down stairs, squatting, sitting and standing

(Edwards, 2018). In addition to decreased movement function, it also has an impact on subsequent injuries (Paterno et al., 2018). Pain in injury causes limbs to lose their function (Sharma et al., 2021). With impaired movement function, it will also have an impact on the joints and muscles around the knee (Alonso-Aubin et al., 2022). If the knee injury is not treated immediately, the entire lower extremity will be compromised (Sonesson et al., 2021). Knee injuries after injury management must be trained so that motion function returns to normal (Büttner et al., 2021). The exercises given are physical exercises that are light and do not cause pain (Nielsen et al., 2018). When one of the knee joint movements is injured, a person will not be free to move (Büttner et al., 2021). An injury that is not treated properly will have a bad impact, and will even worsen the injury (Lee et al., 2018). From some of the descriptions above, it can be seen that decreased function due to knee injury not only affects the function of muscle movement and the injured joint, but will also have an impact on other movement functions because other joints must support excessively to compensate for joints that have decreased function. This will result in muscle and joint stiffness in other parts that eventually suffer injuries as well.

When the knee is injured, it has a significant impact on the tendons of the muscles around the knee. Tendons are unique and important tissues in the human movement system. Tendons are soft tissues that connect muscles and bones (Chen et al., 2022). Tendons connect muscles and bones systematically (Notarnicola & Moretti, 2012). Tendons exert a great influence on muscle movement (Moksnes et al., 2021). Tendons shorten and lengthen according to the needs of motion (Green et al., 2020). After the initial treatment, then the next must be done with masage manipulation to accelerate the healing process of the injury (Slagers et al., 2021). Treatment with manipulation techniques can rehabilitate and strengthen injured muscles and joints (Spanou et al., 2020). When the knee is injured, the entire leg is given treatment in order to restore motion function. Treatment here can be done on the tendons in the ankle and knee. This is done because the knee down is interconnected.

With various manipulation techniques available, tendo-muscular massage is a new breakthrough because it is treated with different manipulation techniques and focuses on the tendons of the surrounding muscles that are injured. All kinds of injuries are associated with bones, muscles, and tendons (Aicale et al., 2018). The pain felt at the time of injury affects the tendons (Aicale et al., 2018). When the muscle is injured, it can be treated at the tendon (Imai et al., 2015). Tendo-muscular massage is a manipulation performed only by friction release or rubbing transversely on the tendon so that there is a shock or reflex motion in the manipulated muscle. This shock motion is what stimulates the muscle to return to its original state so that it can relax the muscle and reduce pain (Imai et al., 2015). It can also be said that it is the tendon that allows us to move because the tendon is the intermediary when the muscle moves the bone (Aicale et al., 2018). If we provide manipulation to the tendon, it will have a significant effect on the injured muscles and joints. With the reflex movement of the muscle, it is expected to overcome and accelerate the healing process of the injury (Murphy & Sheehan, 2021). It can be concluded that the treatment performed on the tendon can provide a relaxing effect and can significantly reduce pain so as to accelerate the healing of the injury in this case using tendo-muscular massage.

Many previous studies discuss sports science or human movement science in its three scientific dimensions, which are ontology, epistemology, and axiology. Studies related to the achievement of physical education learning outcomes have been conducted by (Septiantoko et al., 2024); (Martono et al., 2024). Studies related to the curriculum and management of physical education learning have been conducted by (Mardiyah et al., 2024); (Yani et al., 2024). Studies related to health and fitness sports have been conducted by (Widiyanto et al., 2024a); (Widiyanto et al., 2024b). Studies related to therapeutic sports have been conducted by (Zanada et al., 2024). Studies related to sports training and sports performance have been conducted by (Bahtra et al., 2024); (Kurniawan et al., 2024). Studies related to the management of sports education and achievement have been conducted by (Setyawan et al., 2023a); (Setyawan et al., 2023b); (Setyawan et al., 2024a); (Setyawan et al., 2024b);(Setyawan et al., 2024c); (Komari et al., 2024); (Hamsyah et al., 2024); (Mulyanti et al., 2024); (Destriani et al., 2024). Studies related to movement skills have been conducted by (Pranoto et al., 2024); (Anam et al., 2024). However, there is still very little scientific research that analyses the effectiveness of tendo-muscular massage to reduce pain and increase knee joint ROM after injury. Therefore, this research is important to do because so far what has been done as an effort to heal injuries is to manipulate the muscles, but in this study manipulating the tendon part of the same muscle as well as also focusing on healing and handling sports injuries. The treatment in this study was carried out quickly and had a significant impact (Imai et al., 2015). The treatment of the tendon is important because only the tendon is the main target to be manipulated (Aicale et al., 2018). The novelty in this research is the technique of handling injuries by performing friction release or frirage on tendon parts that have never been used before. The treatment process is carried out on the tendon of the injured muscle and/or other supporting muscles. Handling that focuses on the tendon is expected to be effective in handling and efficient in terms of time used.

Method

This study uses quantitative research. Data collection techniques in this study were carried out by triangulating data

using the Visual Analogue Scale (VAS) with a reliability level of 0.937 (Andreyani & Bhakti, 2023), Range of Motion (ROM) measurements using a Goniometer with a reliability level of 0.94 (Norkin & White, 2016), and Lower Extremity Functional Scale (LEFS) interview instruments with a reliability level of 0.926 (Yeung et al., 2009). The sample in this study totalled 30 people who experienced mild to moderate knee injuries during sports and other physical activities. The order of data collection, which begins with a pretest measurement, then given Tendo-muscullar Massage treatment once which is done for 8 minutes and ends with a posttest measurement. The research data that has been obtained, then analysed with descriptive quantitative. Interval and ratio scale data were analysed using the Paired sample t-test, both parametric and non-parametric depending on the normality of the data distribution.

Pain intensity was measured using a Visual Analogue Scale (VAS) consisting of a horizontal line divided equally into 10 segments numbered 0 to 10. The study sample was told that 0 represents 'no pain at all' and 10 represents 'the most severe pain they can imagine'. The sample was then asked to mark the number that they thought best described the level of pain they were feeling at any one time.

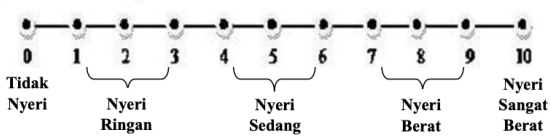

Figure 1. Visual Analogue Scale (VAS)

The criteria and scale felt by the sample on the VAS can be described as follows:

Table 1.
Pain Criteria

Pain Scale		Description of Pain Felt
Scale 0	:	No pain experienced
Scale 1 – 3	:	This is mild pain where objectively, the client can still communicate well. Pain that is only slightly felt.
Scale 4 – 6	:	This is moderate pain where objectively, the client is hissing, grinning and showing the location of the pain. The client can describe the pain, and can follow commands. Pain can still be reduced by changing position.
Scale 7 – 9	:	Severe pain where the client is no longer able to follow commands, but can still show the location of the pain and still respond to actions. Pain cannot be reduced by changing position.
Scale 10	:	This is very severe pain. The client is unable to communicate the client will set a point on the scale that relates to his perception of the intensity of pain severity.

In addition, joint range of motion (ROM) was measured using a goniometer.

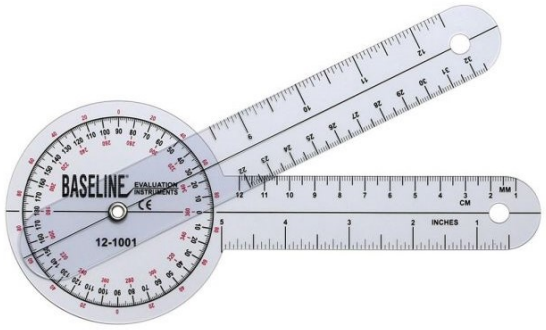

Figure 2. Goniometer to measure Range of Motion

The movements performed in the knee joint are flexion and extension movements. So that measurements are made only in these two movements. The following are normal angles in flexion and extension motion.

Table 2.
Knee Joint Range of Motion

Joints	Joint Motion Activity	
	Flexion	Extension
Knee	130 – 140 Degrees	0 – 5 Degrees

Table 3.
Instrument of Interview Lower Extremity Functional Scale (LEFS)

No	Statement
1	Work that is usually done at work, at home or at school
2	Hobbies that are usually done, recreation or sports activities
3	Entering or leaving the bathroom
4	Walking in the house
5	Wearing shoes or socks
6	Squatting
7	Lifting items such as bags from the floor
8	Doing light activities around the house
9	Doing strenuous activities around the house
10	Getting in or out of the car
11	Walking around the neighbourhood
12	Walk approximately 1 - 2 km
13	Climb up and down 10 flights of stairs
14	Standing for 1 hour
15	Sitting for 1 hour
16	Doing a little running/jogging
17	Walking on uneven ground
18	Cornering sharply when running fast
19	Jumping
20	Rolling over in bed

Description
0 = Very Difficult / Unable to Perform Activities
1 = Difficult
2 = Moderately Difficult
3 = Slightly Difficult
4 = Not Difficult

Result

This study was conducted to determine the effectiveness of tendo-muscular massage on reducing pain and increasing joint ROM in cases of mild and moderate injury to the knee

joint. The sample of this study were sports players aged 20-40 years who had knee injuries when doing sports activities. The sampling technique is random sampling with a quota of 30 people. To determine the effectiveness of tendo muscular massage on increasing knee Range of Motion (ROM), the Wilcoxon test and paired sample T-test were conducted. The results of the study are described as follows:

Table 4.
Results of Pain Intensity Measurement using NRS

Subject	Pretest	Posttest	Subject	Pretest	Posttest	Subject	Pretest	Posttest
1	5	3	11	6	3	21	5	3
2	5	4	12	7	3	22	6	5
3	7	3	13	6	3	23	7	3
4	8	4	14	7	3	24	8	3
5	6	4	15	8	5	25	7	5
6	7	4	16	7	4	26	6	2
7	8	5	17	6	3	27	7	3
8	6	4	18	6	4	28	6	4
9	5	3	19	7	3	29	7	3
10	5	4	20	6	4	30	6	4

Table 5.
Hasil Pretest dan Posttest menggunakan NRS

	N	Mean	Std. Dev	Min	Max	Z	Positif	Negatif	Asymp. Sig.
Pretest	30	6.10	1.094	5	8	-4.832	0	30	.000
Posttest	30	3.60	0.770	2	5				

Table 6.
Measurement Results Using the LEFS Instrument

Item	Measurement		Improvement
	Pretest	Posttest	
1	2,27	3,20	0,93
2	1,47	2,63	1,17
3	3,37	4,00	0,63
4	2,77	3,93	1,17
5	2,33	3,67	1,33
6	1,23	2,67	1,43
7	3,00	4,00	1,00
8	2,50	4,00	1,50
9	1,17	2,63	1,47
10	2,33	3,10	0,77
11	1,47	2,73	1,27
12	1,43	2,73	1,30
13	1,13	2,53	1,40
14	1,23	2,53	1,30
15	2,70	4,00	1,30
16	1,40	2,57	1,17
17	2,53	3,83	1,30
18	1,00	2,00	1,00
19	1,00	2,00	1,00
20	3,37	4,00	0,63
Total	39,70	62,77	23,07
%	49,63%	78,46%	28,83%

In the T test results with the measurement of the Numerical Rating Scale (NRS), the table above explains that of the 30 samples studied, there was a decrease in the intensity of pain felt after being manipulated using tendo-muscular massage. Here there is a number 30 in the negative column indicating that the 30 samples experienced a significant decrease in pain. In the Asymp. Sig (2-tailed) column is 0.000 <0.05, it can be concluded that there is an effect of using the tendo-muscular massage technique on reducing pain in the knee. Furthermore, measurements using the LEFS instrument can be described in the following table.

From the data above, it can be explained that the research subject felt a decrease in pain. Explanation with data description. This situation shows that tendo-muscular massage is effective in reducing pain in cases of mild and moderate injury to the knee joint. In addition, the results of the interview instrument data show that there is an increase in motion function to carry out daily activities by 28.83%. Other data related to the results of the analysis that can be presented are data from the range of motion (ROM) of the knee from flexion and extension movements which are described as follows:

Table 7.
Knee ROM Description Results Flexion Movement

Pair 1	Mean	N	Std. Dev.	Std. Eror Mean	Correlation	Sig.	T	df	Sig.
Pretest	118.04	30	10.17	1.856	.884	.000	6.819	29	0.000
Posttest	124.04	30	8.22	1.501					

In measuring range of motion (ROM) for flexion movements in the knee joint, it can be described that T count is 6.819 and Significance is 0.000. Because T count < T table 1.697 with Significance <0.05, it can be concluded that the use of tendo-muscular massage techniques is effective and has an influence on increasing the range of motion of knee joint flexion movements. As for the knee extension motion data, it can be described as follows:

Table 8.
Results of Description of Knee ROM Extension Movement

Pair 1	Mean	N	Std. Dev	Std. Eror Mean	Correlation	Sig.	T	df	Sig.
Pretest	3.0317	30	.78328	0.14301	.649	.000	7.848	29	0.000
Posttest	3.9100	30	.65197	0.11903					

In the measurement of range of motion (ROM) for flexion movements in the knee joint, it can be described that T count is 7.848 and Significance is 0.000. Because T-count < T-table 1,697. And Significance <0.05, it can be concluded that the use of tendo-muscular massage techniques is effective and has an influence on increasing the range of motion of extension movements in the knee joint. From the table above it can be seen that in flexion movements there is an increase in the average angle of 6 degrees. While in the extension movement there was an increase in the average angle of 0.88 degrees.

Discussion

In the Wilcoxon test results it can be seen that flexion obtained a significance value of probability 0.000 <0.05, meaning that there is a significant effect of Tendo Muscular massage on Pain Decrease and ROM Improvement and Limb Function. Extension obtained a significance value of probability 0.000 <0.05, meaning that there is a significant effect of Tendo-muscular massage on reducing pain and increasing ROM and leg function in cases of mild and moderate injury to

the knee. The decrease in pain will certainly affect the quality of the injured motion function for the subject. Pain that occurs decreases strength by almost 60% (Partner et al., 2022). If an injury occurs, motion function will be impaired (Spanou et al., 2020).Several motion functions on the LEFS instrument performed by the research subjects at the time before treatment and 3 days after treatment have a significant impact. It can be seen that the perceived difference is an increase in motion function of 28.83%. The subject can feel the difference when performing these motion functions. The most important thing is that the subject feels more relaxed and the pain is reduced. The squatting function has the highest increase because before treatment, the subject felt pain when squatting. This decrease in pain occurs due to smoother blood circulation resulting in the transport of O2 and CO2 in the blood which will then reduce pain. The subject felt a shock motion to the tendon during manipulation (Aicale et al., 2018). Shock motion triggers pain, and after being done repeatedly, the pain decreases and even disappears (Imai et al., 2015). This is in line with the research findings that the treatment performed on the tendon has an effect on muscle and bone tissue and joints that may reduce pain and increase joint motion.

The increase in the scale of function in the joints given the treatment certainly goes hand in hand with a decrease in the pain scale. A decrease in pain is an early sign that there will be an increase in the scale of function of the knee joint. Pain is reduced due to the treatment given to the tendon (Imai et al., 2015). Treatment of the tendon has a significant effect (Sharma et al., 2021). Of course, after there is a decrease in pain and an increase in joint motion space, it must still be trained so that the function of movement can return as before (Hertel & Corbett, 2019). Treatment should be carried out gradually starting from light physical activity that focuses on healing the injury (Pherson et al., 2019). Unaccustomed physical activity that may exceed the habits performed by the subject will be able to have a painful effect on the muscles after doing physical activity that is excessive from the initial load (Malm et al., 2019). Muscle disorders that are often felt by the subject are natural where the subject will have physical activities that are getting heavier every day (Sonesson et al., 2021). This is very possible because the limbs are the organs that are most often used for activities such as standing, walking or running and exercising. This situation is usually a special concern to provide treatment or provide therapy to be able to reduce the disorders obtained in the limbs. Therapy for improving movement function carried out with physical activity can help accelerate the recovery of movement function. In other words, therapy carried out after injury treatment must still be carried out for the recovery process (Goncharenko et al., 2019). Such well-controlled exercises can help the injury healing process.

Giving the right tendo-muscular massage treatment will be able to have a positive effect on restoring the condition of the knee muscles. Treated tendons will normalise joint and muscle motion function (Aicale et al., 2018). Knee strength is composed of leg muscles so that the strength needed in the basic ability of the leg is even greater. The disturbance felt in the limb must be able to be minimised by handling tendo-muscular massage (Imai et al., 2015). The right treatment process will be able to help the muscles to get back in shape and lose the pain to be able to move optimally (Lochbaum et al., 2020). In injuries that can still perform certain movements can be done with tendo-muscular massage. This will certainly spur and help re-strengthen the injured part. Strengthening the injured part aims to be able to maintain the injured part so that it is not easily re-injured. Furthermore, after being manipulated with tendo-muscular massage, the garus is given the right therapy programme for joint strengthening so that the knee art can return like all and not easily injured. Tendons control motion in muscles and bones (Imai et al., 2015). Tendons transfer strength from muscles to bones. This model suggests that, after an acute insult to the tendon, an early inflammatory response that would normally result in successful injury resolution veers to ward off an ineffective healing response (Aicale et al., 2018). It can be said that tendons are a very important part of the human limbs and become the controller between bones and muscles which are the main function when moving. If an injury occurs, a significant impact also occurs on the tendon, so injury treatment can be carried out on the tendon which will result in normalising the injured knee muscles and joints.

Conclusion

The conclusion of this study is that the tendo-muscular massage model has a significant effect on reducing pain and increasing knee joint ROM. experienced an average pain reduction of 2.5 and a significance of 0.000 <0.05, while the range of motion measured by a goniometer experienced an average increase of 6 degrees, T count of 6,819 and Significance 0.000 in flexion movements and an average increase of 0.88 degrees, T count of 7,848 and Significance 0.000 in extension movements, as well as an increase in joint motion function of 28.83%.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

References

Aicale, R., Tarantino, D., & Maffulli, N. (2018). Overuse injuries in sport: a comprehensive overview. *Journal of Orthopaedic Surgery and Research*, *13*(1), 309. https://doi.org/10.1186/s13018-018-1017-5

Alonso-Aubin, D. A. ., Rodrigo-Mallorca, D., Gómez, C., & Chulvi-Medrano, I. (2022). *Efectos De La Edad Cronológica En La Puntuación Del Functional Movement Screen Tm En Preadolescentes : Estudio De Cohorte Chronological Age Effects On Fuctional Movement Screentm Score In Preadolescents : A Cohort Study*. *14*(2), 209–218.

Anam, K., Setiowati, A., Indardi, N., Irawan, F. A., Aditia, E. A., Amrulloh, A., Susanto, N., Eken, Ö., Hendra Setyawan, Kozina, Z., & Pavlović, R. (2024). The effect of FIFA 11+ kids warm-up program on agility in football: An experimental study. *Retos*, *56*, 631–638. https://doi.org/10.47197/retos.v56.105659

Andreyani, L., & Bhakti, W. K. (2023). Validitas Skala Ukur Nyeri Visual Analog and Numerik Ranting Scales (Vanrs) Terhadap Penilaian Nyeri. *Jambura Journal of Health Sciences and Research*, *5*(2), 730–736. https://doi.org/10.35971/jjhsr.v5i2.19140

Askenberger, M., Bengtsson Moström, E., Ekström, W., Arendt, E. A., Hellsten, A., Mikkelsen, C., & Janarv, P. M. (2018). Operative Repair of Medial Patellofemoral Ligament Injury Versus Knee Brace in Children With an Acute First-Time Traumatic Patellar Dislocation: A Randomized Controlled Trial. *American Journal of Sports Medicine*, *46*(10), 2328–2340. https://doi.org/10.1177/0363546518770616

Bahr, R., Clarsen, B., Derman, W., Dvorak, J., Emery, C. A., Finch, C. F., Hägglund, M., Junge, A., Kemp, S., Khan, K. M., Marshall, S. W., Meeuwisse, W., Mountjoy, M., Orchard, J. W., Pluim, B., Quarrie, K. L., Reider, B., Schwellnus, M., Soligard, T., … Chamari, K. (2020). International Olympic Committee consensus statement: Methods for recording and reporting of epidemiological data on injury and illness in sport 2020 (including STROBE Extension for Sport Injury and Illness Surveillance (STROBE-SIIS)). *British Journal of Sports Medicine*, *54*(7), 372–389. https://doi.org/10.1136/bjsports-2019-101969

Bahtra, R., Putra, A. N., Fajri, H. P., Susanto, N., Sanchez, W. G. V., Zanada, J. F., Setyawan, H., Eken, Ö., & Pavlovic, R. (2024). Small Side Games: Endurance Training Model for Young Soccer Players. *Retos*, *56*, 514–520. https://doi.org/10.47197/retos.v56.104440

Black, A. M., Meeuwisse, D. W., Eliason, P. H., Hagel, B. E., & Emery, C. A. (2021). Sport participation and injury rates in high school students: A Canadian survey of 2029 adolescents. *Journal of Safety Research*, *78*, 314–321. https://doi.org/10.1016/j.jsr.2021.06.008

Büttner, F., Howell, D. R., Iverson, G. L., Doherty, C., Blake, C., Ryan, J., & Delahunt, E. (2021). Participation in pre-injury level sport one-year following sport-related concussion: A prospective, matched cohort study. *Journal of Science and Medicine in Sport*, *24*(6), 561–566. https://doi.org/10.1016/j.jsams.2020.12.014

Chen, Y., Lyu, K., Lu, J., Jiang, L., Zhu, B., Liu, X., Li, Y., Liu, X., Long, L., Wang, X., Xu, H., Wang, D., & Li, S. (2022). Biological response of extracorporeal shock wave therapy to tendinopathy in vivo (review). *Frontiers in Veterinary Science*, *9*(3). https://doi.org/10.3389/fvets.2022.851894

Dekker, T. J., Godin, J. A., Dale, K. M., Garrett, W. E., Taylor, D. C., & Riboh, J. C. (2017). *Return to Sport After Pediatric Anterior Cruciate Ligament Reconstruction and Its Effect on Subsequent Anterior Cruciate Ligament Injury Background: Anterior cruciate ligament (ACL) graft failure and contralateral ACL tears are more frequent in children a*. Journal of Bone and Joint Surgery.

Destriani, D., Yusfi, H., Destriana, D., Setyawan, H., García-Jiménez, J. V., Latino, F., Tafuri, F., Wijanarko, T., Kurniawan, A. W., Anam, K., Shidiq, A. A. P., Rahmatullah, M. I., & Eken, Ö. (2024). Results of Beginner Archery Skills Among Adolescents Based on Gender Review and Shot Distance. *Retos*, *56*, 887–894. https://doi.org/10.47197/retos.v56.106629

Edwards, W. B. (2018). Modeling Overuse Injuries in Sport as a Mechanical Fatigue Phenomenon. *Exercise and Sport Sciences Reviews*, *46*(4), 224–231. https://doi.org/10.1249/JES.0000000000000163

Goncharenko, O., Belikova, M., & Vdovenko, L. (2019). Changes in cellular immunity indicators in men who did not engage in exercising before the start of the study, and among basketball athletes of the level of higher sports achievements under the influence of systematic exercises in power fitness. *Journal of Physical Education and Sport*, *20*(1), 354–358. https://doi.org/10.7752/jpes.2020.s1050

Green, B., Bourne, M. N., Van Dyk, N., & Pizzari, T. (2020). Recalibrating the risk of hamstring strain injury (HSI): A 2020 systematic review and meta-Analysis of risk factors for index and recurrent hamstring strain injury in sport. *British Journal of Sports Medicine*, *54*(18), 1081–1088. https://doi.org/10.1136/bjsports-2019-100983

Hamsyah, K., Nopembri, S., Komari, A., Setyawan, H., Hermawan, H. A., Eken, Ö., Sugiyanto, S., Shidiq, A. A. P., Pavlovic, R., Latino, F., Tafuri, F., Pranoto, N. W., & Rahmatullah, M. I. (2024). Implementation of Archery Class Management at the Pre-Extracurricular Program Stage To Increase Elementary School Students' Interest. *Retos*, *55*, 849–856. https://doi.org/10.47197/retos.v55.105258

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

Imai, K., Ikoma, K., Chen, Q., Zhao, C., An, K. N., & Gay, R. E. (2015). Biomechanical and histological effects of augmented soft tissue mobilization therapy on achilles tendinopathy in a rabbit model. *Journal of Manipulative and Physiological Therapeutics*, *38*(2), 112–118. https://doi.org/10.1016/j.jmpt.2014.12.003

Komari, A., Setyawan, H., Kriswanto, E. S., Sujarwo, S., García-Jiménez, J. V., Pavlovic, R., Nowak, A. M., Susanto, N., Kurniawan, A. W., Gusliana HB, G. H. B., Shidiq, A. A. P., Putra, A. M. I., & Roziah, R. (2024). The Effect of Physical Education (PE) Class Management Using Badminton Materials to Improve Elementary School (ES) Students' Concentration. *Retos*, *55*, 520–526. https://doi.org/10.47197/retos.v56.104609

Kozin, S., Kozina, Z., Korobeinik, V., Cieślicka, M., Muszkieta, R., Ryepk, O., Boychuk, Y., Evtifieva, I., & Bejtka, M. (2021). Neuro-muscular training for injury prevention of students-rock climbers studying in the specialty "physical education and sports": A randomized study. *Journal of Physical Education and Sport*, *21*(2), 1251–1259. https://doi.org/10.7752/jpes.2021.s2159

Kurniawan, A. W., Wiguno, L. T. H., Mu'arifin, M., Setyawan, H., Shidiq, A. A. P., García-Jiménez, J. V., Eken, Ö., Latino, F., Tafuri, F., Pranoto, N. W., Rahmatullah, M. I., & Anam, K. (2024). I-Spring Assisted Development of a Basketball Shooting Technique Program. *Retos*, *55*, 874–881. https://doi.org/10.47197/retos.v55.105437

Lee, J. W. Y., Mok, K. M., Chan, H. C. K., Yung, P. S. H., & Chan, K. M. (2018). Eccentric hamstring strength deficit and poor hamstring-to-quadriceps ratio are risk factors for hamstring strain injury in football: A prospective study of 146 professional players. *Journal of Science and Medicine in Sport*, *21*(8), 789–793. https://doi.org/10.1016/j.jsams.2017.11.017

Lochbaum, M., Zanatta, T., & Kazak, Z. (2020). The 2 × 2 achievement goals in sport and physical activity contexts: A meta-analytic test of context, gender, culture, and socioeconomic status differences and analysis of motivations, regulations, affect, effort, and physical activity correlates. *European Journal of Investigation in Health, Psychology and Education*, *10*(1), 173–205. https://doi.org/10.3390/ejihpe10010015

Malm, C., Jakobsson, J., & Isaksson, A. (2019). Physical activity and sports—real health benefits: A review with insight into the public health of sweden. *Sports*, *7*(5). https://doi.org/10.3390/sports7050127

Mardiyah, S. U. K., Setyawan, H., García-Jiménez, J. V., Eken, Ö., Latino, F., Pranoto, N. W., Darmawan, A., Shidiq, A. A. P., Rahmatullah, M. I., Tafuri, F., & Anam, K. (2024). Differences in the Implementation of Physical Education (PE) Learning Management Based on Years of Work: Analysis of Differences in the Quality of Quality Assurance Culture. *Retos*, *55*, 797–803. https://doi.org/10.47197/retos.v55.104865

Martono, M., Suherman, W. S., Nugroho, S., Setyawan, H., Sulistiyono, S., Pambudi, D. K., Puri, L. W., Septiantoko, R., Hermawan, Y., García-Jiménez, J. V., Pavlovic, R., Eken, Ö., Pranoto, N. W., Darmawan, A., Shidiq, A. A. P., & Rahmatullah, M. I. (2024). Achievement of Physical Education Learning Results Based on Gender Review and Learning Motivation on High School Students in the Yogyakarta Region, Indonesia. *Retos*, *55*, 1045–1052. https://doi.org/10.47197/retos.v55.106831

McPherson, A. L., Nagai, T., Webster, K. E., & Hewett, T. E. (2019). Musculoskeletal Injury Risk After Sport-Related Concussion: A Systematic Review and Meta-analysis. *American Journal of Sports Medicine*, *47*(7), 1754–1762. https://doi.org/10.1177/0363546518785901

Moksnes, H., Ardern, C. L., Kvist, J., Engebretsen, L., Risberg, M. A., Myklebust, G., & Grindem, H. (2021). Assessing implementation, limited efficacy, and acceptability of the BEAST tool: A rehabilitation and return-to-sport decision tool for nonprofessional athletes with anterior cruciate ligament reconstruction. *Physical Therapy in Sport*, *52*, 147–154. https://doi.org/10.1016/j.ptsp.2021.08.011

Mulyanti, C., Prasetyo, Y., Sumarjo, S., Setyawan, H., Kurniawan, A. W., Shidiq, A. A. P., Eken, Ö., Pavlovic, R., Latino, F., Tafuri, F., Wijanarko, T., Rahmatullah, M. I., & Anam, K. (2024). Differences in Archery Skill Results for Vocational School Students and Beginners Based on Shooting Distance. *Retos*, *55*, 957–962. https://doi.org/10.47197/retos.v55.106081

Murphy, G. P., & Sheehan, R. B. (2021). A qualitative investigation into the individual injury burden of amateur rugby players. *Physical Therapy in Sport*, *50*, 74–81. https://doi.org/10.1016/j.ptsp.2021.04.003

Nielsen, R. O., Bertelsen, M. L., Møller, M., Hulme, A., Windt, J., Verhagen, E., Mansournia, M. A., Casals, M., & Parner, E. T. (2018). Training load and structure-specific load: Applications for sport injury causality and data analyses. *British Journal of Sports Medicine*, *52*(16), 1016–1017. https://doi.org/10.1136/bjsports-2017-097838

Norkin, C. C., & White, D. J. (2016). *Measurement of Joint Motion: A Guide to Goniometry* (Fifth Edit). F.A. Davis Company.

Notarnicola, A., & Moretti, B. (2012). The biological effects of extracorporeal shock wave therapy (eswt) on tendon tissue. *Muscles, Ligaments and Tendons Journal*, *2*(1), 33–37.

Partner, R., Jones, B., Tee, J., & Francis, P. (2022). Playing through the pain: The prevalence of perceived shoulder dysfunction in uninjured rugby players using the Rugby Shoulder Score. *Physical Therapy in Sport*, *54*, 53–57. https://doi.org/10.1016/j.ptsp.2022.01.001

Paterno, M. V., Flynn, K., Thomas, S., & Schmitt, L. C. (2018). Self-Reported Fear Predicts Functional Performance and Second ACL Injury After ACL Reconstruction and Return to Sport: A Pilot Study. *Sports Health*, *10*(3), 228–233. https://doi.org/10.1177/1941738117745806

Pranoto, N. W., Fauziah, V., Muchlis, A. F., Komaini, A., Rayendra, R., Susanto, N., Fitriady, G., Setyawan, H., Pavlovic, R., Sibomana, A., & Nadyisenga, J. (2024). in motor skills of s Exploration of Children's Motor Skills with Stunting Vs. Non-Stunting. *Retos*, *54*, 224–234. https://doi.org/10.47197/retos.v54.103107

Racinais, S., Cocking, S., & Périard, J. D. (2017). Sports and environmental temperature: From warming-up to heating-up. *Temperature*, *4*(3), 227–257. https://doi.org/10.1080/23328940.2017.1356427

Septiantoko, R., Murdiono, M., Saliman, S., Setyawan, H., García-Jiménez, J. V., Latino, F., Tafuri, F., Pranoto, N. W., Kurniawan, A. W., Anam, K., Shidiq, A. A. P., Rahmatullah, M. I., & Eken, Ö. (2024). Differences in Achievement in Physical Education Learning Outcomes for High School Students Based on Parental Occupation: Analysis of Differences in Parental Social Status in Providing Learning Motivation. *Retos*, *55*, 882–888. https://doi.org/10.47197/retos.v55.105980

Setyawan, H., Alim, A. M., Listyarini, A. E., Suri, P. T., Mahsusi, J., Rahmatullah, M. I., Sugiarto, T., Shidiq, A. A. P., Kozina, Z., Eken, Ö., Latino, F., Tafuri, F., & Pranoto, N. W. (2024). Implementation of Archery Class Management at the Pre-Extracurricular Program Stage To Improve Archery Skills of Elementary School Students. *Retos*, *55*, 867–873.

https://doi.org/10.47197/retos.v55.105275

Setyawan, H., Sumaryanto, Suyanto, Suharjana, García-Jiménez, J. V., Pavlovic, R., Nowak, A. M., Susanto, N., Darmawan, A., HB, G., Shidiq, A. A. P., Hardianto, & Suwanto, F. R. (2024). The Importance of Archery Education Management in Physical Education Classes and Curriculum Programs for Students to Gain Skills in Many Areas. *Retos*, *53*, 242–249. https://doi.org/https://doi.org/10.47197/retos.v53.101973

Setyawan, H., Suyanto, S., Ngatman, N., Purwanto, S., Suyato, S., Darmawan, A., Shidiq, A. A. P., Eken, Ö., Pavlovic, R., Latino, F., Tafuri, F., Wijanarko, T., Ermawati. S, E. S., & Gusliana HB, G. H. B. (2024). The Effect Of Implementing Physical Education Class Management Archery Material To Improve Concentration Elementary School Students. *Retos*, *56*, 879–886. https://doi.org/10.47197/retos.v56.105216

Setyawan, H., Suyanto, Suharjana, Prasetyo, Y., Wayoi, D. S., Hardianto, Susanto, N., Gani, I., & Rithaudin, A. (2023). Archery Sport Class Management Using Demonstration Methods To Improve Results Learn Beginner Archery Skills. *Fizjoterapia Polska*, *23*(4), 208–218. https://doi.org/https://doi.org/10.56984/8ZG20A80C

Setyawan, H., Suyanto, Suharjana, Sumaryanto, Prasetyo, Y., Wayoi, D. S., Hardianto, Susanto, N., Gani, I., Komari, A., & Mardiyah, S. U. K. (2023). The Effect of Archery Class Management Implementation Using The 3-Step Focus Technique for Beginners. *Journal of Physical Education and Sport*, *23*(9), 2503–2512. https://doi.org/10.7752/jpes.2023.09288

Sharma, S., Killedar, R., Bagewadi, D., & Shindhe, P. (2021). Protocol based management of common sports injuries by integrated approach of Sandhi Marmabhighata - An open labeled clinical trial. *Journal of Ayurveda and Integrative Medicine*, *12*(1), 119–125. https://doi.org/10.1016/j.jaim.2020.12.009

Slagers, A. J., van Veen, E., Zwerver, J., Geertzen, J. H. B., Reininga, I. H. F., & van den Akker-Scheek, I. (2021). Psychological factors during rehabilitation of patients with Achilles or patellar tendinopathy: a cross-sectional study. *Physical Therapy in Sport*, *50*, 145–152. https://doi.org/10.1016/j.ptsp.2021.04.010

Sonesson, S., Gauffin, H., & Kvist, J. (2021). Early knee status affects self-reported knee function 1 year after non-surgically treated anterior cruciate ligament injury. *Physical Therapy in Sport*, *50*, 173–183. https://doi.org/10.1016/j.ptsp.2021.05.007

Sonesson, S., Österberg, A., Gauffin, H., Ardern, C. L., Kvist, J., & Hägglund, M. (2021). Low correlation between functional performance and patient reported outcome measures in individuals with non-surgically treated ACL injury. *Physical Therapy in Sport*, *47*, 185–192. https://doi.org/10.1016/j.ptsp.2020.12.006

Spanou, A., Mamais, I., Lamnisos, D., & Stasinopoulos, D. (2020). Reliability and validity of the Greek shoulder pain and disability index in patients with shoulder pain. *Disability and Rehabilitation*, *42*(9), 1299–1304. https://doi.org/10.1080/09638288.2018.1519728

Weerapong, P., Hume, P. A., & Kolt, G. S. (2005). The mechanisms of massage and effects on performance, muscle recovery and injury prevention. In *Sports Medicine* (Vol. 35, Issue 3). https://doi.org/10.2165/00007256-200535030-00004

Widiyanto, W., Setyawan, H., Suharjana, S., Purwanto, S., Indra, E. N., Prayudho, S., García-Jiménez, J. V., Pavlovic, R., Nowak, A. M., Susanto, N., Darmawan, A., Purnomo Shidiq, A. A., & Andriansyah, A. (2024). The Differences Result in Serve Skill of Junior Tennis Players Assessed Based on Gender and Age. *Retos*, *54*, 272–278. https://doi.org/10.47197/retos.v54.102757

Widiyanto, W., Setyawan, H., Suharjana, S., Purwanto, S., Indra, E. N., Sujarwo, S., Prayudho, S., García-Jiménez, J. V., Pavlovic, R., Eken, Ö., Purwanto, S., Darmawan, A., Shidiq, A. A. P., Rahmatullah, M. I., & Wali, C. N. (2024). Fitness Levels of Elementary School Students Based on Gender and Race in Indonesia: Are There Differences? *Retos*, *55*, 963–968. https://doi.org/10.47197/retos.v55.105679

Yani, A., Henjilito, R., Noviardila, I., Hasan, B., Setyawan, H., Shidiq, A. A. P., Gerdijan, N., Latino, F., Eken, Ö., Zulbahri, Z., Kurniawan, A. W., & HB, G. (2024). The Role of School Supervisors in the Quality Assurance of Physical Education Learning: A Systematic Review. *Retos*, *57*, 589–597. https://doi.org/10.47197/retos.v57.107189

Yeung, T. S. M., Wessel, J., Stratford, P., & Macdermid, J. (2009). Reliability validity, and responsiveness of the lower extremity functional scale for inpatients of an orthopaedic rehabilitation ward. *Journal of Orthopaedic and Sports Physical Therapy*, *39*(6), 468–477. https://doi.org/10.2519/jospt.2009.2971

Young, K. (2019). *The Suffering Body in Sport: Shifting Thresholds of Pain, Risk, and Injury* (First Edit). Emerald Publishing Limited.

Zanada, J. F., Setyawan, H., Susanto, N., Bahtra, R., Wijanarko, T., Anam, K., Fitriady, G., García-Jiménez, J. V., Pavlovic, R., & Nowak, A. M. (2024). Reducing Dysmenorrhea In School-Aged Teenagers By Practising Yoga: A Literature Review. *Retos*, *54*, 76–83. https://doi.org/10.47197/retos.v54.103066

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