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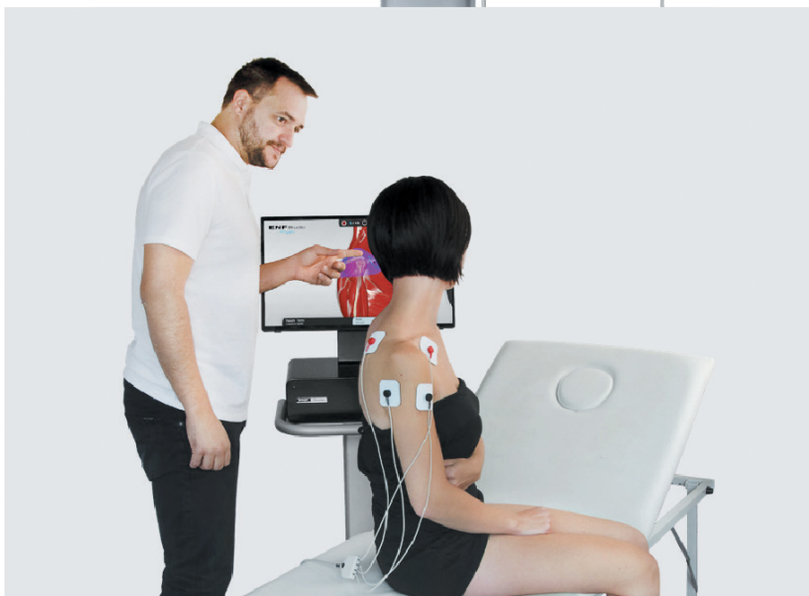

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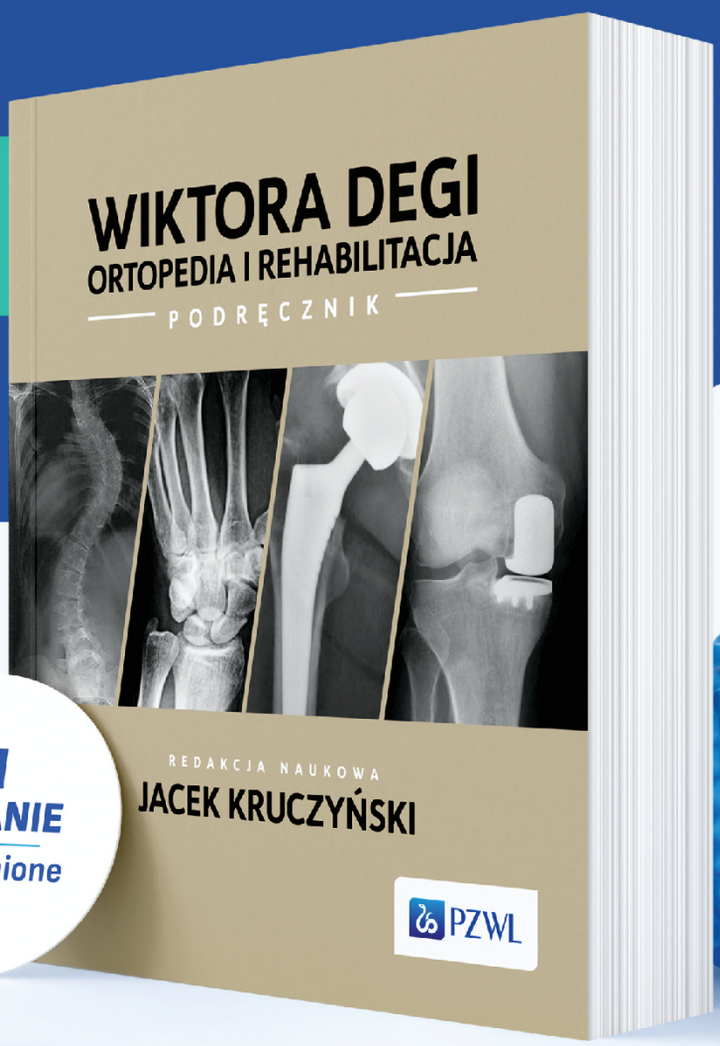

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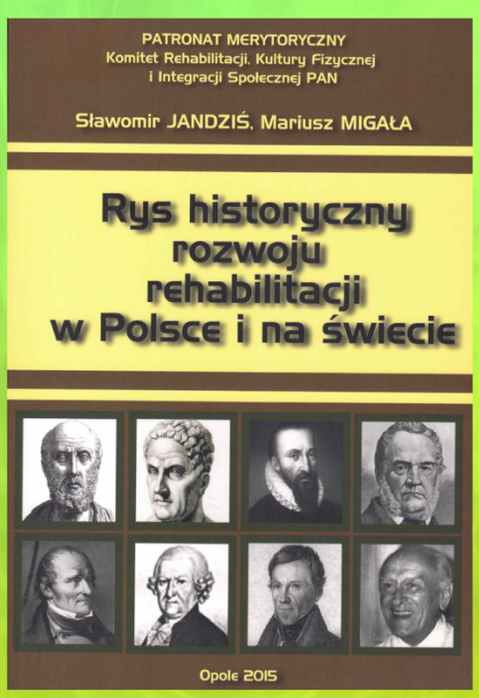

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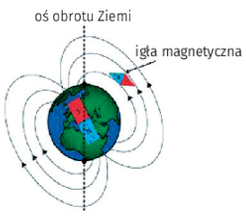

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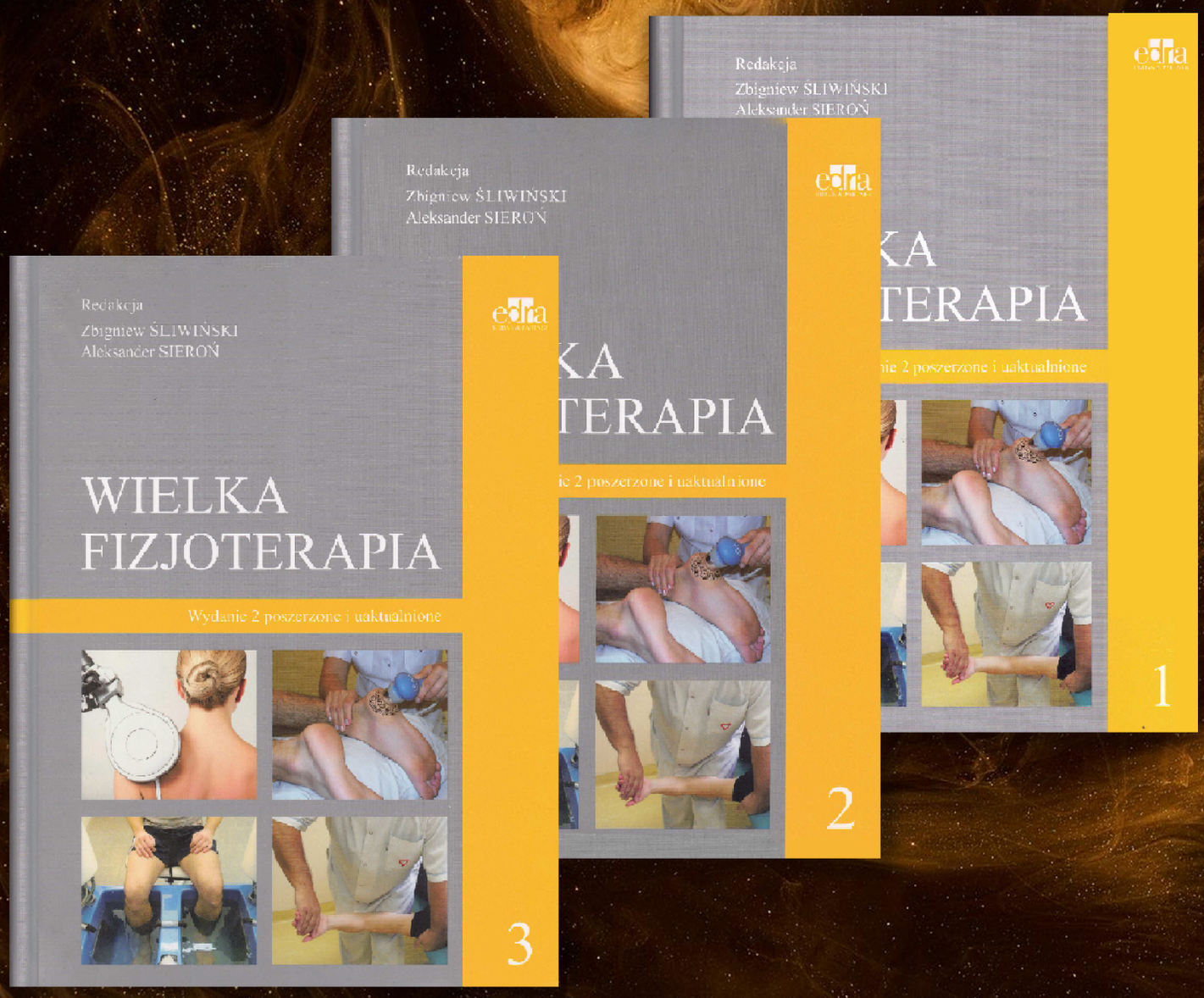

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The impact of knee pain on body balance and electromyographic activity of the quadriceps muscle in fencers during the lunge movement

Wpływ bólu kolana na równowagę ciała i aktywność elektromiograficzną mięśnia czworogłowego u szermierzy podczas ruchu wypadu

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Abstract

Introduction. The lack of research on fencing in Indonesia and the absence of analysis on muscle activation in the lower leg muscles, especially the quadriceps muscles, during fencing movements, such as lunges, is a significant gap in the existing literature. This knowledge gap is especially pronounced for athletes with knee pain and quadriceps angle differences. Knee pain causes athletes to experience a decrease in performance, one of which is caused by a decrease in balance. Purpose: This study aims to determine the difference in balance in athletes with knee pain and without knee pain and to determine the activation of the rectus femoris muscle, vastus medialis muscle, and vastus lateralis muscle in the lunge movement in athletes participating in fencing with sable and floret numbers. in the Fencing Sports Activity Unit at Tunas Pembangunan University (UTP) Surakarta. Methods. A descriptive and analytical observational research design was employed for this cross-sectional study, using purposive sampling to recruit seven fencing athletes of UTP. Stork balance test was used to check the balance score and surface electromyography records were used to collect data, and the data analysis was conducted using the nonparametric Mann-Whitney U test. Results. The results of this study prove that the body balance scores of athletes who have complaints of knee pain are significantly worse ($p < 0.05$) compared to fencers who do not have complaints of knee pain. Knee pain also significantly reduced the activation of the rectus femoris, vastus medialis, and vastus lateralis muscles ($p < 0.05$). Conclusion. Based on the results and discussion above, knee pain significantly decreases body balance and quadriceps muscle activity.

Keywords

knee pain, body balance, quadriceps, muscle activity, electromyography

Streszczenie

Wprowadzenie. Badania nad szermierką w Indonezji są ograniczone, zwłaszcza jeśli chodzi o aktywację mięśni dolnej części nogi, a w szczególności mięśni czworogłowych, podczas ruchów szermierczych, takich jak wypad. Ta luka w literaturze jest jeszcze bardziej widoczna u sportowców z bólem kolana i różnicami kątów mięśni czworogłowych. Ból kolana może prowadzić do obniżenia wyników sportowca, głównie z powodu utraty równowagi. Cel. Celem tego badania jest ocena różnic w równowadze między sportowcami z bólem kolana a sportowcami bez bólu kolana. Badanie ma również na celu określenie aktywacji mięśni prostego uda, mięśni środkowego przyśrodkowego i mięśni środkowego bocznego podczas ruchu wypadu u sportowców rywalizujących w konkurencjach szabli i floretu w Jednostce Aktywności Sportowej Szermierki Uniwersytetu Tunas Pembangunan (UTP) w Surakarcie. Metody. W badaniu zastosowano opisowy i analityczny projekt badania obserwacyjnego. Za pomocą celowego próbkowania rekrutowano siedmiu szermierzy UTP. Do pomiaru równowagi użyto testu równowagi Storka, natomiast do rejestrowania aktywacji mięśni użyto powierzchniowej elektromiografii. Dane analizowano za pomocą nieparametrycznego testu U Manna-Whitneya. Wyniki. Wyniki wskazują, że sportowcy z dolegliwościami bólowymi kolana mają znacząco gorsze wyniki równowagi ciała ($p < 0,05$) w porównaniu z tymi, którzy takich dolegliwości nie mają. Ból kolana również znacząco obniżył aktywację mięśni prostego uda, środkowego przyśrodkowego i środkowego bocznego ($p < 0,05$). Wnioski: Ból kolana znacząco obniża zarówno równowagę ciała, jak i aktywność mięśni czworogłowych.

Słowa kluczowe

ból kolana, równowaga ciała, czworogłowy uda, aktywność mięśniowa, elektromiografia

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Introduction

Fencing is a martial sport involving three techniques and weapons: sable, degen, and floret. Fencing has been identified as a sport with a high risk of injury by the International Olympic Committee (IOC) [1]. This is mainly due to the rapid change of direction when the athlete is attacking and defending [2]. According to an epidemiological study by Byung on South Korean fencers, 47.2% of the total injuries recorded were lower extremity injuries, and knee injuries were among the most common [3]. Furthermore, based on a documentary analysis study conducted on athletes who are members of the training camp for the XVII Indonesian National Sports Week DKI Jakarta Provincial Team, the prevalence of injuries increased within three years from 2009–2012 in line with the addition of sports to the training program and increased training intensity [4]. In another study, Junaidi found that 30% of DKI Jakarta athletes participating in the XIX Indonesia National Sports Week suffered injuries. Among these athletes, 38% had moderate injuries, and 17% had severe injuries [5]. The knee joint plays an important role in fencing because it is the main focus of body weight during footwork [6, 7].

When lunging or keeping your distance from your opponent, footwork in fencing entails a combination of forward and backward foot movements [8]. Lower extremity muscle strength, body mass, balance, leg length, and flexibility all have a significant impact on movement during lunges. The ability to control balance and lunge effectiveness both depend on the quadriceps' strength, which can also change the quadriceps' angle. In order to win matches against opponents more easily or to be balanced, a fencer needs to be able to control the position of their body [9]. Balance refers to how easily a person can control and maintain their body position. Because this agility must be in a state where it is possible to maintain balance while also being aware of one's body's position, playing fencing must also be balanced. On the bottom of the foot, the flexor digitorum brevis is involved [10].

During a lunge, the fencer utilizes the strength and speed of the quadriceps muscle groups, especially the straight thigh and side hip muscles. Contraction of the straight thigh muscles is helpful for efficient lunging in fencing, soccer, and badminton. Although quadriceps muscle activation plays an important role during lunging movements, knee joint anthropometric factors also affect the amount of muscle activation [11]. Of course, fencing athletes who have complaints of knee pain will greatly affect the quality of the game and the achievements produced in a competition. Therefore, the researcher is interested in conducting a research entitled "Knee pain affects to body balance and electromyographic activity quadriceps muscle in fencing athletes during lunge movement".

Method

Study design

This research is a correlational study to see and analyze knee pain's correlation to body balance and electromyographic activity of quadriceps muscle in fencing athletes during lunge movement. This investigation occurred on the fencing athlete pitch at Universitas Tunas Pembangunan in December 2022–January 2023.

Participants

In this study, an analytic observation approach was used to examine a sample of 40 fencing athletes at Universitas Tunas Pembangunan, Surakarta, aged between 12–25 years. The sampling technique used purposive sampling, with inclusion criteria such as having complaints of knee pain, being a male or female fencing athlete at Tunas Development University with approximately one year of fencing experience, having participated in competitions, and being willing to participate in research. Exclusion criteria consisted of not being present during measurement, undergoing post-injury rehabilitation, or injury. Of the athletes selected, only 18 met the inclusion criteria.

Ethical considerations

The research ethics committee of the Faculty of Medicine Universitas Islam Sultan Agung, Semarang, Jawa Tengah has given approval to this study No. 413/XI/2022/Bioethic Committee. Prior to conducting the research, the respondents had agreed and signed their consent to become research respondents after reading of the experimental methods.

Outcome measurement

Before the actual research was carried out, the participants were asked to fill out a questionnaire that included questions about their identities as well as their ages, heights, weights, and body mass index measurements. The formula for determining a person's body mass index is kg/m2, which can be found in the BMI Calculator. This formula can be used to determine a person's BMI [12, 13]. Because of this, the data regarding BMI are utilized as supporting data for this study.

Table 1. Body Mass Index Category [12]

Category	Body Mass Index Score
Underweight	< 18.5
Normal	18.5–25
Overweight	25–30
Obesity	> 30

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The second measurement uses a balance test with a standing stork test. The standing stork balance test is very simple. The balance test is done by standing on one leg with closed eyes. This test is usually used to measure static balance. When comparing the Standing Stork Test to other balance tests for the functional balance test, the Standing Stork Test is typically considered the "gold standard." When a person is 15 to 30 years old, they have the highest average of 26 to 39 seconds to stand on one leg.

Table 2. Standing Stork Balance Test Rate [14]

Category	Score (second)
Not enough	< 10
Enough	10–24
Average	25–39
Good	40–50
Very Good	> 50

The third measurement involves measuring the activation of the quadriceps muscles via electromyography (EMG) during the lunge. Before recording, respondents were asked to warm up. Next, the examiner attaches EMG electrodes to the vastus medial and lateral muscles and the rectus femoris muscle. The participants were asked to remain silent and lunge while sparring with their friends. Each participant completed three lunges for EMG recording to ensure complete data.

Data analysis

Windows version 23 of the Statistical Program for the Social Sciences was used for the statistical analysis. The researchers started by performing a levene test to determine whether or not the data were distributed consistently. The researchers then used the mann whitney was used by the researchers so that they could determine how knee pain affects to body balance and electromyographic activity quadriceps muscle in fencing athletes during lunge movement

Table 3. Sample population

	Category	Frequency	Percentage
Sex	Male	9	50%
	Female	9	50%
	Total	**18**	**100%**
Age	16–17	10	55.5%
	18–19	3	16.7%
	20–21	2	11.1%
	22–23	3	16.7%
	Total	**18**	**100%**
BMI	Underweight	8	44.45%
	Normal	8	44.45%
	Overweight	2	11.1%
	Obesity	0	0%
	Total	**18**	**100%**
Knee pain	Knee pain	8	44.45%
	No nnee pain	10	55.55%
	Total	**18**	**100%**

This study has a sample of 18 respondents. Of the 18 samples, 9 respondents (50%) were male, and 9 respondents (50%) were female. The age of the respondents in this study was between 16–23 years old. Most respondents were 16–17 years old, 10 people

doi.org/10.56984/8ZG143F33

(55%). Then the respondents aged 18-19 amounted to 3 people (17%). Respondents aged 20-21 were 2 people (11%), and respondents aged 22–23 were 3 people (17%).
Body mass index in this study, respondents with underweight BMI consisted of 8 respondents. Normal BMI consists of 8 respondents and overweight consists of 2 respondents.
In this study, 8 respondents complained and had a history of knee injuries/knee pain. Meanwhile, 10 respondents had no history of complaints of knee pain injuries.

Table 5. Result Standing Stork Balance Test

Category	No knee pain		Knee pain		p-value
	Freq	%	Freq	%	
Very less	0		1	0	0.01
Not enough	1		3	0	
Pretty good	5		2	0	
Good	3		1	0	
Very good	1		0	0	
Total	**10**	**100%**	**8**	**100%**	

In the process of taking static balance data using the standing stork balance test, the following results are obtained. For respondents who did not complain and did not have a history of knee injuries/pain, there was 1 respondent whose level of balance was not enough, 5 respondents with a pretty good balance level, 3 respondents with a good balance level, and 1 respondent with a very good balance level.

Whereas in the group of respondents who complained and had a history of knee injuries/pain, there was 1 respondent whose level of balance was very less, 3 respondents with a level of balance not enough, 2 respondents with a level of pretty good balance and 1 respondent with a level of balance good. In this case, knee pain has a significant effect on the static balance of the fencing athlete $p < 0.05$.

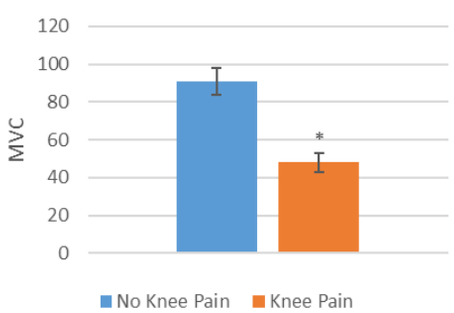

Figure 1. Electromyographic Activity Rectus Femoris Muscle

Maximal Voluntary Contraction of the rectus femoris muscle proves that the average of respondents who do not have complaints of knee pain is 91kg ± 7.3kg, significantly greater $p < 0.05$ when compared to the rectus femoris muscle in respondents who experience knee pain which only gets 48kg ± 5.2kg.

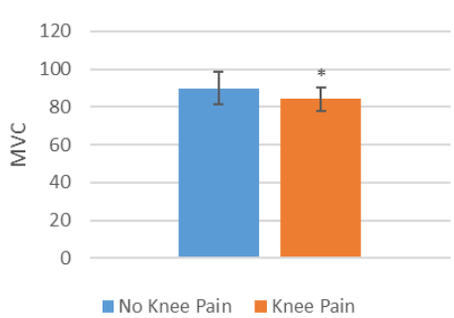

Figure 2. Electromyographic Activity Vastus Medialis Muscle

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Maximal Voluntary Contraction of the vastus medialis muscle proves that the average of respondents who do not have knee pain complaints is 90kg ± 8.5kg, significantly greater $p < 0.05$ when compared to the rectus femoris muscle in respondents who experience knee pain which only gets 84.14kg ± 6.1kg.

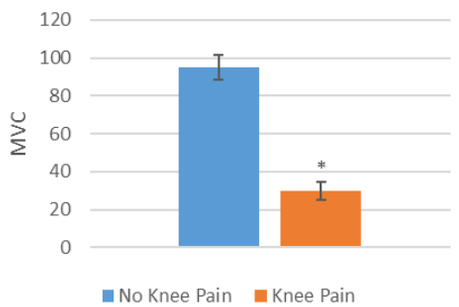

Figure 3. Electromyographic Activity Vastus Lateralis Muscle

Maximal Voluntary Contraction of the vastus medialis muscle proves that the average of respondents who do not have knee pain complaints is 90kg ± 8.5kg, significantly greater $p < 0.05$ when compared to the rectus femoris muscle in respondents who experience knee pain which only gets 40.33kg ± 6.1kg.

Discussion

From a study conducted by researchers on 18 fencing athletes, there was a significant difference in static balance values between groups who had knee pain complaints and those who did not have knee pain complaints. There are many balance problems in athletes with complaints of knee pain, both static and dynamic balance, where body balance is influenced by several factors, such as quadriceps muscle strength [15].

Weakness of the quadriceps muscle almost follows any injury and knee pain disorder [16]. Strength deficits more significant than 30% in the affected limb compared to the contralateral limb have been reported six months after knee injuries when patients often return to total activity. The presence of quadriceps muscle weakness may be dangerous for the patient. The quadriceps muscles are essential for lower extremity control during dynamic activities, and quadriceps muscle weakness can change movement strategy, potentially resulting in re-injury [17].

From a study conducted on 18 fencing athletes during lunges, it was found that there was a significant effect between complaints of knee pain and muscle activation. Some things that affect the activation of the muscles that experience changes are due to several factors, one of which is that the knee joint has lower stability anatomically when compared to other joints, such as the shoulder, which has the glenoid cavity and humeral head, the hip joint which has the acetabulum and the femoral head which structurally very stable [18]. Furthermore, in the knee joint, its stability depends heavily on the surrounding soft tissues such as the meniscus ligaments, bursa, tendons, and muscles so that when a knee injury occurs, it causes changes in the neuromuscular system, one of which is a change in muscle activation [19].

In this study, the rectus femoris muscle had different results between respondents with knee pain complaints and those who did not have joint pain complaints. These results are in accordance with previous studies which stated that reduced activity in the hamstring, quadriceps, and gastrocnemius muscles could reduce the adduction movement of the thigh in patients with knee pain [20]. The rectus femoris muscle is anatomically attached to the proximal portion of the patella and through the patellar ligament to the tibial tuberosity [21]. It is the main muscle responsible for knee extension. Pain located at the front of the knee can significantly affect the activation of the rectus femoris muscle. Imbalance in the work of the quadriceps muscles can also cause a decrease in activating the rectus femoris muscles in individuals who experience pain [22]. Voight and Wieder suggested that motor control deficits in patients with knee pain could reverse the activation sequence of the vastus medialis and vastus lateralis muscles, leading to decreased rectus femoris muscle activation [23]. Some research recommend strengthening exercises for the vastus medialis and lateralis muscles will not reduce pain if the prime movers are not properly trained [24].

Then in the vastus medialis muscle, respondents who complained of knee pain had almost the same muscle activation value when compared to the muscles of respondents who did not have knee pain complaints. The vastus medialis muscle inserts on the patella and functions to pull the patella inward so that when pain occurs in the knee area, this muscle is not too affected [25]. Weakness in the vastus medialis muscle from pain can be compensated for by the popliteus muscle, which helps the muscle function properly [26].

The electromyography results explain that when knee joint pain occurs, it does really affect the activation of the vastus medialis. This happens because, in general, when athletes perform lunges, the vastus medialis contracts eccentrically while the rectus femoris contracts concentrically; this is called the co-activation mechanism [27]. Therefore, when there is an increase in pain, the vastus medialis muscle will increase its activation to maintain knee joint stability, while the vastus lateralis and rectus femoris muscles will decrease their activation as a compensatory strategy so as not to cause other, more severe injuries [28]. On the other hand, knee pain can cause changes in the H: Q ratio (hamstring: quadriceps ratio), where when there is an increase in pain, quadriceps activation increases and hamstring decre-

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ases. When the hamstring decreases, activation will cause high other injury factors, such as hamstring strains [29].

Conclusion

Based on the results and discussion above, knee pain significantly decreases body balance and quadriceps muscle activity.

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Piśmiennictwo/ References

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