



ORIGINAL SCIENTIFIC ARTICLE

THE EFFECT OF LIMB MUSCLE EXPLOSIVE POWER, FLEXIBILITY, AND ACHIEVEMENT MOTIVATION ON SICKLE KICK PERFORMANCE IN PENCAK SILAT LEARNING

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Abstract

Study Purpose. This study background is that the performance of the sickle kick in Pencak Silat learning is very important to improve the athlete's performance during the match, both when attacking and defending. The objective is to analyze the performance of the Pencak Silat sickle kick in terms of the quality of physical conditions (such as leg muscle explosive power and flexibility), and psychological elements (such as achievement motivation).

Materials and methods. This study involved Pencak Silat athletes of Tangan Mas College, Padang, Indonesia. The participants who became the study sample were 30 male athletes aged 14–17 (athletes in the adolescent category). The sample selection was based on the sample criteria providing that participants had participated in regional level competitions and had attended training for at least 2 years. Data were obtained from several tests and measurements: leg muscle explosive power was measured using the Vertical Jump Test and then processed by the Lewis formula (nomogram). Flexibility was measured using the Side Split Test, achievement motivation was assessed using a questionnaire validated by experts, and a sickle kick performance was tested. The data obtained were analyzed using simple regression analysis and multiple regression analysis, followed by path analysis to calculate the coefficient value of each variable.

Results. The data obtained were analyzed using structural model path analysis. Results: (1) there is an effect of leg muscle explosive power on the sickle kick performance by 21.59%; (2) there is an effect of flexibility on the sickle kick performance by 6.94%; (3) there is an effect of achievement motivation on the sickle kick performance by 9.74%; (4) there is an effect of leg muscle explosive power through achievement motivation on the sickle kick performance by 38.14%; (5) there is an effect of flexibility through achievement motivation on the sickle kick performance by 13.51%; and (6) there is a simultaneous effect of these variables by 51.41%.

Conclusions. Based on the analysis of the three factors above, it was concluded that leg muscle explosive power is the dominant factor and needs to be taught and trained seriously. However, the other factors are no less important. Future studies are urgently needed to include other variables that affect the results of this study, as well as a wider number of samples to validate the results of this study.

Keywords: Pencak Silat learning, limb muscle explosive power, flexibility, achievement motivation, sickle kick.

Introduction

Martial arts around the world are stepping phase rapid development, such as, MMA, Wing Chun, Karate, Judo Kungfu, Tai Chi, Shorinji Kempo, Jiu Jitsu, Taekwondo,

Muay Thai and Pencak Silat. This martial art has the characteristics of different moves/techniques in its implementation (Tack, 2013). Martial arts are characterized by high intensity requiring complex skills, emphasizing exercises that harmonize body, soul, and mind (Reishehrei et al., 2014), are also useful as self-defense. The others study said that exercise can form a positive character in humans.

Pencak Silat is one of the fastest-growing martial arts in Indonesia (Kartomi, 2011). It is proven by Pencak Silat being used as one of the lessons in the Physical Education

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curriculum (from Elementary School, Junior High School, Senior High School, to Higher Education). Physical condition is one of the components that must get serious attention for teachers/trainers in the preparation of training/teaching programs (Ihsan et al., 2020). Exercise is a structured and planned learning activity, the initial portion of exercise (learning) is more emphasized on physical conditions (Saputra & Ihsan, 2020). The others study suggested that the physical and physiological state of athletes are supporting factors to determine the quality of athlete performance in a sport (Bridge et al., 2014).

One of the important elements that must be taught and trained in Pencak Silat is kicking, because it can affect a fighter's performance, both when attacking and defending (van der Kruk et al., 2016). Kick technique in martial arts is a complex series, consisting of a series of elements to produce an integrated movement (Quinzi et al., 2016). The common kicking technique in martial arts is the "circle" type (Estevan et al., 2015). This complex kick is also the type of kick that is most often used in competition (Zago et al., 2015).

Power is a physical component to overcome the burden at high contraction speed in the fastest time possible. The basis of explosive power is strength and speed, such as jumping, hitting, running at high speed (Sampaio et al., 2014), throwing, and kicking (Ozbar, 2015). Lower leg muscle function is related to kicking ability. Asymmetry between the legs is associated with decreased kicking ability and a higher risk of injury (Eagle et al., 2019; Ryu & Lee, 2021). Flexibility is defined as the ability of joints to perform movements over a wide range (Pinto-Escalona et al., 2021). This is because flexibility is the main source of controlling the power of a punch or kick, then strength is the main driver in producing a fast and strong attack rate to penetrate the opponent's defense (Lipowski et al., 2019).

In addition to the explosive power of leg muscles and flexibility in the ability to kick the sickle, motivation is a psychological element that needs to be a "question" in learning Pencak Silat. The main psychological characteristic associated with study and exercise habits among children and adolescents is achievement motivation (Shekhar & Devi, 2012). Achievement motivation is a theoretical model that is intended to explain how the motives for achieving goals and motives for avoiding failure. Achievement motivation consists of two components: (1) Motivation to pursue goals that enhance one's performance or knowledge with reference to past levels, regardless of the values of others and society (attainment of self-fulfillment), and (2) Motivation aimed at seek social prestige by beating or achieving better results than others (competitive achievement motivation) (Horino & Mori, 1991).

Basically, Pencak Silat requires quality physical and psychological conditions. To display the quality of the physical and psychological condition of an athlete, interaction between coaches and athletes is needed, as well as adequate infrastructure. Interaction between individuals is one of the important factors in establishing reciprocal relationships between individuals and groups. Seeing this problem, especially in Pencak Silat learning which requires quality physical and psychological conditions, then a person or group requires reciprocal interaction during the learning/training process so that athletes can improve their performance to the maximum during matches. Based on this phenomenon,

we studied scientific data to analyze Pencak Silat's sickle kick ability in terms of: the quality of physical condition (eg, leg muscle explosive power, flexibility) and psychological (eg, achievement motivation).

Materials and Methods

Participant

This study involved Pencak Silat athletes at the Tangan Mas College, Padang, Indonesia. The participants who became the research sample were 30 athletes with an age range of 14-17 (athletes in the adolescent category) and male. Sample selection based on sample criteria had participated in regional level competitions and had attended training for at least 2 years.

Procedure

This research is an associative quantitative with path analysis model. This study will examine and evaluate the effect of leg muscle explosive power (X_1), flexibility (X_2) and achievement motivation (X_3) on sickle kick ability (Y). The following is a chart and procedure for this research (Fig. 1).

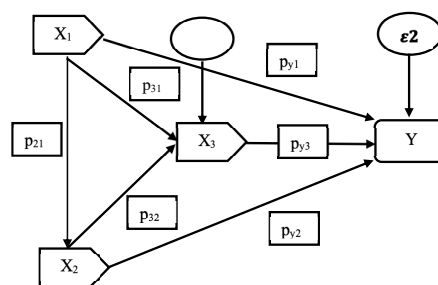


Fig. 1. Research Path Diagram

Based on Picture 1, the procedure in this study through 2 stages of testing the structural model. The first model (structural 1) is leg muscle explosive power (X_1), flexibility (X_2) and achievement motivation (X_3). While the second model (structural 2) is leg muscle explosive power (X_1), flexibility (X_2), achievement motivation (X_3) and sickle kick ability (Y) (Fig. 2, 3).

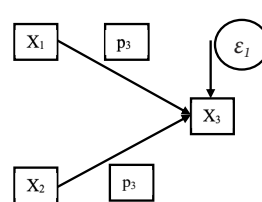


Fig. 2. Path Diagram of Structural Model One

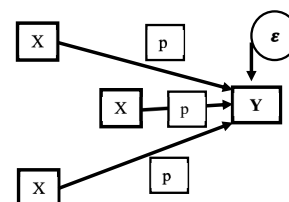


Fig. 3. Path Diagram of Structural Model Two

Instrument

Data in this research were obtained from several tests and measurements: (a) the explosive power of the leg muscles was obtained through the Vertical Jump Test where the data will be the difference between achievement score and

range score. Then, weight measurement was also carried out and then the data was processed using the Lewis nomogram with the formula:

$$P = \sqrt{4.9 \cdot \text{Weight} \cdot \sqrt{D}},$$

Remark: P = Power (kg.m/s), Weight = Sampel Weight (kg), D = Score Vertical Jump (m).

(b) Flexibility is obtained through the Side Split Test. Athletes who were sampled did a side split test by opening their feet as wide as possible to form the lowest possible position. The data in this study were the distance between the floor and the groins; (c) achievement motivation is obtained through questionnaires validated by experts; and (d) Pencak Silat sickle kick ability test. The sample performs a kick towards the target as quickly as possible with the left and right foot for 10 seconds.

Data Analysis

Data were analyzed using simple regression analysis and multiple regression analysis, then continued with path analysis to calculate the coefficient value of each variable.

Result

The objective of descriptive analysis in the research data is to describe the discrimination of differences in the explosive power of leg muscles, flexibility, achievement motivation, and sickle kicks of Pencak Silat athletes, from the average value, standard deviation, minimum value, maximum value, and total amount based on the test results and measurement. The recap of descriptive analysis of data from each variable is shown in the following table.

Table 1. Descriptive Analysis

Remark	Limb Muscle Explosive Power (P)	Flexibility	Achievement Motivation	Sickle Kick
Amount	3320.63	438.70	2264.78	754.00
Average	110.69	14.62	75.49	25.13
SD	10.83	4.94	2.02	1.92
Maximum	132.36	25.60	79.57	30.00
Minimum	96.23	8.00	71.74	22.00

According to Table 1, descriptive analysis stated that there are differences in each variable. This is evidenced by the average value of each (110.69 kg.m/s, 14.62 cm, 75.49, and 25.13).

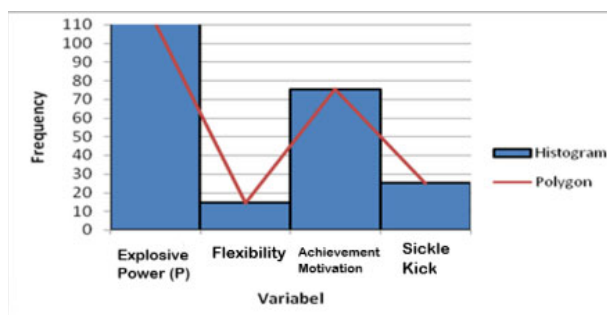


Fig. 4. Histogram of Mean Values for Limb Muscle Explosive Power, Flexibility, Achievement Motivation, and Sickle Kick

The detail information, the description of the data on the variables can be seen in the table below.

Table 2. Sickle Kick Performance

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 28	4	13.33	Very Good
2	27-26	8	26.67	Good
3	25-24	11	36.67	Satisfied
4	23-22	7	23.33	Poor
5	≤ 21	0	0.00	Very Poor
TOTAL		30	100.00	

Based on the table above, it can be seen that most athletes have the ability to kick the sickle in the moderate category. For more details can be seen in the diagram below:

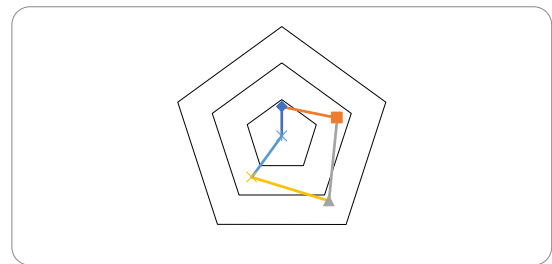


Fig. 5. Sickle kick ability data diagram

Table 3. Limb Muscle Explosive Power

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 127.05	3	10.00	Very Good
2	126.94-116.21	7	23.33	Good
3	116.1-105.27	7	23.33	Satisfied
4	105.16-94.44	13	43.33	Poor
5	≤ 94.33	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have leg muscle explosive power in the less category. For more details can be seen in the diagram below:

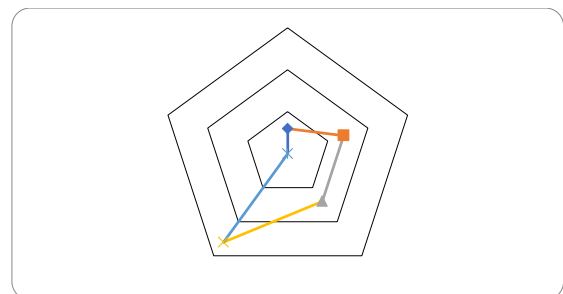
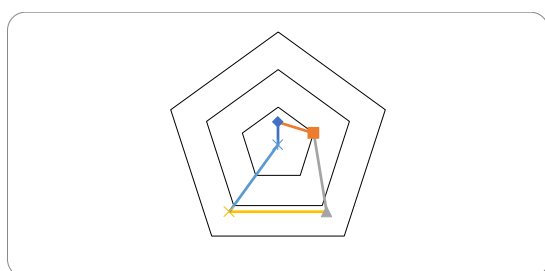


Fig. 6. Data diagram of leg muscle explosive power

Table 4. Flexibility

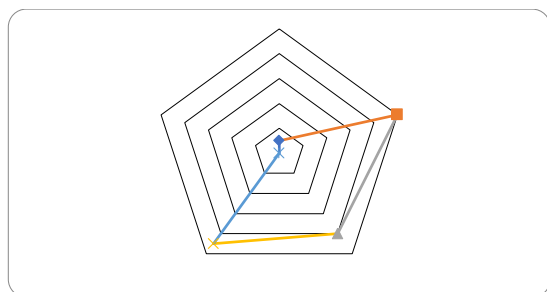
No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 22.09	3	10	Very Good
2	22.04-17.14	5	16.67	Good
3	17.09-12.15	11	36.67	Satisfied
4	12.10-7.21	11	36.67	Poor
5	≤ 7.16	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have flexibility in the moderate and less categories. For more details can be seen in the diagram below:

**Fig. 7.** Flexibility Data Diagram**Table 5.** Achievement Motivation

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 78.54	1	3.33	Very Good
2	78.52-76.52	10	33.33	Good
3	76.49-74.49	8	26.67	Satisfied
4	74.47-72.47	9	30.00	Poor
5	≤ 7.16	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have achievement motivation abilities in the good category. For more details can be seen in the diagram below:

**Fig. 8.** Diagram of achievement motivation data

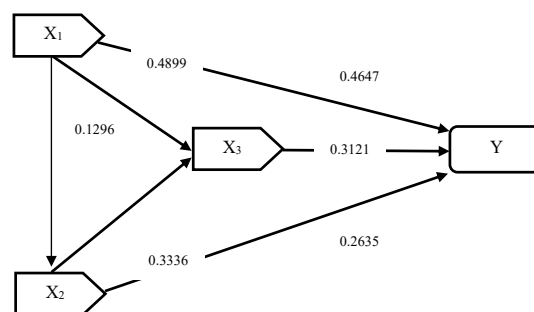
Structural Model

The hypothesis testing result were obtained through two stages of model testing (structural one and structural two). The summary of testing this structural model can be seen in Table 6.

Table 6. Summary of Structural Models One and Two

Structural	Variable	Path Coefficient	t-count	t-table	Remark
One	$X_1 \cdot X_3 (p_{31})$	0.4899	4.5864		Significant
	$X_2 \cdot X_3 (p_{32})$	0.3336	2.2196		
Two	$X_1 Y (p_{y1})$	0.4647	3.6171	1.69	Significant
	$X_2 Y (p_{y2})$	0.2635	2.2263		
	$X_3 Y (p_{y3})$	0.3121	2.2397		

Based on Table 2, the path coefficient of leg muscle explosive power with achievement motivation (p_{31}) is 0.4899, flexibility with achievement motivation (p_{32}) is 0.3336, leg muscle explosive power with sickle kick ability (p_{y1}) is 0.4647, flexibility with sickle kick ability (p_{y2}) obtained 0.2635, and achievement motivation with sickle kick ability (p_{y3}) was obtained 0.3121. In the other words, these two structural models are significant ($t_{count} > t_{table}$).

**Fig. 9.** Combined Results of Structural Model Path Coefficient

Hypothesis Testing

The Influence of leg muscle explosive power on sickle kick ability

Based on the results of testing the structural model two, the path coefficient of the explosive power of the leg muscles on the sickle kick ability (p_{y1}) is 0.4647 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 21.59%.

The Influence of flexibility on sickle kick ability

Based on the results of testing the structural model two, the path coefficient of flexibility on the sickle kick ability (p_{y2}) is 0.2635 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 6.94%.

The Influence of achievement motivation on sickle kick ability

Based on the results of testing the two structural models, the path coefficient value of achievement motivation on sickle kick ability (p_{y3}) is 0.3121 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 9.74%.

Table 7. Summary of Research Result

Path Coefficient	Direct Influence			Indirect Influence			
	Coefficient	(^{^2})	(%)	Intervention	Coefficient	(^{^2})	(%)
X _{1Y} (p _{y1})	0.4647	0.2159	21.59	X1→X3→Y	0.6176	0.3814	38.14
X _{2Y} (p _{y2})	0.2635	0.0694	6.94	X2→X3→Y	0.3676	0.1351	13.51
X _{3Y} (p _{y3})	0.3121	0.0974	9.74				
X ₁ ,X ₂ ,X ₃ →Y		$\rho_{y1}+(\rho_{21}\times\rho_{y2})+(\rho_{31})\cdot(\rho_{y3})+(\rho_{21})+(\rho_{32})\cdot(\rho_{y3})$			0.717	0.5141	51.41

The Influence of leg muscle explosive power through achievement motivation on sickle kick ability

Based on the test results of structural models one and two (X₁→X₃→Y), $p_{31}\cdot p_{y3} = 0.6176 > p_{y1} = 0.4647$. That is, indirectly there is a mediating effect given by the achievement motivation variable on the sickle kick ability of 38.14%.

The Influence of flexibility through achievement motivation on sickle kick ability

Based on the results of testing structural models one and two (X₂→X₃→Y), $p_{32}\cdot p_{y3} = 0.3676 > p_{y2} = 0.2635$ is obtained. That is, indirectly there is a mediating effect given by the achievement motivation variable on the sickle kick ability of 13.51%.

The Influence of leg muscle explosive power, flexibility, and achievement motivation on sickle kick ability

Based on the overall test results, leg muscle explosive power, flexibility, and achievement motivation on the sickle kick ability obtained an effect of 51.41%.

Discussion

Based on these findings, it is necessary to study further why the results of the analysis are accepted as correct and why the explosive power of leg muscles, flexibility, and achievement motivation have a significant effect on the ability of the sickle kick in Pencak Silat learning.

The results of this study indicate that the quality of physical condition (explosive power of leg muscles and flexibility), as well as achievement motivation are the main determinants of the ability to kick the sickle, especially at the Hand College of the City of Padang, Indonesia. This is supported by the results of our descriptive analysis and inferential analysis. If athletes have a good quality of physical condition (explosive leg muscles, flexibility) and achievement motivation, then they can win every match. Likewise, if an athlete does not have the quality of physical condition and achievement motivation, then they will not win every match. The results of this study are supported by the statement, that the physical and technical components play an important role in determining the outcome of the match (Corrêa et al., 2016). Suggested that an athlete has a good quality of physical condition, then they can perform better (Shin et al., 2016). The quality of the physical condition is the dominant basic factor in determining the maximum physical condition so that athletes can gain achievement, and are not easy to experience fatigue when receiving the next training load. Another study states that the stability and technical performance of athletes is determined by the physical ability of the athlete himself (Lipowski et al., 2019).

Pencak Silat is categorized as a sport with complex movements, performed with high speed and good stamina. This intense martial art requires the support of physical abilities (such as strength, stamina, speed, and muscle endurance) that are involved during the training process and matches (Lenetsky & Harris, 2012). Successful sports performance at the elite level of competition is often highly dependent on the explosive power of the athlete's leg muscles (James et al., 2016). Trainers need to develop training techniques designed to improve and measure the explosive power of the athlete's leg muscles (Haff & Stone, 2015; Muceli et al., 2010). Vertical jump has been widely used by professional sports as a direct assessment method to measure limb muscle explosive power (Haff & Stone, 2015), and to determine the effectiveness of training programs (Hara et al., 2006; Peráček et al., 2018). Another study stated that the better the level of flexibility of the body in the hips, the easier it will be to control the speed and power generated. In the literature, sequential actions have been analyzed only for the one-footed technique (Estevan et al., 2015; Jemili et al., 2017; Zago et al., 2015), with the exception of Hoblin (Höbling et al., 2017), and the case study by Alsamad for multiple kicks. The functional phase is defined solely for the action of the kicking leg (Quinzi et al., 2016). Errors in assessment/measurement may occur, therefore the use of technology is very important in measuring sports (Saputra & Ihsan, 2020).

Achievement motivation is a determining factor for athletes to excel, and factors that influence the athlete's appearance during matches. Therefore, the athlete's achievement motivation is one of the psychological indicators to support the athlete's success. Findings from other sports, suggest that several motivational constructs (eg, achievement motivation, achievement goal orientation, self-determination) are relevant for talent development and later success (Forsman et al., 2016; Gillet et al., 2009; MacNamara et al., 2010; Ihsan et al., 2021). Athlete motivation is well researched in the field of sports psychology, with many books and articles written on this issue (Hagger & Chatzisarantis, 2008; Zuber et al., 2015)). Previous research has focused on theories such as: goal attainment orientation (Biddle et al., 2003) and self-determination theory both of which have been helpful in framing and guiding current understanding of athlete motivation for achievement.

Conclusion

Based on these findings, it conclude that the ability to kick the sickle in Pencak Silat learning has a relationship with leg muscle explosive power, flexibility, and achievement motivation. Of these three factors, the explosive power of the

leg muscles is the dominant factor that affects the results of the sickle kick ability. However, other variables are no less important in influencing it, moreover the ability to kick the sickle is a basic technique needed in Pencak Silat, and its implementation requires several components (physical and psychological) that holistically produce maximum kicking abilities. We emphasize the importance of further research to expand what we did in this study, including expanding the sample size, other influencing variables, and the role of teachers/trainers in Pencak Silat learning. This needs to be done to analyze in depth to validate the results of this study.

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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ВПЛИВ ВИБУХОВОЇ СИЛИ М'ЯЗІВ КІНЦІВОК, ГНУЧКОСТІ ТА МОТИВАЦІЇ ДОСЯГНЕННЯ НА ВИКОНАННЯ СЕРПОПОДІБНОГО УДАРУ НОГОЮ ПІД ЧАС НАВЧАННЯ ПЕНЧАК-СИЛАТУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 8 с., 7 табл., 9 рис., 35 джерел.

Мета дослідження. Передумовою цього дослідження є те, що виконання серпоподібного удару ногою під час навчання пенчак-силату є дуже важливим для покращення показників спортсмена під час матчу, як у процесі нападу, так і в процесі захисту. Метою дослідження є аналіз виконання серпоподібного удару ногою в пенчак-силаті з огляду на такі аспекти, як якість фізичного стану (наприклад, вибухова сила м'язів ніг і гнучкість) і психологічні елементи (наприклад, мотивація досягнення).

Матеріали та методи. У цьому дослідженні брали участь спортсмени, які займаються пенчак-силатом, із коледжу Танган Мас, Паданг, Індонезія. Учасниками, які стали досліджуваною вибіркою, були 30 спортсменів чоловічої статі віком 14–17 років (спортсмени юнацької категорії). Вибірку здійснювали за критеріями вибірки, які передбачали, що учасники брали участь у змаганнях на регіональному рівні та відвідували тренування принаймні протягом 2 років. Дані отримували з кількох тестів і вимірювань: вибухову силу м'язів ніг оцінювали за допомогою тесту на стрибок у висоту з наступною

обробкою результатів за формулою (номограмою) Льюїса. Гнучкість вимірювали за допомогою тесту на повздовжній шпигат, мотивацію досягнення оцінювали за допомогою анкети, затверджені експертами, а виконання серпоподібного удару ногою оцінювали шляхом тестування. Аналіз даних здійснювали з використанням простого регресійного аналізу та множинного регресійного аналізу з наступним пат-аналізом для обчислення значення коефіцієнта для кожної змінної.

Результати. Аналіз одержаних даних проводили з використанням пат-аналізу структурної моделі. Результати: (1) встановлено вплив вибухової сили м'язів ніг на виконання серпоподібного удару ногою на 21,59%; (2) встановлено вплив гнучкості на виконання серпоподібного удару ногою на 6,94%; (3) встановлено вплив мотивації досягнення на виконання серпоподібного удару ногою на 9,74%; (4) встановлено вплив вибухової сили м'язів ніг спільно з мотивацією досягнення на виконання серпоподібного удару ногою на 38,14%; (5) встановлено вплив гнучкості спільно з мотивацією досягнення на виконання серпоподібного удару ногою на 13,51%; та (6) встановлено одночасний вплив цих змінних на 51,41%.

Висновки. На підставі аналізу трьох факторів, згаданих вище, зроблено висновок про те, що вибухова сила м'язів ніг є основним фактором і потребує серйозного навчання та тренування. Проте інші фактори є не менш важливими. Терміново потрібні подальші дослідження, що включатимуть інші змінні, які впливають на результати цього дослідження, а також більшу кількість вибірок для підтвердження правильності результатів цього дослідження.

Ключові слова: навчання пенчак-силату, вибухова сила м'язів ніг, гнучкість, мотивація досягнення, серпоподібний удар ногою.

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