Functional Exercise Modification for Developing Anticipatory Skills of Pulling Drop Techniques in Pencak Silat

Author : Johaidah Mistar, Johansyah Lubis , Ramdan Pelana

Affiliation : Physical Education, Faculty of Sports Science, Jakarta State University, Jakarta, Indonesia

Corresponding Author :

Johaidah Mistar

Tel: 082167952903
Fax: -
Mailing address:
E-mail1: johaidah_990492922027@mhs.unj.ac.id

Running Title : Functional Exercise Modification for Developing Anticipatory Skills of Pulling Drop Techniques in Pencak Silat

AUTHORS' CONTRIBUTION
1- Study concept and design: **Johaidah Mistar**

2- Acquisition of data: **Johansyah Lubis**

3- Analysis and interpretation of data: **Johaidah**

4- Drafting of the manuscript: **Johaidah Mistar**

5- Critical revision of the manuscript for important intellectual content: **Johansyah Lubis dan Ramdan Pelana**

6- Statistical analysis: **Ramdan Pelana**

7- Administrative, technical, and material support: **Johansyah Lubis, Ramdan Pelanan, Johansyah Lubis**

8- Study supervision: **Ramdan Pelanan, Johansyah Lubis**

ABSTRACT

Background. Pencak Silat has also competed in regional, national, and international events, including the Sea and Asian Games. Physical skills, techniques, tactics, and intelligence are needed to compete and perform well. In the competing category, the silat athlete is declared the winner if he gets points higher than his opponent. Points are earned from attacks, such as punches, kicks, and falls.

Objectives. The study aims to develop the effectiveness of the functional training model in improving fall anticipation skills in pencak silat.

Methods. Functional training modifications in this study focused on adapting training to three phases (pre-, during, and post-pull) to improve the ability of pencak silat athletes to anticipate falling pulls. This exercise uses tools such as resistance bands, punching bags, dumbbells, and coordination balls and is integrated with realistic match condition simulations. This study uses the Research & Development (R&D) method with the Borg and Gall model approach. The model developed consists of three main phases, namely pre-pull, during-pull, and post-pull, with 12 training items that pencak silat experts have validated. The research sample consists of three test groups: small-scale test (12 athletes), large-scale test (35 athletes), and effectiveness test (70 athletes), which are divided into experimental groups (35 athletes) and control groups (35 athletes). Data analysis using the t-test and effectiveness is assessed based on the N-Gain and Cohen's D values.

Results. There are 12 training items in three phases: pre-pull, during-pull, and post-pull. The training model developed in this study has proven effective in improving fall anticipation skills in pencak silat athletes, with the t-test results showing a significant increase in the experimental group ($p < 0.05$) and a Cohen's D value of 1.91 indicating high effectiveness. This model consists of three main phases validated by experts, ensuring relevance to match conditions. In addition to offering a practical and adaptive training method, this model contributes to innovation in pencak silat training.

Conclusion The results of the effectiveness test show that this training model significantly improves pull-down technique skills in the pencak silat sport. With a systematic approach based on functional training, this model has proven effective in helping athletes master fall anticipation technique skills, especially in the competition category.

Keywords: Functional, training, Pencak Silat, Model, Anticipation, Falling

INTRODUCTION

Pencak silat is a traditional martial art originating from Indonesia. A parent organization of pencak silat in Indonesia is Persatuan Pencak Silat Indonesia (IPSI) (1). Pencak Silat has also competed in regional, national, and international events, including the SEA and Asian Games. To show good performance, physical skills, techniques, tactics, and intelligence are required in competing(2). The competition has two categories: the art category and the sparring

80 category(3–5). In the sparring category, a silat athlete is declared the winner if he gets more
81 points than his opponent. Points are obtained from attacks such as punches, kicks, and falls(6–
82 9). Of the three forms of attack, falls have the highest points. In addition to having to master
83 the technique of falling, a silat athlete must also master the anticipation of falling techniques
84 in order to survive falls or thwart the technique of falling or throwing from the opponent(10).
85 In learning the technique of anticipating a throw, good motor skills and balance are needed
86 because anticipating a fall pull is not a basic technique but an advanced technique that is
87 characteristically more difficult than the basic technique, because in the process of anticipating
88 a fall pull a series of movements are quite difficult. Anticipation is an action to plan and prepare
89 for possibilities or events that may occur in the future. Anticipation is needed to reduce the risk
90 of injury, better planning, resilience, better decision making and increased mental readiness. To
91 be able to master the movement of anticipating this fall technique, it is necessary to train with
92 a method that can help athletes master each movement in anticipating the fall technique. One
93 of them is by utilizing the *functional training method* in the process of anticipating falling
94 techniques.

95   Functional training is simple movements that are similar to everyday activities. The
96 principle of the training program is that an athlete must train with a combination of different
97 body planes and adjust to the conditions on the field of play so that the movement pattern must
98 also be adjusted(11,12). *Functional training* targets the *neuromuscular system* through the
99 order of muscle groups and nerves to optimize movement. This allows the program to include
100 challenges and improve components such as dynamic and static balance, coordination, and
101 *proprioception,* which are important for sports performance, injury prevention, *and* movement
102 function. Therefore, researchers are interested in combining functional exercise modifications
103 in the model. Pencak Silat anticipatory skills training for falling and pulling techniques.
104   Research related to anticipating falls has been studied by previous researchers, such as
105 that conducted by Eko (2024), who studied anticipation of pull fall techniques in pencak silat
106 athletes using the scissor technique. The study confirmed that the scissor technique effectively
107 increased anticipation of pull falls in pencak silat athletes(13). Furthermore, overlapping
108 research has also been conducted by Wulandari (2021), who developed a fall anticipation
109 training model for athletes in the pencak silat sport by testing the level of effectiveness of the
110 training model. The study's results confirmed that the slam anticipation model in pencak silat
111 athletes improves the ability of slam anticipation techniques effectively to be applied in the
112 training process in pencak silat athletes(14). Regarding our research, research related to the
113 development of anticipatory training models for fall techniques is still under-explored, so in
114 this study, we want to study the training model for anticipating fall techniques in Pencak Silat.
115 The novelty of this study lies in the modification of functional training and the production of a
116 training model to hone skills in anticipating fall techniques through pulling. This research will
117 also explore the level of feasibility and effectiveness.
118   The approach used in this study is Research and Development (R&D), which was chosen
119 due to its systematic methodology in developing innovative and effective training methods.
120 Functional training has been widely recognized for enhancing sports performance by
121 improving strength, coordination, and movement efficiency(15–17). R&D ensures that training
122 techniques are developed based on empirical evidence rather than assumptions or traditions.
123 One of the main reasons for adopting this approach is to address the lack of anticipatory skills
124 in Pencak Silat athletes, as falls (pull-down techniques) significantly contribute to scoring in
125 competitions(12). Anticipation is crucial in martial arts, enabling athletes to predict and counter
126 opponents' movements more effectively. Recent studies have shown that functional training
127 can enhance reaction time, agility, and decision-making in combat sports(18,19). The initial
128 study for this research was conducted through observations at the 2023 Student Sports Week

Championship in Lhokseumawe. The findings revealed that many Pencak Silat athletes struggled to anticipate and counter pull-down techniques, highlighting the need for targeted training interventions.

MATERIALS AND METHODS

Study Design

This study employed a Research and Development (R&D) approach using the Borg model, which consists of several systematic stages: needs analysis, planning, development, small-scale trial, product revision, large-scale trial, and operational effectiveness testing. A quasi-experimental design with a pre-test and post-test control group design was implemented to develop a functional training-based program to enhance Pencak Silat athletes' ability to anticipate pull-down techniques.

Participants

The study involved Pencak Silat athletes from East Aceh Regency, Aceh Tamiang, and Langsa City. Participants were selected using purposive sampling based on specific criteria, including age 15–25 years and proficiency in falling techniques according to the latest competition regulations. The participants were divided into three groups: a small-scale trial group comprising 12 athletes, a large-scale trial group comprising 35 athletes, and an effectiveness testing group comprising 70 athletes. In the effectiveness testing phase, the participants were divided into two subgroups: the experimental group (35 athletes), who underwent the functional training program, and the control group (35 athletes), who followed conventional training.

Randomization Process

All participants in this study met the eligibility criteria of having prior experience in competitions conducted under the 2021 Ikatan Pencak Silat Indonesia (IPSI) regulations, particularly regarding valid grip techniques. Each participant was instructed to draw a card to ensure random allocation. Participants who received a red card were assigned to the control group, while those who received a green card were placed in the experimental group. This randomization process was implemented to minimize selection bias and ensure group comparability.

Training Protocol

The experimental group underwent a functional training-based program to enhance anticipation skills in throwing techniques. The program lasted for six weeks, comprising a total of 16 sessions, with each session lasting 60–75 minutes and conducted three times per week. Each session consisted of three main phases:
1. **Warm-up (15 minutes):** Included dynamic stretching and, coordination and balance exercises.
2. **Main training (45 minutes):** Consisted of several components, including quick reaction drills (e.g., response training to opponent movements), plyometric exercises (such as squat jumps and explosive drills), balance and core strength training (e.g., single-leg squats and dynamic lunges), and partner-based throwing technique drills.
3. **Cool-down (10–15 minutes):** Included static stretching and muscle relaxation.

Meanwhile, the control group followed a conventional training program focused on strength and endurance exercises without functional training modifications.

Tools and Assessments

Skill evaluation was conducted before and after the training program using validated instruments. The measured parameters included anticipation reaction time, assessed through an anticipation skill test for the pull-down technique. Each participant faced 10 opponents sequentially, with 20 seconds allocated per encounter. Successful anticipation was recorded, while failure resulted in a null score. Additionally, Pencak Silat experts evaluated the accuracy of the throwing technique using a scoring system. Strength and agility tests were also conducted to assess improvements in functional physical performance.

Study Protocol

The study followed a three-phase procedure consisting of a pre-test, intervention, and post-test. In the pre-test phase, initial measurements were conducted before the training intervention. The experimental group underwent a functional training program during the intervention phase, while the control group followed a conventional training regimen. After six weeks, the post-test phase was conducted, in which the same measurement instruments were used to reassess participants' performance. This procedure ensured consistency in data collection and allowed for a comparative analysis of the training effects between the two groups.

Statistical Analysis

Statistical analysis was conducted using specialized statistical software, following a systematic approach. First, normality testing was performed using the **Kolmogorov-Smirnov test** to determine whether the data followed a normal distribution, with the formula:

$$D = \sup |F_n(x) - F(x)| \qquad \text{eq.1}$$

where $F_n(x)$ represents the empirical distribution of the sample, and $F(x)$ denotes the theoretical distribution. Next, **Levene's test** was employed to assess the homogeneity of variances across groups using the following formula:

$$W = \frac{(N-k)}{(k-1)} x \frac{\sum_{i=1}^{k} N_i (X_i - X)^2}{\sum_{i=1}^{k} \sum_{j=1}^{N_i} N_i (X_{ij} - X_i)^2} \qquad \text{eq.2}$$

A **paired t-test** was conducted to compare pre-test and post-test scores within each group to test the main hypothesis:

$$t = \frac{\bar{x}}{\frac{Sd}{\sqrt{n}}} \qquad \text{eq.3}$$

whare $\bar{x}$ Represents the mean difference, Sd is the standard deviation of the differences, and nnn is the sample size. To compare the experimental and control groups, an **independent t-test** was applied using the formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{Sd_1^2}{n_1} + \frac{Sd_2^2}{n_2}}} \qquad \text{eq.4}$$

The effectiveness of the intervention was determined using the **N-Gain Score**, calculated as follows:

$$N - Gain = \frac{(Posttest - Pretest)}{(\max Score - Pretest)} \qquad \text{eq.5}$$

The interpretation of N-Gain values is as follows:
- N-Gain $\geq 0.7 \rightarrow$ High effectiveness
- $0.3 \leq$ N-Gain $< 0.7 \rightarrow$ Moderate effectiveness

223 • N-Gain < 0.3 → Low effectiveness
224
225 Furthermore, the **effect size** was assessed using **Cohen's d**, calculated as:
226

227 $$d = \frac{\bar{x}_1 - \bar{x}_2}{Sp}$$ eq.6

228 where Sp represents the pooled standard deviation. The Cohen's d values were interpreted as
229 follows:
230 • d < 0.2 → small effect
231 • 0.2 ≤ d < 0.8 → medium effect
232 • d ≥ 0.8 → Large effect
233

RESULTS

Training Model Development

The developed model is based on functional training modification, with a gradual approach, and consists of three main phases, namely (a) pre-pull, (b) during pull, and (c) post-pull. Model development follows the Borg and Gall framework stages, including needs analysis, planning, initial product development, expert validation, small group trials, small group trials, and revisions based on small group trials, large group trials, final revisions, effectiveness tests, dissemination, and implementation (Figure 1).
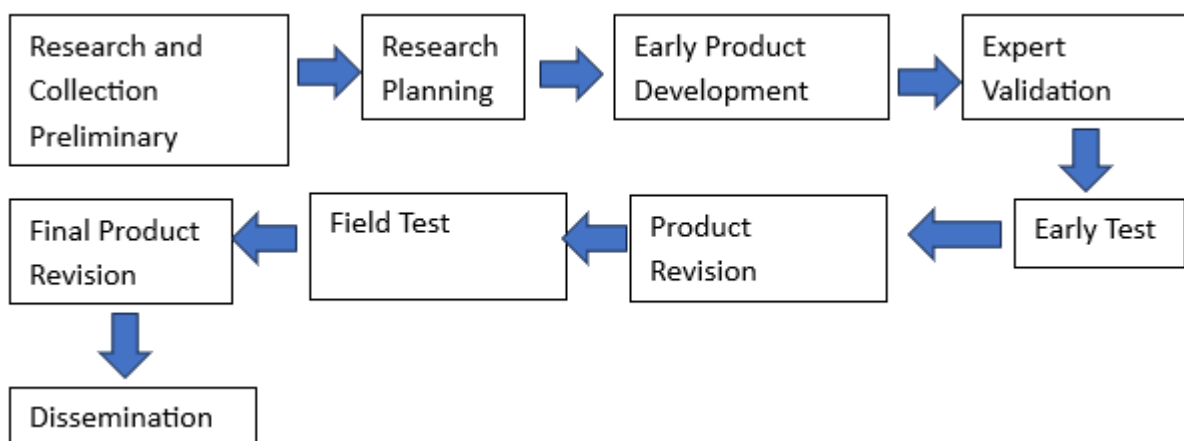

Figure 1. Research and Development (R&D) Model by Borg and Gall (20)

Exercise Model Structure

There are 12 main exercises categorized based on the exercise phase. The exercise phase in this model has three main phases, namely the first phase, "pre-pull," the second phase, "during the pull," and the third phase, "Post-Pull". The first phase focuses on improving reflexes, muscle strength, and motor coordination. The details of the first phase exercise model are shown in table 1 below:

Table 1. First Phase Exercise Model: Pre-Pull

Model Latihan	Tujuan	Peralatan
Top parry training with resistance band	increase strength, speed	*resistance band*

Stand up and pull the rubber down exercise	to strengthen the muscles of the arms, shoulders, and back, improve technique and balance	resistance band
Reaction speed and hand-eye coordination with the ball exercise	respond quickly to visual stimuli and can expand to catch, throw, or control the ball well.	Kasti Ball
Parry up and hit the chest with a rubber exercise	improve the player's ability to avoid opponent attacks and counterattack	resistance band

The second phase, "During Pull," or Execution of technique and balance, focuses on endurance, reaction to the pull, and defensive techniques. The detailed training model is shown in table 2 below:

Table 2. Second Phase Exercise Model: Moment-Pull

Model Latihan	Tujuan	Peralatan
Upper sweep exercise with resistance band	to improve leg muscle strength and upper sweep speed	resistance band
shoulder vortex exercise	to improve shoulder muscle strength, stability, and flexibility	sandbag
Songketan with samsak exercise	to strengthen arm, shoulder, and back muscles and automatic sweeping movements	samsak
Exercise Pulling and locking the legs with samsak	to develop strength, stability, and technique.	samsak

The third phase, "Post-Pull," or recovery and adaptation, focuses on muscle recovery, postural stability, and endurance. The detailed training model is shown in Table 3 below:

Table 3. Second Phase Exercise Model: Post-Pull

Model Latihan	Tujuan	Peralatan
Squats with dumble exercise	effective for developing strength and muscular endurance throughout the lower body and improving core strength	dumble
Versatile squats exercise with dumble	to increase flexibility and range of motion in the hip, knee, and ankle joints	dumble
Push up with one leg exercise with a dumble	Train the body's ability to maintain balance by reducing one point of support	dumble
Cossack squats with dumble pull exercises	to train the quadriceps, hamstrings, glutes, and leg muscles.	dumble

Training Protocol

The experimental group underwent a functional training-based training program for 6 weeks with 16 sessions conducted 3 times per week. Each session lasted 60–75 minutes, consisting of three main phases:
1. Warm-up (15 minutes): Dynamic stretching, balance and coordination exercises.
2. Core Training (45 minutes):

- Rapid reaction drills (e.g., response drills to opponent movements).
- Plyometric exercises (squat jumps, explosive drills).
- Balance and core strength exercises (single-leg squats, dynamic lunges).
- Partner-based tumbling technique exercises.

4. Cool-down (10–15 minutes): Static stretching and muscle relaxation.

In comparison, the control group underwent only conventional training focused on strength and endurance training without functional training modifications, as detailed in Table 4.

Table 4. Structure of Exercises in Experimental and Control Groups

Training Phase	Kelompok Eksperimen	Kelompok Kontrol
Warming	Dynamic stretching, coordination	Static stretching
Core Exercises	Fast-reaction, plyometric, core drill drill	Endurance and strength training
Cooling	Static stretching, muscle relaxation	Static stretching

Skills Evaluation

Skills measurements were carried out before and after the intervention using validation instruments that included:

1. Anticipation Skill Test: Participants face 10 opponents in a row for 20 seconds each.
2. Accuracy of the falling technique: Evaluated by a Pencak Silat expert with a scoring system.
3. Strength and agility tests: Assess the improvement of physical performance functionally.

The pre-test and post-test results were then compared to assess the effectiveness of the developed exercise model (table 5).

Table 5. Pre-Test and Post-Test Results in the Experimental and Control Groups

Group	Reaction Time (ms)	Accuracy(%)	Strength and Agility
Eksperimen (Pre-Test)	950 ± 110	65.4 ± 7.2	72.3 ± 8.1
Eksperimen (Post-Test)	720 ± 95	84.1 ± 5.8	85.7 ± 7.5
Kontrol (Pre-Test)	940 ± 105	66.1 ± 6.9	71.5 ± 7.9
Kontrol (Post-Test)	890 ± 102	70.8 ± 6.5	75.2 ± 7.4

Statistical tests showed a significant improvement in the experimental group compared to the control group (**$p < 0.05$**).

Statistical Analysis

The normality test was carried out using Kolmogorov-Smirnov and Shapiro-Wilk on the pre-test and post-test data of the experimental group. The test results showed a significance value of more than 0.05 for both methods (Experimental Pre-test: 0.200*, 0.426; Post-test Experiment: 0.081, 0.053). Because the significance value > 0.05, the pre-test and post-test data of the experimental group were normally distributed, with the normality assumption fulfilled, the test can proceed to the paired t-test.

Paired Sample T-Test

Compared to the experimental group's average pre-test and post-test scores, there was an increase in post-test scores. The paired t-test showed a Sig. (2-tailed) value < 0.05, meaning that the increase was significant. This means that the training program has a significant positive influence on improving the skills of participants.

Independent t-Test Pre-test Experimental and Control Group
The average pre-test score of the experimental group was higher (55.1270) than that of the control group (43.8175). The Levene test showed a value of Sig. = 0.631 (> 0.05), meaning that the variance of the two groups was homogeneous. The results of the independent t-test showed a Sig. (2-tailed) value < 0.05, so there was a significant difference between the initial abilities of the two groups.

N-Gain Normality and Homogeneity Test
The normality test results showed that the N-Gain data of the experimental and control groups were normally distributed (Sig. > 0.05). The results of the homogeneity test showed a value of Sig. = 0.674 (> 0.05), so the two groups' variance was homogeneous. With the fulfillment of the assumptions of normality and homogeneity, it can be continued to a one-party independent t-test. The average N-Gain value of the experimental group (0.5717) was higher than that of the control group (0.1882). The results of the independent t-test showed a Sig. (2-tailed) value < 0.05, meaning that the improvement in the experimental group was significantly better than that of the control group. Cohen's value of D = 1.905564 indicates that the exercise model's effectiveness is in the high category. Interpretation: The exercise program provided effectively improves participants' skills.

DISCUSSION

This study uses the Borg and Gall model development approach, which consists of 10 stages of research. The process begins with a needs analysis through direct observation in the field and interviews. The results of the analysis show that there is a need for a training model to anticipate *pull-down techniques* that are tailored to the needs of Pencak silat athletes, especially in the competition category (6) The addition of variation in training based on functional exercise modifications aims to improve the effectiveness, attractiveness, and efficiency of the training model(12). This step is expected to be a significant innovation in helping athletes improve their techniques in anticipating *pull-downs*. The developed training model consists of 18 items grouped into three stages: before, during, and after the pull occurs. Each stage initially consisted of six training items, which were later revised to 12 training items (four items per stage) based on validation from pencak silat experts(14). One of the innovations in this study is developing an instrument to measure the skill of anticipating *pull-down* techniques, which were previously not specifically available. This instrument has been tested for validity and reliability by pencak silat experts, so it can be used to measure this skill accurately. The model is also designed to be flexible and can be performed in various places using simple tools, making it practical and accessible to different groups of athletes. The technique of anticipating *pull-downs* plays an important role in pencak silat, especially in the competition category, as it is one of the skills that determines an athlete's success in the competition arena. Modifications based on functional exercises are designed to replicate actual conditions in the field, allowing athletes to train in situations close to the game(5). A well-structured and well-designed training model can significantly improve the quality of athletes' skills. The initial trial was conducted on 12 subjects in Langsa City, followed by revisions based on the implementation results. The next stage, a large group trial involving 35 subjects, showed that all training items could be

applied effectively. Operational tests were carried out on 70 subjects (35 experimental groups and 35 control groups) to measure the effectiveness of the training model. The results of *the independent t-test* showed a significant value (Sig. (2-tailed) < 0.05), so it was concluded that the experimental group using this training model had a better skill improvement than the control group. In addition, Cohen's D value of 1.905564 indicates that the model's effectiveness is on the high criteria. However, several limitations need to be considered. The generalization of the results of this study may be limited to the context of pencak silat and cannot be directly applied to martial arts or other sports without further adaptation. In addition, the selection of samples in this study may contain potential bias, as the study subjects are from Langsa City and the characteristics of athletes in this region may not be fully representative of the population of pencak silat athletes as a whole. Therefore, the results of this study need to be interpreted carefully and further verified with a more diverse sample. Claims about the novelty of functional training modifications in the context of pencak silat training also need to be supported by stronger literature, given that research specifically addressing the application of functional exercises to anticipate *pull-down* techniques in pencak silat is still limited.

CONCLUSION

A training model for anticipating pencak silat pull-down techniques based on *functional training modifications* has been successfully developed, consisting of 12 training items covering three main phases: pre-pull, during-pull, and post-pull. Based on validation by pencak silat experts, this model can be applied in the athlete training process. In addition, the results of the effectiveness test show that this training model significantly influences the skills of pull-down techniques in the pencak silat sport. With a systematic approach based on *functional training*, this model has proven effective in helping athletes master anticipating fall techniques, especially in the competition category.

APPLICABLE REMARKS

1. Population Description: The population studied consisted of pencak silat athletes aged 18-25, with a balanced gender proportion of males and females. The participants had varying experience levels, ranging from beginner to advanced, and had undergone pencak silat training for at least one year before the study.

2. Health Condition: All participants were in good health and had no history of serious injury that could hinder training.

3. Training Context: Training is conducted in a gymnasium with adequate safety standards. The program includes training in basic techniques and fighting strategies specific to the fall pull technique. Training takes place 3 times a week for 90 minutes per session for 16 sessions.

4. Training Objectives: The training program aims to improve the skills of the tumble pull technique and the mental readiness of athletes in facing pencak silat competitions. The program is designed in stages with specific exercises to improve the anticipation of the tumble pull technique, adapting to the needs of athletes based on their ability level.

5. Methodology: This study used an experimental method with control and intervention groups. Data were collected through tests of anticipation skills of the tug fall technique, direct observation, and interviews with participants and coaches.

REFERENCE

1. Anifah L, Syariffuddien Zuhrie M, Muhammad, Haryanto. A novel pencak silat punch pattern recognition approach using supervised learning. Ain Shams Eng J [Internet]. 2024;15(8):102857. Available from: https://doi.org/10.1016/j.asej.2024.102857

2. Siswantoyo, Saputro DP, Hadi SP. Pencak Silat Physical Test (Assesment Method for Indonesian Martial Art). Man India. 2018;98(1):167–74.

3. Damrah, Ihsan N, Muharel A, Komaini A, Rifki MS, Sepriadi, et al. A Measuring Tool for Kick Speed with Dynamic Targets: A Digital-Based Instrument Designed for Pencak Silat Learning. Ann Appl Sport Sci. 2023;11(4):1–10.

4. Irawan FA, Nomi MT, Peng H Te. Pencak silat side kick in persinas asad: Biomechanics analysis. Int J Hum Mov Sport Sci. 2021;9(6):1230–5.

5. Suwirman. The Development of Pencak Silat Physical Training Model for Competitive Athlete. 2020;464(Psshers 2019):902–6.

6. Kartini K, Kartini K, Sugiyanto S, Siswandari S. Development of Training Model of Pencak Silat Dropping Technique in Match Category Based on Biomechanical Analysis for Youth Athletes. J Educ Heal Sport [Internet]. 2018;8(12):135–48. Available from: http://www.ojs.ukw.edu.pl/index.php/johs/article/view/6356

7. Ahmad A, Prasetyo Y, Nugroho S. on a single topic . Here are some things to consider when analyzing an annotated bibliography : 2024;2041:185–92.

8. Doewes RI, Elumalai G, Azmi SH. Biomechanics analysis on Jejag kick of pencak silat. J Popul Ther Clin Pharmacol. 2022;29(4):116–25.

9. Alfiansyah A, Karo P, Rahayu T, Setyawati H. Application of Biomechanical Analysis of Pencak Silat Techniques. Int Conf Sci Educ Technol. 2023;1(2):48–53.

10. Mistar J, Lubis J, Pelana R. BIBLIOMETRIC ANALYSIS : ANTICIPATION OF THE TUG FALL TECHNIQUE PENCAK SILAT BASED ON VOSVIEWERS [Internet]. Atlantis Press SARL; 2025. Available from: http://dx.doi.org/10.2991/978-2-38476-354-2_4

11. Hao L, Fan Y, Zhang X, Rong X, Sun Y, Liu K. Functional physical training improves fitness and cognitive development in 4~5 years old children. Front Psychol. 2023;14(November):1–10.

12. Lubis J, Haqiyah A, Robianto A, Ihsani SI, Wardoyo H, Ginanjar S, et al. The effect of six-week plyometric, functional, and interval trainings on body composition, power, and kicking speed in male Pencak Silat University Athletes. Int J Disabil Sport Heal Sci. 2024;7(1):46–53.

13. Saputro EN, Setiakarnawijaya Y, ... IMPROVING THE SKILL OF ANTICIPATING FALLING PULLS USING "GUNTINGAN" ON PENCAK SILAT ATHLETES (Study Action Research at PPLM DKI Jakarta). Gladi J Ilmu … [Internet]. 2024;15(02):241–57. Available from: https://journal.unj.ac.id/unj/index.php/gjik/article/view/45730

431 14. Wulandari R. Model Latihan Antisipasi Jatuhan Dalam Cabang Olahraga Pencak Silat
432   pada Atlet Daerah DKI Jakarta. 2021; Available from: http://repository.unj.ac.id/38890/

433 15. Wang X, Soh KG, Samsudin S, Deng N, Liu X, Zhao Y, et al. Effects of high-intensity
434   functional training on physical fitness and sport-specific performance among the
435   athletes: A systematic review with meta-analysis. PLoS One [Internet]. 2023;18(12
436   December):1–24. Available from: http://dx.doi.org/10.1371/journal.pone.0295531

437 16. Xiao W, Soh KG, Wazir MRWN, Talib O, Bai X, Bu T, et al. Effect of Functional
438   Training on Physical Fitness Among Athletes: A Systematic Review. Front Physiol.
439   2021;12(September):1–12.

440 17. Xiao W, Bu T, Zhang J, Cai H, Zhu W, Bai X, et al. Effects of functional training on
441   physical and technical performance among the athletic population: a systematic review
442   and narrative synthesis. BMC Sports Sci Med Rehabil. 2025;17(1).

443 18. Alfredatama I, Fauzi F, Tomoliyus T, Budiarti R, Prabowo TA. The Impact of
444   Functional Training on Physical Abilities in Combat Sport: A Mini Review. J Adv Sport
445   Phys Educ. 2024;7(05):105–10.

446 19. Rodrigues JCC, Penna EM, Machado HES, Sant'Ana J, Diefenthaeler F, Coswig VS.
447   Effects of lower and upper body fatigue in striking response time of amateur karate
448   athletes. PeerJ. 2023;1:1–14.

449 20. Hendarto P, Maridi M, Prayitno BA. Validity of guided inquiry-based modules on
450   digestive system to improve argumentation skill. JPBI (Jurnal Pendidik Biol Indones.
451   2019;5(1):127–40.

452