

Speed analysis of the front kicks technique in 2022 pencak silat world champion athletes: Kinematic analysis

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Abstract

Pencak silat is the dominant sport using the feet and hands. Kicks in pencak silat require speed to produce points, the faster the kick is made, the more difficult it will be to stop, fend off, or catch. This study aims to describe the difference in front kick speed between two male and female athletes of the Indonesian national team who are the 2022 pencak silat world champions. The research method used in quantitative descriptive research with the subjects of 2022 world champion pencak silat athletes in male and female numbers. This research instrument uses a Fujifilm XT 4 camera with camera placement at a distance of 5 meters from the arena. The video results were analyzed using Kinovea 0.9.4 software by calculating the speed of the subject's Front Kicks. The male sample produced an average speed of 3.25 m/s with an average breakdown of a 1.82-meter kick distance and an average travel time of 0.56 seconds. The female sample produced an average speed of 2.71 m/s with details of an average 1.90-meter kick distance and an average travel time of 0.70 seconds. Future research is expected to examine kinematic parameters in other techniques in pencak silat so that they know more about things that can support the performance of pencak silat athletes.

Keywords: Kinematics analysis, front kick, pencak silat.

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INTRODUCTION

Pencak silat is a full-body contact sport that involves all biomotor components, such as endurance, strength, speed, power, stamina, endurance strength, flexibility, agility, and coordination (Ferdinands et al., 2013; Mun et al., 2015). Pencak silat matches are divided into 4 categories: Singles, Doubles, Teams, and Sparring. The basic principle of pencak silat in the sparring category is to seek points by attacking and defending. The score in the sparring category of pencak silat is obtained when the attack

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hits the target and is not blocked by the opponent's defence. To be able to attack and defend, it is necessary to master the skills of applying basic techniques that are needed during the match. The basic technique in pencak silat that is needed is the kick technique, Kick technique In carrying out attacks, and kicks are the technique with the highest use during the match at 44% (Nugroho, 2020). A kick is an effort or process using both feet to defend and attack to get as many points as possible during the game. Kicks can also be interpreted as attacks using the legs and feet as attacking components. Four types of kicks in pencak silat are often used: front, sickle, side, and back. The front kick is a kick that is difficult to stop, fend off, catch, and even slam because the square shape of the kick keeps the body standing upright by facing the opponent so that it will be more stable in maintaining balance (Sudiana et al., 2023).

One of the main principles of Front Kickss or "Front kicks", namely the pattern of straight kicks, attacks that use one foot and leg, the trajectory is forward with the body facing forward, with the base of the inner toes, with the target solar plexus and chin (Soo et al., 2018). The front kick is done quickly, hitting the target, therefore, the front kick is effective enough to attack the opponent. Every fighter must have speed in kicking, especially doing front kicks well. The fighters must be trained in front kick techniques to improve the achievements achieved. To increase the speed of the kick you have, a proper training program is needed by paying attention to the elements that affect the speed of the front kick.

The importance of Front Kicks is that they are often used to obtain points in pencak silat matches. In the sparring category of pencak silat, the front kick is often used as the primary weapon for attack and defence to earn points (Ediyono & Widodo, 2019). Kicks are necessary for pencak silat to obtain points, so according to (Dimiyati et al., 2020), it takes speed when athletes perform kicking techniques. Kicks in pencak silat require speed so that the attack can generate points because the kick will be judged if the incoming attack on the target is powerful and steady, not accompanied by catch/grip, without being hindered by deflection or elbow and with the

support of stance, or good fulcrum, the right range and the correct attack trajectory. So pencak silat athletes need to be evaluated in performing kicking techniques, especially Front Kicks techniques.

There is a motion analysis called sports biomechanics to know and evaluate the movement of the front kick in pencak silat athletes correctly. The role of biomechanics in sports (Ferdinands et al., 2013), Explains the science that evaluates the structure and function of human biological systems in terms of motion systems or mechanics called biomechanics. While the role of biomechanics is conveyed by (Ferdinands et al., 2013), Biomechanics is the study of external and internal forces that can intervene in the human body and the impact it gets. The application of biomechanics in sports has a positive impact, such as improving athlete performance, besides that, it can also analyze movements to avoid unnecessary movements that result in injuries during physical activity in sports so that achievements can be achieved (Mun et al., 2015). The application of biomechanics in the world of sports can be made by observation with the help of applications that can analyze Movement through 2D and 3D analysis and also analysis of the observed muscle work of athletes. Analysis can also be selected from dependence on the tools' readiness and the detail of the analysis to be carried out. Movement Analysis with several techniques is an analysis that is often used in sports needs because it can be done using one camera and movement analysis application.

The mechanical efficiency of the kick movement often determines a sports athlete's success. Therefore, this study related to the kinematic analysis of Front kicks helps to understand the scientific aspects related to movement techniques and also helps improve athletic performance optimally (Kwon et al., 2017). Kinematics is a branch of physics that studies the motion of objects without considering the causes of those movements, such as the forces acting on objects (Ishac & Eager, 2021). Kinematics includes the analysis of the position, speed, and acceleration of each body part involved in the movement. Through kinematics analysis, information can be obtained about the factors that affect the speed and effectiveness of

various techniques. This study aims to describe the parameters of motion kinematics, especially in Front Kicking techniques, when performing kicking techniques on athletes who have skills (skilled) and are world champions at the 19th World Championship Pencak Silat 2022 Malaysia and are still actively part of the Indonesian pencak silat national team that will compete in the 2023 Cambodia Sea Games with an analytical approach to observation of movements in pencak silat techniques.

METHOD

This research uses quantitative descriptive methods, with the subjects of the study being male and female singles pencak silat athletes who are world champions at the 19th World Championship Pencak Silat 2022 Malaysia and are still actively part of the Indonesian pencak silat national team, which will compete in the 2023 Cambodia Sea Games with 2 people. This research was conducted at the Indonesian Pencak Silat Training Center, Jakarta. Data capture using video recording using the Fujifilm XT 4 camera, capable of recording at a speed of 240fps and can then be slowed down 10x to 24fps to perform more detailed motion analysis. The lens uses a focal length of 50mm to minimize distortion that can interfere with distance calibration in the image. Furthermore, the video results will be analyzed using Kinovea 0.9.4 software.

Research Instruments

The instrument in this study uses a Fujifilm XT 4 camera capable of recording at a speed of 240fps, One kinematics analysis technique that is often used in biomechanics is two-dimensional motion analysis. In two-dimensional motion analysis, the motion of the human body is projected into two coordinate planes (usually the x and y planes).

Test Execution Procedure

Before the test activity was carried out, the research subjects warmed up with a time of 15 minutes. Then the activity continued by kicking forward using devices and arenas that had been prepared in advance to make it more comfortable and faster to adapt. When doing the activity, the subject

stands on the prepared arena and then kicks forward with a predetermined movement. Athletes perform 10 front kicks with a fixed stance, one by one, and using the strongest legs of each athlete.

Figure 1 describes the camera's video position and field scheme. Video camera 1 is placed on the front side of the subject's position or the side of the field with a distance of 5 meters square with the position of the subject standing.

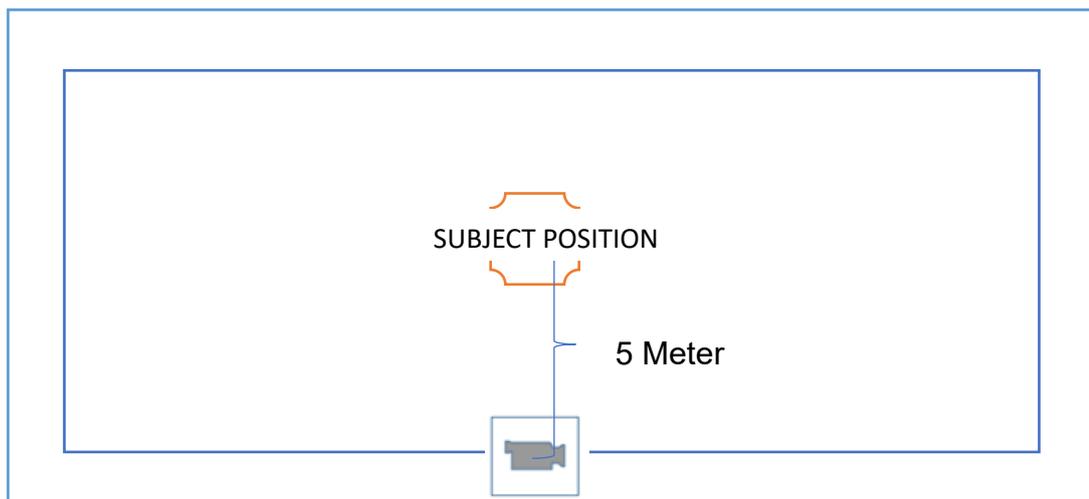


Figure 1. Scheme of field data retrieval from the front of the athlete's subjects

Motion Kinematics Parameters

To make it easier to analyze the kinematics of the movement of the Front Kicks technique of pencak silat athletes, the process of Front Kicking speed is according to the picture below.



Figure 2. Pencak silat front kick shape

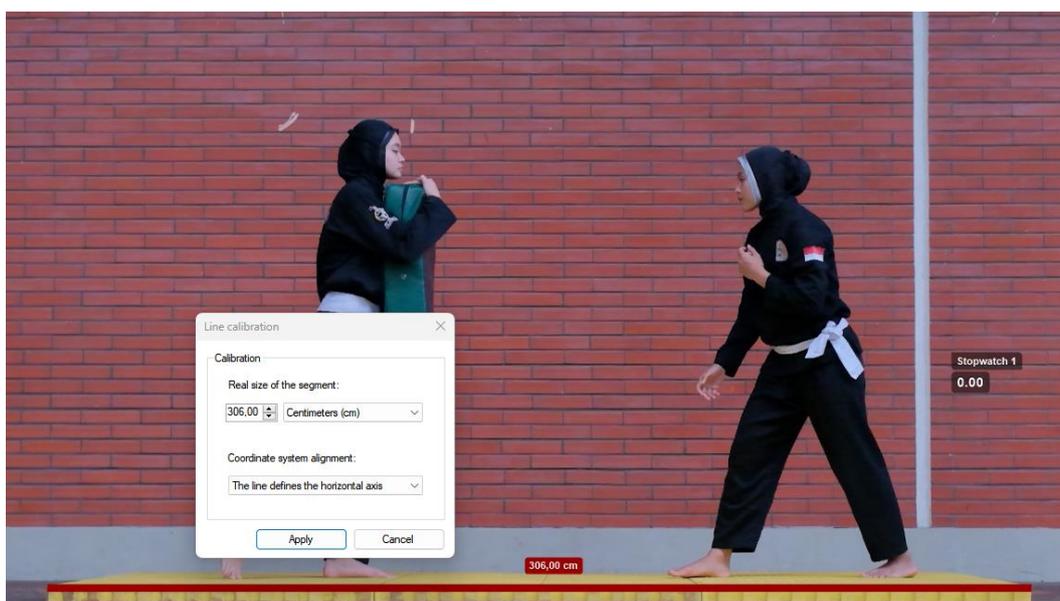


Figure 3. Calibrate the transformation of pixels in an image into real-world unit sizes



Figure 4. Kick Distance Measurement

Distance measurement using tracking features available in the software and tracks on foot used to kick from the starting point (x_0) up to the endpoint (x_1), The distance is obtained from moving the starting point to the endpoint with the formula.

$$s = x_1 - x_0.$$



Figure 5. Kick Time Measurement

The collected data is calculated by measuring time using the stopwatch feature that is also available in the software. After getting the

displacement distance (meters) and kick travel time (second), calculate the speed using the following mathematical equation.

$$v = \frac{s}{t}$$

Note:

v = Speed (m/s)

s = Distance (m)

t = Time(s)

RESULT

The following is an explanation of data analysis from the results of data collection in the field related to Front kicks and changes in the kinematics circuit of motion when performing Front Kick movements that have been compiled in data collection. Table 1 is the result of measuring the speed of the front kick in the form of speed (v) with the supporting variables, namely, distance (s) and time (t) and shows the difference in the magnitude of speed, distance, and time, in the front kick of each athlete.

Table 1. Results of measuring the speed of the front kick on the Indonesian pencak silat world champion

Variable	Sample 1 (Men's)	Sample 2 (Women's)
Distance (m)	1,82	1,90
Time (s)	0,56	0,70
Speed (m/s)	3,25	2,71

Note: The above results are an average of ten front-kick attempts.

Of the ten front kick attempts, sample 1 produced an average speed of 3.25 m/s with details of an average 1.82-meter kick distance and an average travel time of 0.56 seconds. Sample 2 produced an average speed of 2.71 m/s with details of an average 1.90-meter kick distance and an average travel time of 0.70 seconds.

DISCUSSION

The findings of this study from ten front kick attempts, male subjects produced an average speed of 3.25 m/s with details of an average 1.82-meter kick distance and an average travel time of 0.56 seconds. The women produced an average speed of 2.71 m/s with an average 1.90-meter kick

distance breakdown and an average travel time of 0.70 seconds. In Pencak Silat, kick speed is an important factor every athlete must consider. Kick speed can be affected by various factors such as kick technique, muscle strength, flexibility, coordination, physiological factors, gender, and exercise (Adamec et al., 2021).

The kicking technique is the main factor affecting the speed of the kick in pencak silat. Proper technique will allow the athlete to produce optimal kick speed. A study on kick speed states that the correct kick technique can increase kick speed in pencak silat practitioners (Rydzik & Ambroży, 2021). Therefore, pencak silat athletes must master the correct kick technique to increase the kick's speed.

In addition to the kick technique, physiological factors can affect the speed of the kick in pencak silat. Some physiological factors affecting kick speed include muscle strength, contraction speed, endurance, and aerobic capacity. Muscle strength also plays an important role in increasing kick speed. Muscle strength allows athletes pencak silat to generate enough power to perform kicks at high speed. A study on the relationship between speed and leg muscle strength shows that leg muscle strength is positively related to kick speed in pencak silat practitioners (Vagner et al., 2021). Therefore, muscle strength training on the limbs should be part of the training program of a pencak silat practitioner.

The speed of muscle contraction also plays an important role in generating kick speed. The faster the muscle contraction, the faster the kick movement is produced. The speed of muscle contraction can be increased through plyometric exercises and speed training (Jeknić et al., 2022). Muscular endurance is also important in increasing kick speed in pencak silat. The greater the endurance of the muscle, the longer the muscle can work effectively in producing a powerful and fast kick movement. Muscular endurance can be improved through aerobic and anaerobic exercises.

Aerobic capacity also plays an important role in increasing kick speed in pencak silat. Good aerobic capacity can improve endurance and allow athletes to perform kick movements more effectively. Aerobic exercises

such as jogging, fartlek, or swimming can help increase aerobic capacity. In addition, physiological factors such as hormone levels and metabolism can also affect the speed of kicks in pencak silat. Hormones like testosterone can increase muscle strength and contraction speed, while a high metabolic rate can help increase muscle endurance.

No less important, physiological factors such as anthropometry influence the quality of kicks in pencak silat. [Subekti et al. \(2020\)](#) show that anthropometric factors, such as the limb length ratio to height, affect the ability of pencak silat kicks. The longer the athlete's limbs, it will take a long distance so that the kick can be done perfectly, of course, if the athlete's physical condition is good, the kick speed of people with long legs will be good too.

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In addition to physiological factors, flexibility also affects the speed of kicks in pencak silat. A study on the flexibility of pencak silat athletes on kick speed shows that limb flexibility positively relates to kick speed in pencak silat practitioners ([Hölbling et al., 2020](#)). Good flexibility allows a pencak silat practitioner to obtain a greater range of motion in kick movements, resulting in higher kick speeds ([Huang et al., 2018](#)). Coordination between the muscles also plays an important role in increasing kick speed. Coordination between the muscles allows a pencak silat athlete to perform kick movements efficiently to produce optimal kick speed. A study of leg muscle coordination on kicking speed showed that coordination between muscles in the legs was positively related to kick speed in pencak silat practitioners ([Skoufas et al., 2018](#)).

Speed is one of the determining factors of momentum in kicks. The front kick of the pencak silat must have great momentum, making the attack difficult to anticipate. Momentum is the multiplication of the mass and velocity of a moving object (Diewald et al., 2022). Kicks at high speed will cause the opponent difficulty anticipating the kick. The speed of kicks can be increased by training muscle strength. Strength and power have been shown to correlate with speed and the ability to change the direction of the body. In addition to speed, mass is also a factor that plays an important role in generating momentum. The mass involved in the kicking process will depend on the body's Center of Mass (CoM) (Fuchs et al., 2018; Mapelli et al., 2014). The Center of Mass (CoM) is the imaginary point at which the total body mass is assumed to be concentrated. The evaluation of CoM in pencak silat athletes will be beneficial to increase momentum.

Biomechanical feedback is key to improving athlete performance (Zhang et al., 2019). The use of Kinovea software to analyze movements in pencak silat is very cheap, easy, and practical to be done by the coach and by the athlete himself so that each practitioner can evaluate various kick techniques, even all techniques in pencak silat (Pueo et al., 2020; Puig-Diví et al., 2019). For more detail in measuring speed, research is needed to compile a tool that can measure distance automatically and reliably, such as using sensors (Taborri et al., 2020). Thus, multidisciplinary research between sports and engineering science will be very useful in compiling various sports equipment needed to support or evaluate athlete performance.

CONCLUSION

From the results and discussion that has been explained, from ten front kick attempts, sample 1 produced an average speed of 3.25 m / s with details of an average 1.82-meter kick distance and an average travel time of 0.56 seconds. Sample 2 produced an average speed of 2.71 m/s with details of an average 1.90-meter kick distance and an average travel time of 0.70 seconds. Identifying the kinematic motion parameters in athletes with skills can evaluate Technical Movements in sports movements,

especially pencak silat. The selection of subjects who excel in having the skill shows technical performance by producing higher movements at the time of impact in pencak silat kicks.

After a comprehensive analysis of the characteristics of the Front Kicks technique in pencak silat, it is recommended that an evaluation of the athlete's movements and wildly kicking techniques can be carried out with the resulting time analysis to get the purpose of doing the technique. For further research, it is expected to measure parameters in other techniques in pencak silat so that they know more about things that can support the performance of pencak silat with good techniques.

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