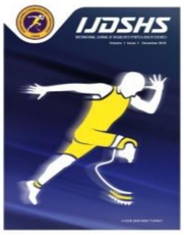

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RESEARCH ARTICLE

Different Biomechanics in Football Shooting Using Inside and Instep Kick

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Abstract
This research purposes were examinedthe differences in shooting accuracy using inside and instep kicks and observe differences in kick movements based on biomechanical variables. Twelve professional football players shot using inside and instep kicks on circular hops targets, shooting motions were recorded using a camera at 1000 frames per second. The kinematics during the swing phase and the impact phase with the ball producing the ball's trajectory were analyzed. Independent t-test used to compare shooting using inside and instep kick. The results showed that there was a significant difference in shooting accuracy using inside and instep kick (t_{count} = 3.317, p = 0.003) with a effect size large (Cohen's d = 1.35). When observing the movements, there were significant differences in backswing knee angle (p=0.024), frontswing knee angle (p=0.034), shoulder tilt angle (p=0.045), ball bearing foot placement (p=0.019), and inclination angle of pedestal foot(p = 0.000), while other biomechanical variables showed no significant difference (p > 0.05). This research concludes that accurate shooting movement is achieved using inside kicks, caused by the backswing and frontswing knee angles, body tilt, and the placement and angle of the pedestal foot.

Keywords
Accuracy, Shooting, Inside Kick, Instep Kick

INTRODUCTION

Football is a sport that requires tactical, technical, and physical performance skills (Modric et al., 2021). Football is essentially a movement performance consisting of elements of well-coordinated motion, in this case it is very dependent on the ability of a player to take into account and foster physical condition through the basic movements of the movement process of a football player. Football is a type of game that has complex movements. This means that the movement consists of movement elements that are well coordinated, so that they can be played well. To be able to achieve mastery of the basic techniques of playing football, players must perform with the principles of correct, careful, systematic technical movements that are carried out repeatedly and continuously, so as to produce good cooperation between a set of muscle nerves for the formation of a harmonious movement, thereby resulting in movement automation.

Good mastery of movement skills can be obtained through research efforts in the field of sports biomechanics as a learning capital for movement as well as supporting factors in the sport in question. Sports biomechanics is a method by which the very fast actions occurring in sport can be recorded and analyzed in detail. Sports biomechanics represents a science that provides quantitative and qualitative assessments of sports performance, especially kinematics and sports movement kinetics (Taborri, 2020). In the game of football, kicking technique is an important

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technique for skilled ball manipulation during passes and shots.

Players must position themselves to support maximum acceleration during the kicking action, ensuring a strong shot and body balance.Kinematic studies of kicking motion describe variations in the angle and speed of the 3 most involved limb joints, namely the hip, knee, and ankle. Thus it has been observed that in kicking, the limbs are involved during the back swing, hip hyperextension, knee flexion, and ankle flexion. During the wind up phase,the hips are bent while the knees reduce flexion. So at the time of collision with the ball there is hip flexion, knee flexion, and ankle flexion. In this phase, the ankle is in a fixed position so that the foot forms a single unit to allow for effective contact and ensure fast ball release.

Shooting is the most common way to score. Accuracy are the most important variables related to football shooting (Martinez et al., 2020). Inside kick results better accuracy. In shooting, kick accuracy is most important and players usually use inside kicks (Rodenas, et al., 2020). However, instep kick can also produce good accuracy. Izovska, Maly, & Zahalka (2016) reported that regarding instep kick accuracy, we noted high variability in accuracy when the mean difference between the best and worst trials was 56.8 ± 19.6%. Research shown that the most accurate instep kick is found at speeds between 90-102 km.h-1, which is about 80-90% of the maximum kick speed. This shown that both kicks types can produce good accuracy.

Viewed from the accurate kick mechanism, activation of the kicking leg muscles is a significant mechanism that contributes greatly to the accuracy of kicks in football (Katis et al., 2012). Katis et al (2012) analyzed the activation of the tibialis anterior (TA), rectus femoris (RF), biceps femoris (BF) and gastrocnemius muscles (GAS) of the swinging leg and ground reaction forces (GRFs) of the support leg. GRFs did not differ between kick conditions ($P > 0.05$). Significantly higher TA and BF activity and lower GAS EMG activity during accurate kicks to the upper target ($P < 0.05$) compared to inaccurate kicks. In addition, there was significantly lower TA and RF activation during accurate kicks against the bottom target ($P < 0.05$) compared to inaccurate kicks. Increasing TA and BF muscle activation and reducing GAS activation can help players to kick accurately against high targets. Conversely, players displaying higher TA and RF activation may be less accurate against bottom targets. While comparing the two types of kicks, previous studies reported comparisons in terms of muscle activation, the results showed that a significant interaction effect was identified for the hamstrings ($P = 0.02$) and tibialis anterior ($P <.01$). Greater activation of the kicking limb iliacus (P, .01), gastrocnemius ($P =0.01$), vastus medialis ($P = 0.016$), and hip adductors (P, .01) occurred during the instep kick (Brophy et al. , 2007).

The explanation above explained the accuracy of kicks and differences in kick accuracy based on muscle activation. However, the lack of related studies comparing the accuracy of the two types of kicks based on their biomechanical variables still needs to be done. So that it shown the kinematics of the two kickstypes. Through biomechanical analysis of the inside and instep kick movements, it can assist coaches in preparing training programs for football athletes, as well as evaluating the movements made by athletes, so that athletes can improve their abilities and identify the weak points.Therefore, this research was conducted to examines differences in shooting accuracy using inside and instep kicks and observes differences in kick movements based on biomechanical variables. The research hypothesis that there are differences in shooting accuracy using inside and instep football kicks and there are differences in biomechanical variables in the movements of the two types of kicks.

MATERIALS AND METHODS

Research methods

The researcher used a quantitative approach with an analytical observational research design. The cohort research design is classified as an observational analytic research design (Rezigalla, 2020). The design of the observational analytic research compared the two groups, with exposure and outcome. This research design is used to find out how and why a phenomenon occurs through statistical analysis of causal factors. The type of observational analytic used is a cross sectional research. Cross-sectional research design is the kind of observational research design. In a cross-sectional research, researchers measure outcomes and exposures to research participants at the same time (Setia, 2016). Cross sectional research studies the relationship of causal factors and effects simultaneously or at a time in a population. Simultaneous means that all variables are observed/measured at the same time. This research measures the different biomechanics of football shooting using inside and instep kicks. Shooting accuracy is an important factor (Arafat et al., 2020). The variables examined for each type of kick consisted of the swing phase and the impact phase with the ball producing the ball's trajectory. Variables include the angle of knee flexion of the backswing kick, the angle of extension of the knee of the pedestal leg, the angle of the frontswing pelvis, the angle of extension of the knee of the frontswing kick,the angular speed of the frontswing, the angular acceleration of the frontswing, the speed of the ball after the collision, the angle of inclination of the kicking leg, the distance of the pedestal feet with the ball, pedestal feet angle, hip tilt angle, shoulder tilt angle, ball momentum, touch force, impulse, power, effort, hip angle follow through, angular velocity follow through, slowdown follow through, kinetic energy of ball moving, ball height, potential energy of ball moving, and mechanical energy of ball moving.

Research subjects

In total, 12 healthy, male, outfiled professional football players, with at least 4 years of experience. They are players who play for league 1 or league 2 of Indonesian football. Average age of 20.6±1.41 years, 69.09±6.98 kg, 173.4±6.1cm, 8.1±2.6 years of training experience, 5.6±1.3 number of training sessions per week. All of them are experienced football players with their right foot as their dominant foot. The participants were fully informed about the protocol before participating in this study. Informed consent was obtained prior to testing from all participants. This study was approved by the ethics committee of Sebelas Maret University of Surakarta.

Data collection

Before the test, all players warmed up for about 10 minutes including jogging and kicking practice and all participants were previously familiarized with the shooting test procedure before the test session (Li, et al., 2015). After installation, participants were instructed to do a shooting test.The subject stands 16 yards from the goal. Subjects were instructed to shoot a stationary ball into the goal at four circular targets with a diameter of one meter mounted on the goal postsuse inside and instep kicks. Shot starts bottom-left, bottom-right, top-left, and top-right. So that a total of 8 shots for each subject were used for analysis whether they succeeded or failed to enter the circular target (4 shots using inside kicks and 4 shots using instep kicks) (Khalifa, et al., 2021). Successful and failed shots are used to determine the percentage of accuracy of the inside and outside kick. Then from a successful shot, proceed to analysis of body kinematics.Full body kinematics recorded using a camera at a high speed of 1000 frames per second.

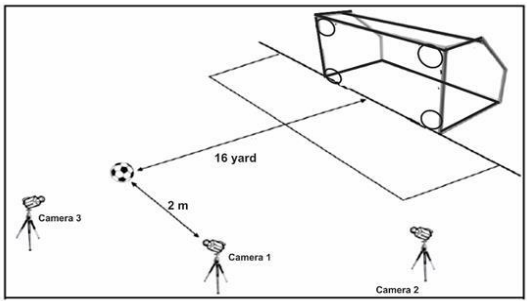

Figure 1. Camera Position for Recording

Camera 1 is mounted two meters on the right side of the ball and perpendicular to capturing the movement of the foot from side when shooting using inside and instep kicks. Camera 2 is installed in the middle aiming to capture the path of the ball to a circular target to determine the ball that goes to a circular target.Camera 3 is behind the participant to capture the body tilt position when shooting using inside and instep kicks (Figure 1).

Data analysis

Kinematics analysis was used dartfish software. The kinematic analysis is divided into two phases, namely the swing phase and the impact phase with the ball producing the ball's trajectory. Kinematics analysis used Dartfish software only can determine angle, time, and distance, while to find out angular velocity, angular acceleration, ball velocity, momentum, touch force, impulse, power, work, and energy, researchers use following formula:

The angular velocity along the cycle step wave (rad/s) is shown to increase linearly with the highest speed (Clark, 2022), where is the angular velocity ω (rad/s), is the change in angle (rad), and is the change in time (s), so it can be determined by:

$$\omega = \Delta\theta . \Delta t^{-1} \qquad \text{(Equation 1)}$$

During the kick, the thigh rotates in a sagittal plane in the swing phase. The model equations for angular velocity ω (rad/s), time (s) and angular acceleration (rad/s^2) is (Clark et al., 2021):

$\alpha = \Delta\omega.\Delta t^{-1}$ (Equation 2)

The ball speed is calculated based on the equation with the distance traveled by the ball and the elevation angle of the ball (Chudinov, 2021), where L is the balls reach distance, θ is the balls elevation angle, v is the balls velocity, and gravity (9.8 m/s2), so it can be determined by:

$L = (v^2 \sin 2\theta).g^{-1}$ (Equation 3a)
so to determine v with the formula:

$v^2 = L.g.(\sin 2\theta)^{-1}$ (Equation 3b)

When an impact occurs between foot and ball, momentum (p) is generated from mass (m) and velocity (v) (Noé, 2006), formulated by:

$p = m.v$ (Equation 4)

Then, the resulting force exerted by the body will be equal to the change in momentum (Δp) per unit time (Δt), where is the force (N), is the change in momentum (N.s), and Δt is the change in time (s), so it can be determined by (Grassmann et al., 2004):
$F = \Delta p.\ \Delta t^{-1}$ (Equation 5)

The supporting limb displacement requires to produce an initial impulse (net effect of the force acting for a certain period of time (Noé, 2006), where I is the impulse (N.s) F is the force (N), and Δt is the change in time (s):
$I = F.\ \Delta t$ (Equation 6)

When kicking a ball, power is also needed which is related to speed (v), P where is power (watts), F is force (N), and v is velocity (m/s), so it can be determined by (Toussaint & Beek, 1992):
$P = F.v$ (Equation 7)

When analyzing the energy to kick the ball, it takes an effort (Joule) which is done with a force (F) at the distance the ball has traveled (d), so that it can be determined by (Toussaint & Beek, 1992):
$W = F.d$ (Equation 8)

Then, the size of the kinetic energy of the ball is depends on the mass and speed of the ball, where EK is the kinetic energy (Joule), m is the mass of the ball (0.45 kg), and v is the velocity (m/s), so it can be determined by (Grassmann et al. al., 2004):

$EK = \frac{1}{2} mv^2$ (Equation 9)

In addition to kinetic energy, potential energy is also generated when there is a change in the vertical position or height of an object or ball. If want to change the vertical position of an object or ball to a height h, work must be done to overcome the weight force of W or the gravitational force of F_g. Where EP is potential energy (Joule), m is the mass of the ball (0.45 kg), g is gravity (9.8 m/s2), and h is the height of the ball (m). This equation applies to objects near the Earth surface, where gravity is assumed to be nearly constant. Thus, it is necessary to apply an external force F = W (weight) and the equation (Alcocer, 2021) is obtained:
$EP = m.g.h$ (Equation 10)

The rate of segmental energy change is defined as the rate of mechanical energy change of a segment. Mechanical energy (EM) refers to the sum of potential energy (EP) and kinetic energy (EK) (Chen, Chang, & Cheng, 2019), where EM is mechanical energy, EP is potential energy (Joule), and EK is kinetic energy (Joule), so it can be determined with:
$EM = EP + EK$ (Equation 11)

The Kolmogorov-Smirnov test shows that the data is normally distributed, to compare the accuracy of shooting types on targets and to compare shooting biomechanics variables using inside and instep kicks, the researcher used *independent t-test.*The significance level is set at 0.05 (Devi & Sing, 2021). To show the magnitude of the difference, the effect size is calculated. The magnitude of the effect size is interpreted with the criteria<0.02 = *trivial*, 0.2–0.6 = *small,*>0.6–1.2 = *moderate,*>1.2–2.0 = *large*, and >2.0 *very large Differences* (Sekulic et al., 2021). Independent t-test analysis was performed using SPSS 16.

RESULTS

Data Description

Table 1. Description of Shooting Accuracy Data Using Inside and Instep Kick

Shooting Type	N	Shooting Accuracy	Target Position				Total
			Bottom left	Bottom right	Top Left	Top right	
Inside Kick	48	Accurate	2	4	2	6	14
		No Accurate	10	8	10	6	34
Instep Kick	48	Accurate	2	1	0	1	4
		No Accurate	10	11	12	11	44

The description of the shooting accuracy data using inside and instep kicks is presented in table 1. Based on the table, it can be seen that in 48 shooting attempts, each type of shooting showed a higher shooting accuracy in number shooting using inside kick with a total accuracy of 14 balls enter the target, while in shooting using instep kick only 4 balls that enter the target. Of the 14 balls that entered the target when shooting using an inside kick, 2 balls entered the lower left target, 4 balls entered the lower right target, 2 balls entered the upper left target, and 6 balls entered the upper right target. Meanwhile, of the 4 balls that entered the target when shooting using an instep kick, 2 balls entered the lower left target, 1 ball entered the lower right target, and 1 ball entered the upper right target.

Percentage of accurate shooting using inside and instep kick served in the table 2. According to the table, it can be seen that the percentage of the ball enter the target of shooting using the inside kick is 14.583% and that did not enter the target is 35.417%, while the percentage of ball enter the target of shooting using Instep kick is 4.167% and those who did not enter the target is 45.833%. Based on table 2, most of the shooting that entered the target is shooting using inside kick where the percentage of accuracy on the lower left target is 4.167%, the lower right is 8.333%, the upper left is 4.167%, and the upper right is 12,500%. While shooting using instep kick, the percentage of target accuracy on the lower left is 4.167%, lower right is 2.083%, upper left is 0.000%, and upper right is 2.083%.

Table 2. Percentage of Shooting Accuracy Using Inside and Instep Kick

Shooting Type	Shooting Accuracy	Target Position				Total
		Bottom left	Bottom right	Top Left	Top right	
Inside Kick	Accurate	4.167%	8.333%	4.167%	12.500%	14.583%
	No Accurate	20.833%	16.667%	20.833%	12.500%	35.417%
Instep Kick	Accurate	4.167%	2.083%	0.000%	2.083%	4.167%
	No Accurate	20.833%	22.917%	25.000%	22.917%	45.833%

Independent t-test

Table 3. Testing differences in football shooting accuracy using inside and instep kick

Shooting type	*Mean*	t_{count}	*sig* (p)	*Effect size*
InsideKick	1.17	3.317	0.003*	1.35
Instep Kick	0.33			

*Significant difference in shooting biomechanics using inside and instep kick ($p < 0.05$)

The difference in the accuracy of shooting football using inside and instep kicks is presented in table 3. Based on the table, it wa shown that there is a statistically significant difference in shooting football using inside and instep kicks (t_{count}= 3.317, p = 0.003)with the effect size large*(cohen's d* =1.35), where the percentage of shooting accuracy on targets is higher for shooting using inside kicks than shooting using inside kicks. Furthermore, the biomechanical analysis to determine the characteristics of each motion shooting is done, so it can be the difference biomechanics variables shooting using the inside and instep kick in producing precision.

Table 4. Test of biomechanics differences in football shooting using inside and instep kick

No	Biomechanics Variables	Inside Kick (mean)	Instep Kick (mean)	t_{count}	sig (p)
1	Knee flexion angle of the backswing kick (^{0})	85.35	102.17	3.213	0.024*
2	Knee extension angle of pedestal leg (^{0})	152.50	158.00	1.575	0.175
3	Frontswing hip angle (rad)	1.12	1.17	0.154	0.883
4	Frontswing kick knee extension angle (^{0})	146.46	137.67	2.883	0.034*
5	Frontswing angular speed (rad/s)	2.37	2.44	0.449	0.672
6	Frontswing angular acceleration (rad/s ^{2})	5.10	5.12	0.033	0.975
7	Velocity of ball after collision (m/s)	19.63	28.58	1.192	0.287
8	Kick foot tilt angle (^{0})	69.06	60.50	2.213	0.078
9	Distance from pedestal leg to ball (m)	0.27	0.22	3.427	0.019*
10	Pedestal leg tilt angle (^{0})	70.10	56.67	11.926	0.000*
11	Pelvic tilt angle (^{0})	11.04	11.50	0.167	0.874
12	Shoulder tilt angle (^{0})	23.38	12.83	2.662	0.045*
13	Momentum of the ball (Ns)	8.84	12.86	1.192	0.287
14	Touch force (N)	83.43	128.63	1.345	0.236
15	Impulse (Ns)	8.84	12.86	1.192	0.287
16	Power (Watts)	1707.93	4316.41	1.234	0.272
17	Effort (J)	181.53	431.64	1.180	0.291
18	Pelvic angle follow through (rad)	0.46	0.48	0.312	0.768
19	Angular follow through speed (rad/s)	0.79	0.89	0.556	0.602
20	Angular deceleration follow through (rad/s ^{2})	-1.41	-1.67	0.569	0.594
21	The kinetic energy of the moving ball (J)	90.77	215.82	1.180	0.291
22	Ball height (m)	1.35	1.05	0.413	0.697
23	Potential energy of the moving ball (J)	5.95	4.64	0.415	0.696
24	Mechanical energy of the moving ball (J)	96.72	220.46	1.189	0.288

*Significant difference in shooting biomechanics using inside and instep kick ($p < 0.05$)

The average comparison of shooting biomechanics variables using inside and instep kicks is presented in table 4. There is a statistically significant difference in biomechanics variables between shooting using inside and instep kicks for the knee flexion angle of the backswing kick (p = 0.024), the knee extension angle of the leg frontswing kick (p = 0.034), the distance of the pedestal leg with the ball (p = 0.019), Pedestal leg tilt angle (p = 0.000), and the Shoulder tilt angle (p = 0.045).

There was no statistically significant difference in biomechanical variables between shootingusing inside and instep kicks for the extension angle of pedestal leg (p = 0.175), frontswing hip angle (p = 0.883), angular frontswing velocity (p = 0.672), angular frontswing acceleration (p = 0.975), ball speed (p = 0.287), kick foot tilt angle (p = 0.078), hip tilt angle (p = 0.874), ball momentum (p = 0.287), touch force (p = 0.236), impulse (p = 0.287), power (p = 0.272), effort (p = 0.291), hip angle follow through (p = 0.768), angular speed follow through (p = 0.602), angular deceleration follow through (p = 0.594), the kinetic energy of moving ball (p = 0.291), the ball height (p = 0.697), the potential energy of moving ball (p = 0.696), and the mechanical energy of moving ball (p = 0.288).

Based on the results of the independent t-test, it was shown that there is a statistically

DISCUSSION

Shooting is the most common way to score. All parts of the legs can be used for shooting based on the situation and conditions of the game. Although all parts of the foot can be used in shooting, ball accuracy is an important variable related to football shooting (Martinez et al., 2020). significant difference in the accuracy of the ball between shooting using inside and instep kicks with a p-value of 0.003 ($p < 0.05$),which in this research shown that the accuracy of shooting using inside kicks is more precise than shooting using instep kick with the accuracy percentage of shooting using inside kick is 14.583%, while accuracy of shooting using instep kick is 4.167%. In line with these results, Ródenas et al(2020) stated that inside kick generate better accuracy.The study of Bubanj et al (2010) reported that there was a certain range of values where inside kick accuracy was achieved, while the speed of the ball after being kicked found no difference. The instep kick reported no significant difference in kick accuracy at both target positions and at the approach angle, however there was a difference in ball speed (Majelan et al., 2011). This shown that the instep kick is a powerful kicking technique.

When comparing body kinematics when shooting using inside and instep kicks, it shows that there are statistically significant differences in the angle of knee flexion of the backswing kick, the angle of knee extension of frontswing kick, the distance between the pedestal leg and the ball, the pedestal leg tilt angle, and the shoulder angle. Kellis & Katis (2007) reported that the football kick is characterized by a movement proximal to the distal segment of the lower leg of the kicking leg. Arguz et al (2021) shown a relationship between penalty kick variables during the performance phase and accuracy where the knee angle during the swing (backswing and frontswing) is an important factor. In this study, the players shown shooting using the inside kick, the backswing knee angle is smaller than shooting using instep kick and the frontswing knee angle is larger than shooting using an instep kick, namely the backswing knee angle of 85.35^0 and the frontswing knee angle of 146.46^0 on shooting using an inside kick, and a backswing knee angle of 102.17^0 and a frontswing knee angle of 137.67^0 when shooting using an instep kick.Majelan et al (2011) reported that players kick with more knee extension and hip flexion efficacy. Matteo et al (2015) also report hip extension, abduction and rotation into the kicking leg. After ball contact, the move ends in the airborne phase.

Kellis & Katis (2007) explained that an accurate kick is achieved through a slower kicking motion and a lower ball speed value. Although there is no difference in terms of foot speed and ball speed between the two types of kicks in this study. But according to the type of accurate kick, the inside kick displays lower frontswing angular acceleration and speed and lower ball speed than the instep kick. According to Kellis & Katis (2007), angular velocity is maximized first by the thigh, then the calf and finally the foot. During the backswing, the thighs slow down because the movement depends on the activation of the hip muscles. Forward acceleration is achieved through knee extension. The final velocity, path and spin of the ball largely depends on the quality of the foot-ball contact.

In relation to foot speed, according to Less (2003), the forward rotation stage and the moment of impact with the ball are the most important from a performance standpoint. A high angular velocity of the shank means a high foot velocity. It appears that to achieve a high foot velocity, energy must be built up in the early stages of the movement. Thigh energy is built in the swing phase. Therefore the range of movement in which the hips and legs move, and the muscle strength applied during this stage will determine the maximum speed of the foot at impact. Related to the energy that must be built during the initial stages of movement, effort is the energy that is channeled to successfully move the foot to kick the ball with a certain style. This means that it takes a lot of effort to generate a lot of energy and eventually achieve a high foot velocity.

The results of our study also report that, although the results of the study reported no statistically significant difference related to effort, the instep kick was carried out with an effort of 431.64 Joules greater than the inside kick which was 181.53 Joules. From this big effort, the instep kick produces a greater force, namely 128.63 N than the inside kick, which is equal to 83.43 N, to kick the ball so that the ball that is kicked produces a faster ball. Because of this, why is the instep kick said to be a powerful kick because it is done with high effort and style and results in high ball speed. Unlike the case with the dominant inside kick on accurate kicks.

Then related to kick accuracy, Arguz et al (2021) relate it with increasing the body tilt angle to increase the level of accuracy in penalty kicks on the side of the target, this is because the accuracy of the kick can be affected by the position of the body joints during performance. In this study, the players shown shooting using the inside kick is done with the shoulder tilt angle greater than shooting using instep kick which is

23.38^0 of the shoulder tilt in shooting using inside kick and 12.83^0 the shoulder tilt in shooting using instep kick. Regarding the research results, to produce an accurate kick, the placement of the pedestal leg is very important for kick performance, because the pedestal leg helps stabilize the body when swinging the kicking leg (Katis et al., 2013). In this study, the players shown shooting using the inside kick, the placement of the pedestal leg with the ball is slightly farther away than shooting using an instep kick, which is 0.27 meters for shooting using an inside kick and 0.22 meters for shooting using an instep kick. The angle of the pedestal leg for shooting using inside kick is greater than for shooting using instep kick, which is 70.10^0 for the pedestal leg tilt for shooting using inside kick and 56.67^0 for the pedestal leg tilt for shooting using instep kick.

Conclusion

This study concludes that accurate shooting movements are achieved using inside kicks and depend on the size of a certain angle. Based on accurate shooting kinematics studies, it was carried out with a backswing knee angle of 85.35^0, a frontswing knee extension angle of 146.46^0, the distance of the pedestal foot from the ball is 0.27 m, the inclination angle of the pedestal leg is 70.10^0, and the shoulder tilt angle is 23.38^0. The magnitude of the rotation angle, namely the backswing and frontswing knee angles, is important in kick performance. This is because it will affect the range of movement in the hips and legs moving and determines the maximum speed of the foot when impacted by the ball. Accurate kicks are generally slower, performed with a smaller backswing knee angle and a greater frontswing knee angle during rotation. Through the magnitude of the angle during this rotation, it then generates the amount of effort to channel energy to succeed in moving the foot to kick the ball with a certain style, which then determines the magnitude of the foot speed and momentum with the ball, and determines the speed of the ball after being kicked.

Conflict of interest

The author states that there is no conflict of interest. No financial support received.

Ethics Statement

Approval from the Scientific Research Ethics Committee of Sebelas Maret University Surakarta was obtained for this research (protocol number 254/UN27.22/PT.01.03/2022)

Author Contributions

The study design was carried out by RID; Data collection is done by RID; Statistical analysis was performed by RID; Data interpretation was performed by HN; The preparation of the manuscript was carried out by HN; Literature search was conducted by IS. All authors have read and approved the published version of the manuscript.

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