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Anthropometry and Physical Condition Factors for Determining the Speed of Sickle Kick

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Abstract

This research aims to determine the anatomical and physiological factors of the body that have a correlation and role in the speed of sickle kicks of pencak silat athletes. The basic anatomical (anthropometric) factors studied include body height and leg length. Meanwhile, the physiological factors (physical condition) studied include speed, agility, leg power, anaerobic endurance, balance, and flexibility. This research examines the fighting category in men's class C, which is the fighting category that dominates most adolescent pencak silat matches. This research used a quantitative approach with a confirmatory factor analysis (CFA) method which tested the consistency of indicators that had been grouped based on latent variables. All data obtained, processed, and tested went through several stages then would be eliminated if it did not meet the criteria to pass the test. The research population was adolescent pencak silat athletes aged 14-17 years old in Wonosobo Regency. The research location was conducted at 3 (three) high schools which had pencak silat training units and had trained athletes in the men's class C fighting category. The research samples were 15 people taken by using a purposive sampling technique. The research instruments were observation and documentation. The results of the research show that out of 9 latent factor variables, 8 variables are obtained which are the determining factors for the speed of the sickle kick. These factors with their role values are body weight (0.748), height (0.536), leg length (0.834), anaerobic endurance (0.838), speed (0.817), agility (0.876), leg power (0.856), and flexibility (0.902). Meanwhile, the balance is eliminated during the first analysis.

Keywords: *Anthropometry; CFA; Speed, Physical Condition; Pencak Silat; Sickle Kick*

1. Introduction

Pencak silat is classified as a sport in the field of martial arts from Indonesia with fight and art categories that have undergone various developments. The developing effort sports elements in pencak silat can be carried out through educational sports, achievement sports, and recreational sports or mass sports (I Ketut S, 2017; Tatang M, 2020). At the youth level in the IPSI (Ikatan Pencak Silat Indonesia) Competition Regulations in 2023, youth athletes Pencak Silat is aged 14 to 17 years old. The stage of specialization in pencak silat is at the age of 15-16 years old and the peak of achievement is at the age of 18-22 years old (Bompa. 1990; and Harsono. 1988). The teenage level becomes the peak of training specialization at the age of 15-16 years to reach the peak level of achievement which is called the golden

age at the age of 18-22 years. So, where this period in youth level in ages 14-17 years old is called the golden time in developing pencak silat's deeper talent.

At youth level, the development of match regulations is different from the belowed categories. Under with the new regulations starting in 2021, he match allows one-handed pull attacks and locks. So, the development of various effective new techniques emerged to be able to use pulling techniques as points that bring down opponents. However, in reality, the sickle kick technique is still dominates matches under the new regulations. As stated by Sinulingga (2023) in his research, one of the kicks in pencak silat, namely the sickle kick, is the most widely used kick in pencak silat. The results of a survey conducted by Ivan (2021) regarding the effectiveness of kicks used in pencak silat, namely in the event PRAPON, PON and SEA GAMES championships. The effectiveness of side kicks is more likely to hit the target in a percentage of (41.76%) PRAPON matches, (48.33%) PON matches, and (50%) SEA GAMES matches. The sickle kick is still the dominant for attacking technique after the drop technique in the youth category.

In performance sports, stability and improving an athlete's performance is a coach's homework in preparing a training program. Many people ask about what makes an athlete successful in the sport they sport speciality and various answers is physiology, biomechanics and sports skills (Kevin Norton & Tim Olds, 1996). Therefore, all aspects of the information that produced by the body can predict an athlete's success, especially in achieving achievements.

Anthropometric characteristics and physical fitness are important information that includes body size, body health condition and body shape (Munoz-Catol et al., 2007; Kurt, Catokkas & Atalog, 2011; Radu, et al. 2014). Some variables that play a small role (can play a big role in certain sports) are in terms of anthropometry which can show a proportional body shape according to the composition of each type of sport to achieve success or achievement (Kevin Norton & Tim Olds, 2004). By knowing the necessary anthropometric factors, it can be used as a benchmark or guide for coaches in carrying out talent scouting from an early age.

The efficiency and effectiveness of physical performance in a sport, especially in martial arts, depends on the size, weight and physical proportions of the athlete (Venkteshwarlu, 2010). Optimal physical conditions influence the athlete's playing performance (Arizal, Y&Lesmana H. S, 2019). Physical, technical, tactical and mental conditions are big supporting factors that can influence achievement (Soniawan, V & Irawan. R, 2018). From an expert and practitioner perspective, it is very important to carry out systematic monitoring of athlete profile data such as anthropometric data and body composition which are related to physical performance at various stages of athlete development (Chaabene, et al. 2019).

This research aims to determine two internal factors that can influence the speed of pencak silat sickle kicks, for basic of anthropometric factors (anatomy) and physical condition factors (physiology). Anthropometric factors studied include height, weight and leg length. Meanwhile, the physical condition factors studied include anaerobic endurance, speed, agility, balance, leg power and flexibility. The latest in this research is research after the development of new rules in pencak silat where lot of people developing of new techniques, the sickle kick is still needed as one of the techniques trained to achieve maximum speed and is used as a deceptive attack, counter attack or absolute attack.

2. Methodology

This research uses a quantitative approach which emphasizes analysis on numerical data (numbers) which are processed using statistical methods (Azwar, 2010: 5). The method used is confirmatory factor analysis (CFA) techniques. Factor analysis aims to obtain the dominant factors in an event (Nugroho, 2008). Confirmatory factor analysis is a tool needed to analyze construct validation (Moore & Brown, 2012). Confirmatory factor analysis is used to look for unmeasured indicator variables

based on existing theory. The sample in this study consisted of 15 people using a purposive sampling technique. In purposive sampling, samples are taken using the inclusion criteria, namely; (1) physically and mentally healthy, (2) Teenage age (14-17 years), (3) Men's martial arts fighter, (4) Class C fighting category (48-51 kg). The sample came from 3 high schools in Wonosobo Regency which actively took part in training and had participated in minimum district championships.

The instrument of the data was collected out by observing and documenting. According to the measurement technique: (1) height using a stadiometer (cm), (2) body weight using a body scale (kg), (3) leg length using a body meter (cm), (4) anaerobic endurance using the RAST test, (5) speed using the 35 meter sprint test (m/s), (6) agility using the illinois running test, (7) leg power using the standing broad jump test (cm), (8) balance using the strock stand test, (9) flexibility using the side split test, and (10) sickle kick speed using the 10 second kick speed test (Johansyah. 2014).

Data analysis uses confirmatory factor analysis with the stage was described by (Purnomo and Eddy. 2014), namely determining variables, calculating the correlation matrix, extraction, determining the number of factors, and determining factor scores. The analysis used uses the SPSS application to assistance the calculation. The stages in this analysis are:

Stage 1. Normality Test

In this research, data analysis uses the One-Sample Kolmogorov-Smirnov Test with the condition that the population is normally distributed if the probability value is > a=0.05 then H_0 is accepted, if the probability value is <a=0.05 then H_0 is rejected.

Stage 2. Linearity Test

The linearity test with a prerequisite significance value is 0.05 using the Test of Linearity method to determine the linearity between each independent variable and the dependent variable by looking at the significance of the deviation from linearity.

Stage 3. Correlation Calculation

Correlation calculations using factor analysis are used in this research to reduce factors that are worthy of further analysis. Correlation matrix is calculated using the Bartlett test of specificity method to determine the relationship between variables and measure MSA (measure of sampling). In the Bartlett Test of Spericity method, correlation calculated using KMO (Kaiser-Meyer-Olkin). Meanwhile, for MSA, use data distribution from anti-image correlation. If the KMO-MSA value is greater than 0.5 then H_0 is accepted, so it can be concluded that the amount of data sufficient to factorized.

Stage 4. Factor Extraction

In this stage, the size of the variable variance is filtered with other variables using communalities data. In these communalities, the role of each variable can also be seen.

Stage 5. Determine the Number of Factors

Determining the number of factors is based on the magnitude of the eigen value of each factor that appears. Eigen value is the amount of variance explained by each factor. The core factors selected are factors that have an eigenvalue > 1.

Stage 6. Factor Rotation

Factor rotation is carried out to facilitate interpretation in determining which variables are included in a factor. The results of factor extraction have no meaning if they are not rotated because extraction rotation is useful to enable scientific interpretation and review.

Stage 7. Determine Factor Scores

Factor scores are values for unobserved random factors. Determining factor scores can provide an explanation of the strength of the relationship between small variables. As the final stage to obtain a meaningful structure. A factor score is an individual measure of a factor that is a weighted average value.

3. Result and Discussion

3.1 Result

From the results of observations and data collection, the following data summary was obtained.

Descriptive Statistics

	N	Min	Max	Mean	Std. Dev
Body Weight	15	48.00	51.80	50.575	1.07523
Height	15	161.0	176.00	165.933	4.04381
Leg Lenght	15	83.00	96.00	88.466	3.79599
Anaerobic End.	15	4.87	12.52	7.832	2.17638
Speed	15	8.87	5.54	7.178	1.07618
Agility	15	20.28	11.58	15.104	2.20106
Leg Power	15	230.0	268.00	249.600	9.18695
Balance	15	11.86	57.74	23.856	11.76610
Flexibility	15	8.00	36.00	25.600	9.09317
Sickle Kick Sp.	15	22.00	33.00	27.133	3.20416
N	15				

From the results of factor analysis, the results of the data normalization test can be seen as well as the distribution.

Variabel	Asymp Sig.	Prob	Kesimpulan
Body Weight (X1)	0.005	0.05	tidak berdistribusi normal
Height (X2)	0.145	0.05	berdistribusi normal
Leg Lenght (X3)	0.200	0.05	berdistribusi normal
Anaeobic End.(X4)	0.200	0.05	berdistribusi normal
Speed(X5)	0.137	0.05	berdistribusi normal
Agility (X6)	0.200	0.05	berdistribusi normal
Leg Power (X7)	0.200	0.05	berdistribusi normal
Balance (X8)	0.127	0.05	berdistribusi normal
Flexibility (X9)	0.141	0.05	berdistribusi normal
Sickle Kick Sp. (Y)	0.200	0.05	berdistribusi normal

From the results of data normality, all data is normally distributed except for the Body Weight variable. Weight data is not normally distributed is not influenced by several factors, and can still be continued in further tests with linearity correlation testing.

Linearity testing uses the test of linearity in SPSS. The results of linearity can be seen in below.

Var	Sig. Dev. From Linearity	Sig	Kesimpulan
X_1Y	.646	0.05	Ada hubungan linear
X_2Y	.701	0.05	Ada hubungan linear
X_3Y	.975	0.05	Ada hubungan linear
X_4Y	.541	0.05	Ada hubungan linear
X_5Y	.479	0.05	Ada hubungan linear
X_6Y	.821	0.05	Ada hubungan linear
X_7Y	.779	0.05	Ada hubungan linear
X_8Y	.863	0.05	Ada hubungan linear
X_9Y	.921	0.05	Ada hubungan linear

The results of the linearity test showed that the overall data had obtained a significance value above 0.05, therefore, all variables had a strong correlation with the speed of the sickle kick.

Next, factor analysis was carried out with validation using Keiser-Meyer-Olkin (KMO) analysis. The results of the analysis are as follows.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.703
Bartlett's Test of Sphericity	**Approx. Chi-Square**	85.508
	df	36
	Sig.	.000

Based on the KMO-MSA results table above, a value of 0.703 is obtained which is greater than 0.5 and a significance value of 0.000 which is smaller than 0.05. In this way, the analysis process can be continued to the next stage to MSA analysis by looking at the correlation results of the anti-image.

Anti-image Matrices

		BW	H	LL	Anaerobic End.	Sp	Ag	Leg Pow	Bal	Flex
Anti-image Correlation	BW	.563[a]	-.021	-.131	.016	-.578	.674	-.198	.554	.327
	H	-.021	.785[a]	-.222	-.151	.157	.004	-.180	.110	-.181
	LL	-.131	-.222	.733[a]	-.290	-.073	-.038	-.477	-.113	-.146
	Anaer End.	.016	-.151	-.290	.892[a]	-.244	.056	.112	.078	-.280
	Sp	-.578	.157	-.073	-.244	.684[a]	-.631	-.143	-.143	-.447
	Ag	.674	.004	-.038	.056	-.631	.677[a]	.119	.618	-.049
	Leg Pow	-.198	-.180	-.477	.112	-.143	.119	.777[a]	-.236	.289
	Bal	.554	.110	-.113	.078	-.143	.618	-.236	.250[a]	-.285
	Flex	.327	-.181	-.146	-.280	-.447	-.049	.289	-.285	.815[a]

a. Measures of Sampling Adequacy(MSA)

From the anti-image table above, there are variables that get a value above 0.5, that is body weight (X1), height (X2), leg length (X3), anaerobic endurance (X4), speed (X5), agility (X6), power (X7), and flexibility (X9). Meanwhile, the balance variable (X8) will be reduced and declared unfit for analysis to the next stage because the inflation variable has an MSA value of 0.250, which means less than 0.5.

The next stage is to reduce inappropriate variables. After the inflation variable has been removed or eliminated, it is then analyzed in factor analysis II by retesting the other eight variables. The following are the results of factor analysis II.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.729
Bartlett's Test of Sphericity	**Approx. Chi-Square**	77.727
	df	28
	Sig.	.000

Based on the table above, after the inflation variable was eliminated, the KMO-MSA value increases to 0.729 with the significance of Barlett's Test of Sphericity being 0.000. Because 0.729 > 0.5 and the sig value. 0.000 < 0.05, so the data has a significant correlation and can be analyzed to the next stage.

Anti-image Matrices

		BW	H	LL	Anaerobic End.	Sp	Ag	Leg Pow	Flex
Anti-image Correlation	**BW**	.612[a]	-.099	-.082	-.033	-.605	.506	-.083	.609
	H	-.099	.790[a]	-.212	-.161	.175	-.082	-.159	-.157
	LL	-.082	-.212	.715[a]	-.284	-.091	.041	-.522	-.187
	Anaro. End	-.033	-.161	-.284	.896[a]	-.236	.010	.135	-.270
	Sp	-.605	.175	-.091	-.236	.643[a]	-.698	-.184	-.514
	Ag	.506	-.082	.041	.010	-.698	.735[a]	.347	.169
	Leg Pow	-.083	-.159	-.522	.135	-.184	.347	.754[a]	.238
	Flex	.609	-.157	-.187	-.270	-.514	.169	.238	.758[a]

a. Measures of Sampling Adequacy(MSA)

The analysis results from the anti-image matrix correlation in second factor analysis show that 8 (eight) variables obtained MSA values above 0.5. So that all these variables meet the requirements for next analysis. Then the next stage is the principle component analysis method with communalities which is presented in below.

Communalities

	Initial	Extraction
BW	1.000	.748
H	1.000	.536
LL	1.000	.834
Anaro. End	1.000	.838
Sp	1.000	.817
Ag	1.000	.876
Leg Pow	1.000	.856
Flex	1.000	.902

Extraction Method: Principal Component Analysis.

The extraction value explains the percentage role or contribution of each factor dimension to all factors. It can be concluded that greater the value of communalities, better the relationship between variable one and the variables formed. From the table above, it is known that the variable that has the biggest role is flexibility with a value of 0.902 or 90.2% and the variable that has the smallest role is height with a value of 0.536 or 53.6%. A communalities value that is more than or equal to 0.5 means the variable can be analyzed further. All variables were declared to have passed this second factor analysis test.

Next is a test of the number of factors that can be explained by total variance explained (Supranto, 2004). The number of factors that have an eigen indicator value greater than 1(one) are the factors produced in this analysis. Followed by a component consistency test with rotated component matrices to see the contribution value provided by each variable with a shift or rotation of the variable components to show consistency. These results are as follows.

Total Variance Explained

	Initial Eigenvalues		
Component	**Total**	**% of Variance**	**Cumulative %**
1	4.049	50.616	50.616
2	2.358	29.471	80.087
3	.646	8.069	88.156
4	.362	4.523	92.679
5	.234	2.924	95.602
6	.165	2.067	97.669
7	.134	1.669	99.338
8	.053	.662	100.000

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component	
	1	**2**
BW	-.781	**.372**
H	.031	**.731**
LL	.021	**.913**
Anaro. End	**.710**	.578
Sp	**.746**	.511
Ag	**.935**	.039
Leg Pow	**.541**	-.751
Flex	**.908**	.278

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

From the results of the rotated component matrix analysis, it can be explained that the larger component value will be the component group. Body weight, height, and leg length have larger group in 2 group. Meanwhile, anaerobic endurance, speed, agility, leg power and flexibility are in component group 1. This shows the consistency that in this study there are 2 factors, that is anthropometric factors and physical condition.

VAR	MSA I	MSA II	CHANGE	*COM*	GROUP
BW	.563	.612	Up	.748	2
H	.785	.790	Up	.536	2
LL	.733	.715	Down	.834	2
ANAER END.	.892	.896	Up	.838	1
SP	.684	.643	Down	.817	1
AG	.677	.735	Up	.876	1
LEG POW	.777	.754	Down	.856	1
BAL	.250	-	Eliminated	.	
FLEX	.815	.758	Down	.902	1

3.2 Discuss

It can be explained that all variables are interconnected and influence each other. Starting from body weight which will have a big influence on speed, agility and kick frequency. The higher the athlete's weight, the lower his body's agility, even though the attack distance is relatively far, but the impact on movement speed is relatively small (Yao, Yanbing, 2022). Many factors can influence work movements, including the slope of the terrain, body size (height and weight), and gravity (Saibene, F., Minetti, A.E. 2003). Likewise, the duration of the long activity is supported by research by Ahmad Lamusu (2024), which correlates short duration with the speed of a sickle kick (10 seconds). The results showed that there was a significant correlation between the length of the air and the speed of the sickle kick. In terms of physical conditions, anaerobic endurance is the dominant energy system in pencak silat. Characteristic of speed, strong movements, and short duration movement, pencak silat in terms of technical endurance is included in the short and medium categories. When attacking with a fast sickle kick, strong and has high power, the energy required is also high. Athletes need the ability to produce lactate as energy that appears during fast and short movements when kicking in pencak silat. Speed in pencak silat is divided into 2 type, movement speed and reaction speed, both of which influence the effectiveness of kicks as attacks to get points. The higher the speed level of a pencak silat athlete, the ability to perform sickle kicks will increase their speed (Wilujeng, 2013). Meanwhile, agility is the ability to change direction of movement in the minimum possible time. It will be profitable and increase your chances of winning if you can gave as many attacks as possible. Agility describes an athlete's ability to move quickly in response to changes in the environment (Buchel D, et al 2022). In pencak silat, agility is needed because the type of competition is body contact, so it involves and requires attack speed from change of direction, that is the opponent himself with various counter attacks. The next physical condition is leg power. Power is the main element in all sports that require high-speed movement and technical skills (T. Bompa & Carrera, 2015). Power is used for explosive movements such as; throwing, kicking, pushing, jumping and hitting (Singgih Angga, 2017). The function of the power leg in performing the pencak silat sickle kick is to provide thrust and lift the leg towards the target. If a pencak silat athlete has good leg power, he will be able to gain momentum and speed when kicking. Next, regarding the components of physical condition, that is balance. In this study, balance was eliminated in the first factor analysis, this is assumed to occur because pencak silat requires 2 types of balance, unstable and static balance. Balance is needed by a silat fighter to carry out attacks and defenses which are carried out with the right body position and provide a solid foundation to avoid injury and is one of the components to improve the ability of basic pencak silat techniques (Pomatahu, 2011). This opinion shows the need for static balance in pencak silat. The opinion from Aryanto and Margono (2010) that when kicking, good balance is prioritized, not only does the body weight resting on one leg but is also caused by the shock of the reverse force at the time of impact as well as change of direction and position of the body in speed move situation. This opinion shows the need for unstable balance when kicking. So, for balance, it is still necessary to develop balance measurements for the sport of pencak silat. The last physical condition is flexibility. Flexibility has a big influence on kick speed. Flexibility in pencak silat functions for attack is defense and also injury prevention. Good

flexibility will maximize the muscle's range of motion, so, that the range of motion is wider. Flexibility also minimizes injury because the condition of the ligaments is ready to make movement more flexible.

Of all the variables, only balance did not pass the dominance and role test in pencak silat kick speed. Starting from body weight, it has a communalities value had 0.748 or 74.8%, body height has a communality value of 0.536 or 53.6%, leg length has a communality value of 0.834 or 83.4%, anaerobic endurance has a communality value of 0.838 or 83.8%, speed has a communality value 0.817 or 81.7%, the value of the communalities of agility is 0.876 or 87.6%, the value of the communalities of leg power is 0.856 or 85.6%, and the value of the communalities of flexibility is 0.902 or 90.2%.

In this research, there are some research limitatation, including limited sample size, differences in athletes' abilities due to differences in training units and coaches, samples in a transition period after the competition, and samples whose body weight exceeds the specified (over) weight. Based on these limitations, it is hoped that similar research can minimize these disturbances so that the research carried out becomes better and more specific.

Conclusion

Based on the results of the analysis and discussion that have been described, it can be concluded that the anthropometric factors of body weight, height and leg length, as well as the physical condition factors of anaerobic endurance, speed, agility, power and flexibility have a dominant influence on the pencak silat sickle kick speed. Meanwhile, balance does not have a dominant effect on the speed of pencak silat sickle kicks.

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