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The effect of arm muscle strength, waist flexibility, eye coordination and bat swing speed on power hitting pull shot female cricket athletes in DKI Jakarta

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Abstract
This study aims to determine the effect of arm muscle strength (X1), waist flexibility (X2), eye-hand-foot coordination (X3) and bat swing speed (X4) on the power hitting pull shot (Y) of female cricket athletes in DKI Jakarta. The research method is a survey using path analysis techniques, distributing a sample of 26 DKI Jakarta female cricket athletes. Hypothesis testing using path analysis techniques, the data obtained were analyzed by SPSS.25. This study resulted in a description of the data: a) the direct effect of X1 on Y or (r1y) = 0.330 (0.3302 x 100%); b) direct effect of X2 on Y or (r2y)= 0.306 (0.3062 x 100%); c) The direct effect of X3 on or (r3y)= 0.311% (0.3112 x 100%); d) direct effect of X4 on Y or (r4y)= 0.373 (0.3732 x 100%); e) direct effect of X1 on X4 (X1-X4) or (r14)= 0.716 (0.7162 x 100%); f) direct effect of X2 on X4 (X2-X4) or (r24) = 0.339 (0.3392 x 100%); g) direct effect of X3 on X4 (X3-X4) or (r34)= -0.094 (-0.0942 x 100%); h) indirect effect of X1 on Y through X4 (X1-X4-Y) or (r14y)= 0.716 x 0.373 = 0.267 (0.2672 x 100%); i) indirect effect of X2 on Y through X4 (X2-X4-Y) or (r24y)= 0.339 x 0.373 = 0.126 (0.1262 x 100%); j) the indirect effect of variable X3 on Y through X4 (X3-X4-Y) or (r34y) = 0.094 x 0.373 = 0.035 (0.035 x 100%). It was concluded that there was an influence of arm muscle strength, waist flexibility, eye-hand-foot coordination and bat swing speed, all of which affected the hitting pull shot power. There is an effect of arm muscle strength and waist flexibility on the swing speed of the bat. There is no effect of eye-hand-foot coordination on the swing speed of the bat. There is an indirect effect of arm muscle strength, waist flexibility and eye-hand-foot coordination on the power hitting pull shot through the speed of the bat swing. There is an indirect effect of waist flexibility and eye-hand-foot coordination on the power hitting pull shot through the swing speed of the bat.

Keywords: Arm muscle strength; waist flexibility; hand-foot coordination; bat swing speed; power hitting pull shot

Introduction

The popularity of the sport of cricket continues to increase, coupled with the introduction and development of test match and twenty/20 match numbers (Pote, King, & Christie, 2020) [10]. The basic techniques of cricket include batting (hitting), bowling (throwing) and fielding (keeping). Existing techniques are the main elements in a match and have their respective uses. The batting technique is one way to win a cricket match, because batting itself aims to score as many runs as possible. Batting in cricket has various basic techniques such as front foot drive, pull shot, hook shot, cut shot, sweep shot, back foot drive, and many other strokes. With so many variations of this stroke, it makes the cricket game more interesting.

Recognizing the ability to hit a batsman's boundries is a major contributor to the success of today's cricket matches, so it becomes one of the main focuses during training sessions (Peploe, McErlain-Naylor, Harland, & King, 2019). The pull shot is one of the opportunities to maximize the collection of scores that are many and also fast. The movement of the pull shot can be done if the ball produced by the thrower (bowler) is not good, such as short or too full. This can be used by the batsman to get a score of four or six without the need to run to swap places with a non-striker bat. Power hitting is defined as the explosive power generated when hitting with a complex motion, doing so requires coordination and observation, decision making to hit, speed and strength to hit a bowler throw with an unknown speed (Mirzazadeh, 2012) [6].

Hausal and Lubis (2018) [4] explain that power hitting is a skill that is difficult to do so that every cricket player is required to always develop the coordination skills between hands, eyes, feet and observations needed to produce a perfect shot.

Furthermore, power hitting on a pull shot is a shot with a movement that is usually done by a person naturally when hitting the ball with a cross or horizontal bat position. In doing a pull shot, a cricket athlete certainly needs power to hit the ball. If an athlete has good power hitting or what we call power hitting, of course this will be beneficial for the athlete himself and also the team. If an athlete hits the ball with good power then the result of hitting the ball can be out of the field, where the score can be four runs or six runs without the need to run.

Power hitting in pull shot cricket is an explosive power when batting maximally with a pull shot technique for the purpose of getting a number in the form of a shot out of the field. A good pull shot certainly requires good power hitting so that the results of the shot soar far. If you look closely at the success of the pull shot, there is a contribution from the strength of the arm muscles, the flexibility of the waist with the support of hand-eye coordination skills and the speed of the bat swing. According to Ismaryanti, stating that strength is a muscle contraction that is achieved in maximum effort. So the muscles will reach maximum strength when the muscles are repeatedly trained more than they are normally trained on the muscles (Lubis et al., 2021) [5]. It was further explained that arm muscle strength is a biomotor ability which is one aspect of the required ability, in cricket strength sports in power hitting so that the ball flies far and makes it difficult for opponents and gets points or scores (Wolter et al., 2020) [13].

Not only the strength of the arm muscles, the need for flexibility at the waist when batting takes advantage of the joint space of the shoulder, spine, pelvis, wrist, and foot. To maximize joint space as a component of flexibility that supports the success of cricket activities, it requires exercises that involve joint motion and stretching of the muscles involved in these activities on a regular basis (Hary & Firdiansyah, 2020) [2].

The speed of the bat is important to develop and improve because it will result in a higher ball velocity when impacted with the bat. This is one of the important components for a batsman to hit the ball hard consistently. The performance of a batsman is often measured by the speed or speed of the ball after impact with the bat. However, the maximum speed at which the implementation of the bat swing directly affects the speed of the ball from the stroke can therefore also be treated as a key performance parameter (Firdiansyah, 2017) [1].

Athletes who have good strength in the arm muscles will maximize the perfection of hitting the ball in a pull shot. The perfection of this shot is also assisted by the flexibility of the waist, the waist with high flexibility will increase the space for movement in the rotation of the body when doing pull shots. The two existing components will be carried out well if eye-hand-foot coordination is efficient, therefore this coordination is needed carefully. The speed at which the bat swings will add force to the ball when it hits the bat.

Method

This research was carried out with a quantitative approach using a survey method with path analysis techniques. Path analysis technique or often referred to as path analysis is the relationship of influence between independent variables, intervening variables and dependent variables where the researcher clearly defines that a variable will be the cause of other variables which are usually presented in the form of a diagram (Firdiansyah, 2020) (Noor, 2011) [7]. The research design needed in planning and implementing this research can be seen in the image below:

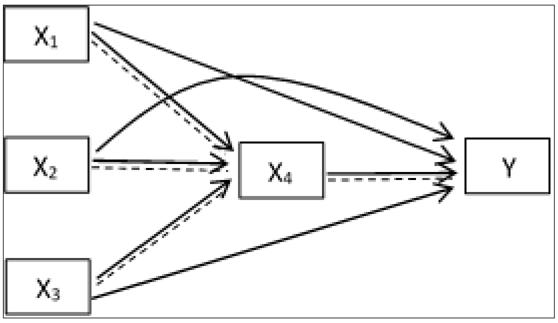

Fig 1: Research Design

Information

X1: Arm Muscle Strength
X2: Waist flexibility
X3: Eye Hand Foot Coordination
X4: Bat swing speed
Y: Power Hitting Pull shot

The research instrument uses existing measuring tools from several experts and development instruments made by the research team. In the research of power hitting pull shot using research development. The measurement test instrument used to measure arm muscle strength is the Smith Machine multifunction tool in the gym. For the eye-hand-foot coordination variable, the pass the ball instrument is used. For waist flexibility variables and power hitting pull shot using instruments developed by researchers who have carried out validity and reliability tests. The data that has been obtained will go through a data analysis process through data description, data normality test and homogeneity test of data variation, regression linearity test and significant regression test as well as path analysis which includes hypothesis testing (Subagio et al., 2019).

Results and Discussion

The values presented from raw data were processed using descriptive statistical methods with SPSS version 25 program. The following will present a recapitulation of the total score for each variable:

Table 1: Variable Data Description Arm Muscle Strength, Waist Flexibility, Eye Hand Foot Coordination, Bat Swing Speed, and Power Hitting Pull Shot

E	Variable				
	X_1	X_2	X_3	X4	Y
Number of samples (n)	26	26	26	26	26
Maximum Value	30	145	44	43	42
Minimum Value	15	110	27	27	25
Range	15	35	17	16	17
Average (X)	22,12	127,69	34,96	34,81	33,81
Standard Deviation (S)	4,28	9,51	3,93	4,20	4,05
Variance (S2)	18,35	90,46	15,48	17,60	16,40

The range of empirical values in the power hitting pull shot data is 17 with the lowest value of 25 and the highest value of 42. Furthermore, it is known that the mean value is 33.81 and the standard deviation is 4.05 and the variance is 16.40. The range of empirical values in the arm muscle strength data is 15 with the lowest value of 15 and the highest value of 30.

Furthermore, it is known that the mean value is 21.12 and the standard deviation is 4.28 and the variance is 18.35. The range of empirical values for waist flexibility is 35 with the lowest value being 110 and the highest value being 145. Furthermore, it is known that the mean value is 127.69 and the standard deviation is 9.51 and the variance is 90.46. The range of empirical eye-hand-foot coordination values is 17 with the lowest value of 27 and the highest value of 44. Furthermore, it is known that the average value or mean is 34.96 and the standard deviation is 3.93 and the variance is 15.48. Bat swing speed on the empirical value of 16 with the lowest value of 27 and the highest value of 43. Furthermore, it is known that the mean value is 34.81 and the standard deviation is 4.20 and the variance is 17.60.

Normality test

The data from the instrument test results were tested for normality using the Estimation Error normality test using the Liliofers technique using a nilai value of 0.05 in the SPSS version 25 application. From the results of the total sample, the L0 table value for the number of samples was 26 people, namely 0.173. By testing if L0 Count < L0 Table then the data is normally distributed and if L0 Count > L0 Table then the data is not normally distributed.

Table 2: Normality test

Estimated Error	L_0 Count	L_0 Table	Conclusion
X4 over X1	0,120	0,173	Normal
X4 over X2	0,119	0,173	Normal
X4 over X3	0,128	0,173	Normal
Y over X1	0,106	0,173	Normal
Y over X2	0,127	0,173	Normal
Y over X3	0,117	0,173	Normal
Y over X4	0,123	0,173	Normal
X4 over X1, X2, X3	0,100	0,173	Normal
Y over X1, X2, X3, X4	0,108	0,173	Normal

Homogeneity Test

The homogeneity of variance test is intended to test the homogeneity of variance between groups of Y data grouped based on the similarity of the X value. By testing if L0 Count > 0.05 then it can be concluded that the data is homogeneous and if L0 Count < 0.05 then it can be concluded that it is not homogeneous.

Table 3: Homogenity test table

Variable	L_0 Count	Sig (0,05)	Conclusion
X1 to X4	0,762	0,05	homogeneous
X2 to X4	0,997	0,05	homogeneous
X3 to X4	0,835	0,05	homogeneous
X1 to Y	0,469	0,05	homogeneous
X2 to Y	0,667	0,05	homogeneous
X3 to Y	0,827	0,05	homogeneous
X4 to Y	0,670	0,05	homogeneous

Regression Linearity Test And Regression Significance Test

Regression test was conducted to test the relationship between variables, with the fulfillment of the conditions that these variables must have a linear relationship and the significance of the regression. The linearity requirement is if Fcount<Ftable. Which then brings up the results of the regression linearity test and regression significance:

a. X1 Test Against Y

The calculated F value in the regression linearity test is 2.457 and the F table value is 3.44. So the value of Fcount < Ftable. It was concluded that the regression linearity test of X1 against Y was linearly distributed. While the regression significance test obtained the Fcount value of 11.329 where the Ftable value of 4.26. So that the value of Fcount > Ftable, it is concluded that the regression significance test of X1 against Y has a significant distribution.

b. X2 test against Y

The Fcount value is 1.096 and the Ftable value is 2.66 (Fcount <Ftable), it is concluded that the regression linearity test of X1 against Y is linearly distributed. The regression significance test for the calculated F value is 16.849 and Ftable 4.26 (F count > F table), it is concluded that the regression significance test of X1 against Y is quite significant.

c. Test X3 against Y

The calculated F value is 1.481 and F table 2.58 (Fcount < Ftable), it is concluded that the linearity test of X1 against Y is linearly distributed. Regression significance test F count 14,760 F table 4.26. (F count > F table), it can be concluded that the regression significance test of X1 against Y has a significant distribution.

d. Test X4 against Y

The calculated F value is 1.098 and the F table value is 2.63, it is concluded that the regression linearity test of X1 against Y is linearly distributed. The regression significance test of the calculated F value is 20,963, the value of Ftable is 4.26, it is concluded that the regression significance test of X1 to Y has a significant distribution.

e. Test X1 against X4

The calculated F value is 0.821 and the Ftable value is 3.44, it is concluded that the regression linearity test of X1 against Y is linearly distributed. The significance test of the regression F count is 34,783 and the F table is 4.26, it is concluded that the regression significance test of X1 to Y has a significant distribution.

f. Test X2 against X4

The calculated F value is 0.737 and the F table value is 2.66, it is concluded that the regression linearity test of X1 against Y is linearly distributed. The significance test of the calculated F regression is 8.423 and the F table value is 4.26, it is concluded that the X1 regression significance test against Y has a significant distribution.

g. Test X3 against X4

The calculated F value is 1.056 and the F table value is 2.58, the regression linearity test of X1 against Y is linearly distributed. Regression significance test F count 5.033, F table 4.26, it was concluded that the regression significance test of X1 to Y had a significant distribution.

Hypothesis test

Conclusions on the proposed hypothesis will be drawn through the path coefficients and significance for each path studied. The structural equation model of this research consists of 2 sub structures.

a. Sub Structure I

In sub structure 1, the combined and partial effect of arm muscle strength, waist flexibility and eye-hand-foot coordination on bat swing speed can be seen through the results of the calculations in the following summary model.

Table 4: Model-1 Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.827[a]	.684	.641	2.512
a. Predictors: (Constant), Eye Hand Leg Coordination, Waist Flexibility, Arm Muscle Strength				

R square (r2) is 0.684, meaning that the effect of arm muscle strength, waist flexibility and eye-hand-foot coordination on the speed of the bat swing is 0.684 or 68.4%, the remaining 31.6% is influenced by other factors outside the model. To find out whether the regression model above is correct or not, it is necessary to test the hypothesis. Test this hypothesis using the number F as shown in the table below:

Table 5: Model 1 Anova

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	301.164	3	100.388	15.903	.000[b]
	Residual	138.874	22	6.312		
	Total	440.038	25			
a. Dependent Variable: Bat Swing Speed						
b. Predictors: (Constant), Eye Hand Leg Coordination, Waist Flexibility, Arm Muscle Strength						

Based on the table, the F value is 15.903 with a significance of 0.000. Because the significance value is less than 0.05, the research hypothesis of arm muscle strength, waist flexibility and eye-hand-foot coordination on the swing speed of the bat can be accepted. The next stage is to see the influence of the variable arm muscle strength, waist flexibility and hand-eye coordination on the swing speed of the bat partially. The test used is the T test, then to see the magnitude of the effect, the Beta number is used as in the table above.

The effect of arm muscle strength on bat swing speed (0.716). The results of the test with the T test obtained a T value of 5.141 with a significance of 0.000, it was concluded that there was an effect of arm muscle strength on the speed of the bat swing. The effect of waist flexibility on the swing speed of the bat (0.339). The results of the test with the T test obtained a T value of 2.526 with a significance of 0.019, it was concluded that there was an effect of waist flexibility on the swing speed of the bat. The magnitude of the influence of waist flexibility on the swing speed of the bat. The effect of eye-hand-foot coordination on the swing speed of the bat (-0.94). The results of the test with the T test obtained a T value of -0.631 with a significance of 0.534, it was concluded that there was no linear effect of eye-hand-foot coordination on the swing speed of the bat.

b. Sub Structure II

In sub-structure 2 shows the combined and partial effect of arm muscle strength, waist flexibility, hand-foot coordination and bat swing speed on the power hitting pull shot as seen through the calculation results in the following summary model.

Table 6: Model-2 Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	.813[a]	.661	.596	2.573
a. Predictors: (Constant), Eye Hand Leg Coordination, Waist Flexibility, Arm Muscle Strength				

The number R square (r2) is 0.661. This figure can be used to determine the effect of arm muscle strength, waist flexibility, eye hand foot coordination and bat swing speed on power hitting pull shot which is 0.661 or 66.1% while the remaining 33.9% is influenced by other factors. To find out whether the regression model above is correct or not, it is necessary to test the hypothesis. Test this hypothesis using the number F as shown in the table below:

Table 7: Model 2 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	270.988	4	67.747	10.231	.000[b]
	Residual	139.050	21	6.621		
	Total	410.038	25			
a. Dependent Variable: Power Hitting Pull Shot						
b. Predictors: (Constant), Eye Hand Leg Coordination, Waist Flexibility, Arm Muscle Strength						

The table shows the F value of 10.231 with a significance of 0.000. Since the significance value is less than 0.05, the research hypothesis of arm muscle strength, waist flexibility, hand-eye coordination and bat swing speed on power hitting pull shot can be accepted.

The effect of arm muscle strength on the power hitting pull shot (0.330). The results of the test with the T test obtained a T value of 2.149 with a significance of 0.043, it was concluded that there was an effect of arm muscle strength on the hitting pull shot power. The effect of waist flexibility on power hitting pull shot (0.306). The test results with the T test obtained a T value of 2.891 with a significance of 0.022. it can be concluded that there is an effect of waist flexibility on the power hitting pull shot. The effect of eye-hand-foot coordination on power hitting pull shot (0.311). The results of the test with the T test obtained a T value of 1.958 with a significance of 0.034, it was concluded that there was an effect of waist flexibility on the power hitting pull shot. Effect of bat swing speed on power hitting pull shot (0.373). The results of the test with the T test obtained a T value of 1.647 with a significance of 0.014, it was concluded that there was an effect of waist flexibility on the power hitting pull shot.

The calculation of the path analysis of the direct effect of the X1 variable on Y (X1-Y) or (r1y) = 0.330. So the effect (X1) directly affects Y by 10.89% (0.3302 x 100%), this rank count applies to the provisions on other variables. The direct effect of X2 on Y (X2-Y) or (r2y) = 0.306, so the effect of (X2) directly affects Y by 9.4%. The direct effect of X3 on Y (X3-Y) or (r3y) = 0.311, so the effect (X3) directly affects Y is 9.7%. The direct effect of X4 on Y (X4-Y) or (r4y) = 0.373, so the effect of (X4) directly affects Y by 14%. The direct effect of X1 on X4 (X1-X4) or (r14) = 0.716, so the effect (X1) directly affects (X4) is 51.3%. The effect of the variable X2 on X4 (X2-X4) or (r24) = 0.339. So the influence (X2) directly affects (X4) by 11.5%. The direct effect of X3 on X4 (X3-X4) or (r34) = -0.094, so the effect of (X3) does not directly affect (X4) of 0.9%. The indirect effect of X1 on Y through X4 (X1-X4-Y) (r14y) = 0.716 x 0.373 = 0.267, so the effect (X1) indirectly affects (Y) through (X4) of 26.7%. The indirect effect of X2 on Y through X4 (X2-X4-Y) (r24y) = 0.339 x 0.373 = 0.126, so the effect (X2) indirectly affects (Y) through the swing speed of bt (X4) of 12.6%. The indirect effect of X3 on Y through X4 (X3-X4-Y) (r34y) = 0.094 x 0.373 = 0.035, so the effect (X3) indirectly affects (Y) through (X4) of 0.035 or 3.5%.

There is a direct effect of arm muscle strength on the power hitting pull shot. Arm muscle strength is required when doing a power hitting pull shot. Data analysis shows the effect of arm muscle strength on power hitting pull shot of 0.330 and significant at 0.043 <0.05. Based on the results of the data analysis, it can be interpreted that athletes who have good arm muscle strength can produce further power hitting pull shots so that they get the maximum score or points. Data analysis shows that the effect of waist flexibility on hitting pull shot power is 0.303 and is significant at 0.022<0.05. Based on the results of the data analysis, it can be interpreted that athletes who have good waist flexibility can produce more power hitting pull shots so that they get the maximum score or points.

There is a direct effect of eye-hand-foot coordination on the power hitting pull shot. Data analysis shows the effect of eye-hand-foot coordination on power hitting pull shot of 0.311 and significant at 0.034 <0.05. Based on the results of the data analysis, it can be interpreted that athletes who have good eye-hand-foot coordination can produce more power hitting pull shots so that they get the maximum score or points. Coordination makes the difference between good performance and poor performance (Syaifullah Irwan & Lismadiana, 2019). This means that in doing power hitting pull shots, good coordination is needed from the eyes and then channeled to the brain to be processed into one precise and harmonious movement.

There is a direct effect of bat swing speed on hitting pull shot power. The swing speed of the bat is defined as the speed of the bat when the ball hits the surface of the bat. Data analysis shows the effect of bat swing speed on power hitting Pull shot of 0.373 and significant at 0.014 <0.05. Based on the results of the data analysis, it can be interpreted that athletes who have a good bat swing speed can produce further power hitting pull shots so that they get the maximum score or points. The bat movement created by the batsman is referred to as bat swing (Poerwanto & Firdiansyah, 2019).

There is a direct influence of arm muscle strength on the swing speed of the bat. Data analysis showed that the effect of arm muscle strength on the swing speed of the bat was 0.716 and significant at 0.000<0.05. Based on the results of the data analysis, it can be interpreted that athletes who have good arm muscle strength can produce good bat swing speeds. There is a direct influence of waist flexibility on the swing speed of the bat. Data analysis showed that the effect of waist flexibility on the swing speed of the bat was 0.339 and significant at 0.019<0.05. Based on the results of the data analysis, it can be interpreted that athletes who have good arm muscle strength can produce a good bat swing speed so that the faster a batsman can swing the bat,

There is no direct effect of eye-hand-foot coordination on the swing speed of the bat. Data analysis showed that the effect of eye-hand-foot coordination on the swing speed of the bat was -0.094 and significant at 0.534>0.05 so that eye-hand-foot coordination had no effect on the swing speed of the bat. against power hitting pull shot. Data analysis shows the indirect effect of arm muscle strength on power hitting Pull shot of 0.267. Based on the results of the data analysis, it can be interpreted that athletes who have good arm muscle strength can produce a good bat swing speed so that the power hitting pull shot results will be maximized and produce a high score.

There is an indirect effect of waist flexibility through the speed of the bat swing on the power hitting pull shot. Data analysis shows the indirect effect of waist flexibility on power hitting Pull shot of 0.126. Based on the results of the data analysis, it can be interpreted that athletes who have good waist flexibility can produce good bat swing speeds so that the power hitting pull shot results will be maximized. The swing speed of the bat is defined as the speed of the bat when the ball hits the surface of the bat. The faster a batsman can swing the bat, the more time he has to make decisions when batting. Data analysis shows the indirect effect of eye-hand-foot coordination on power hitting Pull shot of 0.035.

Conclusion

The conclusion in this study is that there is an effect of arm muscle strength, waist flexibility, eye hand foot coordination and bat swing speed, all of which affect the hitting pull shot power. In addition, there is an effect of arm muscle strength and waist flexibility on the swing speed of the bat. There is no effect of eye-hand-foot coordination on the swing speed of the bat. There is an indirect effect of arm muscle strength, waist flexibility and eye-hand-foot coordination on hitting pull shot power through bat swing speed. There is an indirect effect of waist flexibility and eye-hand-foot coordination on the power hitting pull shot through the speed of the bat swing.

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