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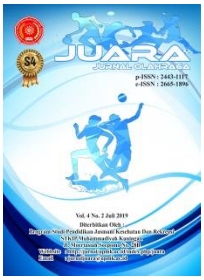

ARM MUSCLE POWER AND TORSO FLEXIBILITY: KEY DETERMINANTS OF ROLL-KIP PROFICIENCY IN FLOOR EXERCISE

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Abstract

This study aims to share the contribution of arm muscle strength and trunk flexibility to roll-kip performance in floor gymnastics in students of the Sports Coaching Education Study Program, Cenderawasih University. The background of the study was based on significant variations in roll-kip performance among students, allegedly due to reduced arm muscle strength and trunk flexibility. The research method used a quantitative correlational approach with a sample of 40 students selected purposively. Data were collected through push-up tests (arm muscle strength), trunk lift extension tests (torso flexibility), and roll-kip performance assessments by instructors. Data analysis used SPSS for correlation and multiple regression tests. The results showed a positive and significant relationship between arm muscle strength (r = 0.800; p < 0.05) and trunk flexibility (r = 0.796; p < 0.05) with roll-kip performance. The combined contribution of both variables was 73%, with trunk flexibility having a more dominant influence (1.663) than arm muscle strength (0.401). The conclusion of the study emphasizes the importance of training both aspects in a balanced manner in a floor gymnastics training program to improve performance in performing transition movements such as roll-kip.

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INTRODUCTION

Floor exercise, as one of the fundamental disciplines in gymnastics and athlet performance, demands an optimal integration of strength, flexibility, coordination, and courage (Hao, 2024). For students in the Sports Coaching Education Program at Cenderawasih University, floor exercise is not only a core curricular component but also a critical foundation for developing motor competence and kinesthetic awareness. The roll-kip a dynamic transitional movement from a supine to a standing position serves as a pivotal skill in floor routines. Beyond enhancing movement fluidity, proficiency in the roll-kip is a prerequisite for mastering more advanced techniques (Fraya et al., 2019). However, observational data reveal significant variability in roll-kip performance among students, with many struggling to execute the movement effectively and efficiently. This underscores the urgent need to investigate the biomechanical and physiological determinants of roll-kip proficiency to optimize training interventions.

The primary underlying issue contributing to the suboptimal roll-kip performance among students in the Sports Coaching Education Program at Cenderawasih University is hypothesized to stem from insufficient arm muscle strength and trunk flexibility - critical components for generating propulsion and ensuring movement fluency during the roll-kip. As Pichardo et al (2019) emphasize, strength serves as the foundation of all physical capacities and forms the basis for motor skill development. This assertion confirms that muscular strength, particularly in the arms, constitutes an essential prerequisite for proper roll-kip execution. Furthermore, Koźlenia & Domaradzki (2021) highlight that flexibility - the range of motion around a joint - enables efficient movement execution while preventing injuries. Inadequate trunk flexibility may impede students' ability to perform the necessary body flexion during the roll-kip, consequently compromising movement efficacy and increasing injury risk.

Previous studies have demonstrated significant relationships between arm muscle strength, flexibility, and floor exercise performance. Suhendra et al (2024) identified a significant correlation between arm muscle strength, trunk flexibility, leg muscle strength, and forward roll performance. Furthermore, Rizky et al (2023) found that arm strength and hip flexibility collectively contribute 72.25% to handspring skill proficiency. However, despite these findings, limited research has specifically examined the role of physical conditioning factors in roll-kip performance.

This research gap provides theoretical justification for conducting a study titled "Arm Muscle Power and Torso Flexibility: Key Determinants of Roll-Kip Proficiency in Floor Exercise." The current study aims to: quantitatively analyze the relative contributions of arm muscle strength and torso flexibility to roll-kip performance, and provide evidence-based training recommendations to improve students' technical execution of this basic gymnastics movement.

This study is expected to yield significant contributions for gymnastics students, coaches, and sports curriculum development. By elucidating the critical roles of arm muscle strength and trunk flexibility, coaches and instructors can design more effective training programs to enhance roll-kip performance. Furthermore, the findings will provide an empirical foundation for developing comprehensive floor exercise training modules that better address the biomechanical demands of this discipline. The study employs a quantitative correlational design to analyze the relationships between arm muscle strength, trunk flexibility, and roll-kip performance metrics. Collectively, these contributions will advance both sports science knowledge and the quality of physical education instruction.

METHODS

This study employs a quantitative approach with a correlational research design to examine the relationship between arm muscle strength, trunk flexibility, and roll-kip performance (Gazali et al., 2022). The sample comprises 40 students from the Sports Coaching Education Program at Cenderawasih University, selected through purposive sampling. Participants were chosen based on the following criteria: (1) current enrollment in the Fundamental Gymnastics Skills course, and (2) attendance records exceeding 50%, ensuring active engagement in the learning process.

Data collection employed three principal measurement instruments. First, arm muscle strength was assessed through a 60-second push-up test, counting only repetitions meeting standardized technical criteria (Pasaribu, 2020). Second, trunk flexibility was evaluated using the trunk lift extension test, measuring the maximal vertical distance achieved during upper-body elevation from a prone position (Fenanlampir & Faruq, 2015). Third, roll-kip performance was rated by certified instructors based on movement fluency and transition success criteria (Fraya et al., 2019). The collected data were analyzed using SPSS software (version 27) for normality tests, Pearson correlation analysis, and multiple regression to determine each variable's relative contribution.

FINDINGS AND DISCUSSION

Findings

Table 1 presents the preliminary descriptive statistics for all observed variables in the study

Table 1. Descriptive Statistics of Study Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Otot Lengan	40	8	35	23.80	7.657
Fleksibilitas	40	3.3	9.5	6.906	1.7855
Roll Kip	40	22	50	35.82	6.598
Valid N (listwise)	40				

Based on the table, the results of the arm muscle strength of a total of 40 research samples reached a minimum value of 8, a maximum of 35, a mean of 23.80 and a SD of 7.657. The mobility ability reached a minimum value of 3.3, a maximum of 9.5, a mean of 6.906 and a SD of 1.7855. For the ability to perform twisting movements with a statue, a minimum value of 22, a maximum of 50, a mean of 35.82 and a SD of 6.598 was achieved. In addition, a normality test was performed to ensure that the distribution of the three variables conformed to the parametric assumptions. The results of the normality test can be seen in table 2 below:

Table 2. Results of Normality Tests for Study Variables

	Shapiro-Wilk		
	Statistic	df	Sig.
Otot Lengan	.952	40	.092
Fleksibilitas	.951	40	.083
Roll-Kip	.980	40	.671

According to the table above, the output results of the normality test for the variables of arm muscle strength, togok mobility and Roll-Kip are normally distributed because the sig value is > 0.05. The analysis used is therefore a parametric test analysis.

Subsequently, correlation analysis was conducted to examine relationships between variables, with results presented in table 3.

Table 3. Correlation Matrix of Study Variables

		Otot Lengan	Fleksibilitas	Roll Kip
Otot Lengan	Pearson Correlation	1	.743**	.800**
	Sig. (2-tailed)		.000	.000
	N	40	40	40
Fleksibilitas	Pearson Correlation	.743**	1	.796**
	Sig. (2-tailed)	.000		.000
	N	40	40	40
Roll Kip	Pearson Correlation	.800**	.796**	1
	Sig. (2-tailed)	.000	.000	
	N	40	40	40

Based on the results of the correlation analysis of arm muscle strength with the Roll-Kip, a correlation coefficient of $r = 0.800$; $p = 0.000$ ($p < 0.050$) was obtained, which means that there is a positive and significant correlation between arm muscle strength and the Roll-Kip, meaning that the higher the arm muscle strength of an individual, the better their performance of the Roll-Kip and vice versa.

From the results of the correlation between Togok Flexibility (flexibility) and Roll-Kip, the correlation coefficient is obtained $r = 0.796$; $p = 0.000$ ($p < 0.050$), so it can be said that there is a positive and significant correlation between Togok Flexibility and Roll-Kip, meaning that the better the individual's Togok Flexibility skill, the better the Roll-Kip performance of the individual.

Subsequent analysis employed multiple linear regression with partial t-tests, the results of which are presented in table 4.

Table 4. Multiple Linear Regression Analysis with Partial Regression Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
Model		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	14.794	2.257		6.554	.000			
	Otot Lengan	.401	.110	.465	3.651	.001	.800	.515	.312
	Fleksibilitas	1.663	.471	.450	3.529	.001	.796	.502	.301

The results of the regression analysis show that the constant value in the model is 14.794. This indicates that if the variables Arm Muscle Strength (X_1) and Trunk Flexibility (X_2) are considered zero (0), then the Roll Kip value will remain at 14.794. In addition, it was found that every 1% increase in Arm Muscle Strength will increase the Roll-Kip ability by 0.401, which is indicated by the regression coefficient of the X_1 variable. Meanwhile, the contribution of Trunk Flexibility (X_2) is greater, namely every 1% increase in this variable will increase the Roll-Kip ability by 1.663.

Thus, the results of the statistical test show that Arm Muscle Strength has a tcount value = 3.651 > ttable = 1.984 with a significant level of 0.001 < 0.05, then H0 is rejected and H1 is accepted. So that Arm Muscle Strength has an effect on Roll Kip. While flexibility has a calculated value of 3.529 > ttable = 1.984 with a significance level of 0.001 < 0.05, then H0 is rejected and H2 is accepted. So Togok's flexibility has an influence on Roll Kip.

Simultaneous effects of all predictors were assessed through F-test analysis of variance, the outcomes of which are shown in table 5.

Table 5. F-test Results for Overall Model Significance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1239.926	2	619.963	50.101	.000[b]
	Residual	457.849	37	12.374		
	Total	1697.775	39			

Based on the results above, it shows the Fcount value of 50.101 > 3.09 Ftable and significant for Arm Muscle Strength and Trunk Flexibility, is 0.000 or less than 0.05. So the regression model of Arm Muscle Strength and Trunk Flexibility, simultaneously contributes to the Roll Kip ability.

Subsequently, coefficient of determination (R^2) analysis was conducted to quantify the proportion of variance in the dependent variable (roll-kip performance) explained by the independent variables (arm muscle strength and trunk flexibility). The analysis revealed that:

Table 6. Coefficient of Determination Analysis Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	.855[a]	.730	.716	3.518	.730	50.101	2	37	.000

The coefficient of determination ($R^2 = 0.730$) indicates that 73.0% of the variance in roll-kip performance can be explained by the combined effects of arm muscle strength and trunk flexibility. The remaining 27.0% of variance is attributable to other factors not included in the current regression model.

Discussion

The results of this study show that arm muscle strength and trunk flexibility are significantly associated with roll-kips performance in floor gymnastics students, with a combined contribution of 73%. This finding supports Aliriad (2021) claim that arm muscle strength is the fundamental basis for dynamic movements such as roll-kip, as it provides the necessary propulsion when transitioning from a prone to a standing position. Furthermore, Fousekis et al (2021) explained that trunk flexibility plays an important role in maximizing the range of motion, allowing the body to bend effectively during the movement.

Other studies have shown that flexibility contributes significantly to the ability to roll forward in floor gymnastics, which is 48.5%. This indicates that the better an athlete's flexibility, the easier and more effective it is for him to do a roll-kip (Sulaeman et al., 2021). Hip joint flexibility in particular has also been identified as an important indicator in front and back roll performance (Omran & Abdulkareem, 2021), as well as Ade 's (2023) which also shows a significant relationship between arm muscle strength and trunk flexibility with front roll skills in high school students, where arm muscle strength contributes 38.88% and trunk flexibility 11.25% to front roll movement performance. This is in line with the results of a regression analysis study which shows that every 1% increase in trunk flexibility can increase roll-kip ability by 1.663, greater than the contribution of arm muscle strength of 0.401.

The conformity of the findings obtained with previous studies shows a clear pattern regarding the role of physical condition in floor gymnastics. Such as research by Suhendra et al (2024) found a significant relationship between arm muscle strength and body flexibility with the ability to roll forward. Ibrahim's research (2023) showed a very significant relationship between body flexibility and arm muscle strength with the ability to roll forward in high school students, with a significance value reaching 0.931. Likewise, research by Rizky et al (2023) reported that the combination of arm strength and hip strength contributed greatly to handspring skills.

However, this study reveals a new nuance where the flexibility of the trunk turns out to have a more dominant influence compared to the findings of Fraya et al (2019) which emphasizes upper-body strength. This difference may be due to the characteristics of the roll-kip movement which requires optimal spinal flexibility to create smooth momentum during the transition. This is supported by the statement of Pallett (2014), which states that the transition movement from a supine to a standing position is highly dependent on the ability of spinal flexion to generate sufficient momentum.

The practical implications of these findings are very relevant to the world of coaching and sports education. Coaches can design more targeted training programs by balancing strength training, such as progressive push-ups, and flexibility training through dynamic stretching specifically for the trunk. This approach is in line with the recommendations of Batista et al (2019) regarding the importance of training both physical aspects in an integrated manner. In addition, research by Suhendra et al (2024) added that the development of leg muscle strength also plays a significant role in supporting the forward roll movement, so a comprehensive training program should include whole-body strength training.

At the curriculum level, the results of this study can be the basis for developing an evaluation module that includes periodic assessments of arm strength and trunk flexibility as indicators of athlete readiness before learning more complex movements. This approach is in line with the statement of Neupert et al (2022) who emphasized the importance of specific diagnostic tests before athletes learn the movement in its entirety.

Despite making important contributions, this study has several limitations that need to be acknowledged. The limited sample size of students from one university makes generalization of the findings need to be done with caution. In addition, there was 27% of the variance in roll-kip performance that could not be explained by this research model, indicating the possibility of other factors such as coordination, balance, or psychological factors playing a role. For further research, it is recommended to conduct longitudinal studies involving a more diverse sample and integrating biomechanical analysis tools, such as motion capture, to gain a deeper understanding of the roll-kip movement mechanism. This recommendation is in line with Mukhamedovich (2024) view on the importance of a multidisciplinary approach in gymnastics research.

Thus, based on the research results obtained, it not only confirms the importance of arm muscle strength and trunk flexibility in roll-kip performance, but also provides a new perspective on the dominance of trunk flexibility that has not been widely revealed in previous studies. These findings enrich the sports literature while offering an evidence-based framework for the development of more effective training programs.

CONCLUSION

This study proves that arm muscle strength and trunk flexibility have a significant effect on roll-kip performance, with a combined contribution of 73%. Trunk flexibility has a greater impact (1.663) than arm strength (0.401) in improving roll-kip movement performance.

These findings emphasize the importance of training both aspects in a balanced manner in a floor gymnastics program. Coaches and educators are advised to design balanced exercises, such as progressive push-ups for arm strength and dynamic stretching for trunk flexibility, to improve the effectiveness of transition movements in floor gymnastics such as roll-kip. In addition, the results of this study can be the basis for developing more comprehensive evaluation modules and curricula in sports education.

However, there are still 27% of other factors such as coordination, balance, and biomechanical aspects that need to be further explored through research with more comprehensive methods, including the use of motion capture technology for deeper movement analysis. Thus, these findings not only enrich the sports literature but also provide an evidence-based framework for improving the quality of floor gymnastics training and education.

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